National Innovations in Climate Resilient Agriculture (NICRA)

AICRP on Agrometeorology Component

Annual Report
2019-20

All India Coordinated Research Project on Agrometeorology

National Innovations in Climate Resilient Agriculture

ICAR-Central Research Institute for Dryland Agriculture
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1. Introduction

India's agricultural sector is central to the Indian economy and it accounts for 50% of the country's employment and 18% of its GDP. However, it is facing a significant threat from climate change as extreme weather events are on the rise. According to the Indian government's latest annual economic survey, the climate change related issues could hurt farmers' income by up to 20-25% in the medium term. Indian farmers, who are mostly small and marginal are a vulnerable population where social, market and economic pressures are huge, often leading to considerable distress. So the effects of fluctuations in weather, temperature and rainfall on agricultural productivity will have a significant impact on the wider population. Overall, extreme weather events, temperature rise and lower rainfall threaten to pose problem to the Indian government's agenda of doubling farmers' income across the country.

A study conducted by 29 researchers around the world, published in the *Proceedings of the National Academy of Sciences*, found that "each degree-Celsius increase in global mean temperature would, on an average, reduce global yields of wheat by 6.0%, rice by 3.2%, maize by 7.4%, and soybean by 3.1%." Another study stated that, climate change could reduce farm incomes of the country by 15-18%, and in un-irrigated areas by 20-25% (Economic Survey 2017-18). 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.

Climate change models, such as the ones developed by the Intergovernmental Panel on Climate Change (IPCC), predict 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 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 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 from 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 making adjustments through 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 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 users interface. AICRPAM- NICRA 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. Dry-spell duration and its impact on *kharif* season crop productivity

The duration of dry spells within the season significantly influenced the crop productivity. A new index named Cumulative Dry Spell (CDS) was derived to estimate the cumulative impact of dry spells during *kharif* season (Jun-Sep) in different states of India. In this study, period of 7-days continuously with rainfall lesser than 2.5 mm is considered as one dry-spell. Weightage for each dry-spell is assigned in accordance with the number of dry days in that dry spell, i.e., the weightage of a dry spell was assigned as the number of dry days divided by 7. For example, the value of a dry spell with 7-dry days will be 1, 10-dry days will be 1.43, 14-dry days will be 2 and 21-dry days will be 3 etc. Later, the values of weightage of the individual dry-spells from the date of commencement of south-west monsoon to the end of the monsoon season i.e., 30th September were added and the resultant value was considered as the cumulative dry spell (CDS) during the season. District-wise spatial variability of CDS were analyzed across the states of Rajasthan, Gujarat, Maharashtra, Karnataka, Telangana and Andhra Pradesh using observed rainfall data. The observed daily rainfall data recorded from 1636 stations spread across **(Fig 2.1)** the states of the study area during the period 1991-2016 were collected by coordinating centres of AICRPAM. Area weighted daily rainfall for each district was computed using Thiessen polygon method in GIS software.

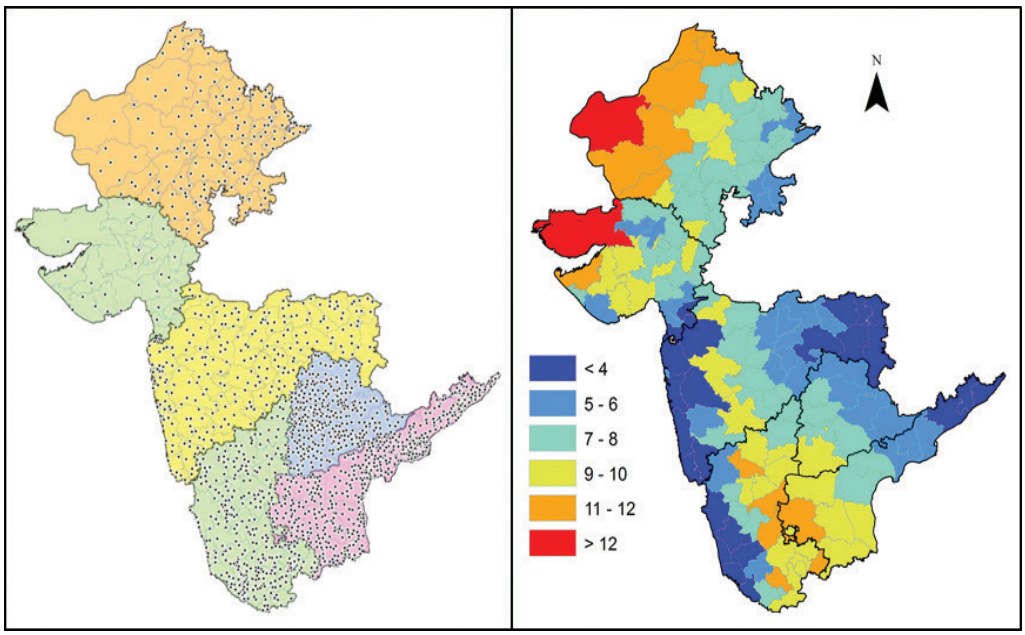


Fig 2.1: (a) Spatial distribution of rainfall stations and (b) number of average CDS during kharif season over different districts

The district-wise spatial variation of CDS during 1991-2016 indicates that, the highest values were observed (> 12) in 2 districts (one each in Rajasthan and Gujarat) comprising 6% of the study area, whereas the lowest values (< 4) were noticed in 25 districts distributed in western Maharashtra and Karnataka and eastern parts of Maharashtra and Andhra Pradesh, altogether comprising 15% of the study area **(Fig 2.1)**. It varied between 9 to 12 in 44 districts spread across Western Rajasthan, Gujarat, Northeastern and South-eastern Karnataka, Central Maharashtra and South-western Andhra Pradesh comprising 34% of the study area. The CDS values 5 to 9 were observed in 76 districts (covering 45% of the study area) distributed over eastern Rajasthan, Gujarat, Telangana, Central Maharashtra, Andhra Pradesh and Central Karnataka. The impact of CDS on the productivity of the crops viz., maize, cotton, groundnut, and pigeon pea, across the crop growing districts in the study were analyzed. The study area accounts for 57% of maize, 87% of cotton, 86% of groundnut and 73% of pigeon pea growing regions during *kharif* season in India **(Fig 2.2)**. When district level de-trended yield data is correlated with CDS for the period 1997-2016, 87% of groundnut (43 districts), 73% of maize (60 districts), 66% of both pigeon pea (59 districts) and cotton (64 districts) growing regions of the study area showed significant (≥ 95% confidence level) negative correlation.

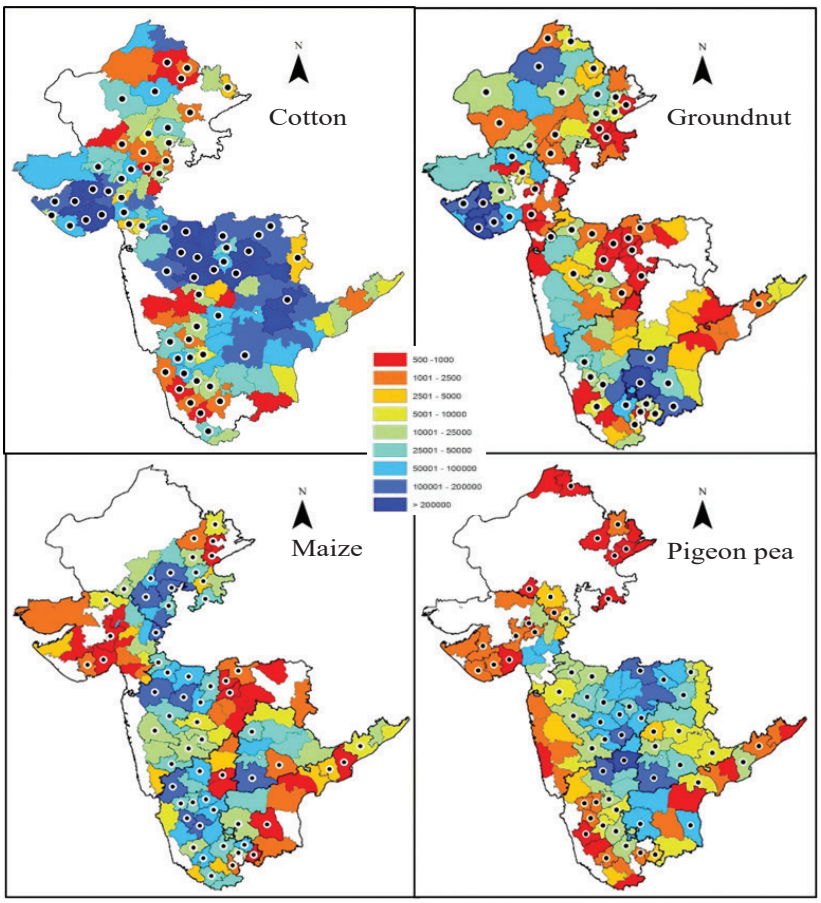


Fig 2.2: Distribution of Crop growing area (ha) across the districts in the study area. The districts marked as dots showing significant negative correlation between CDS and crop yield.

2.2. Occurrence of extreme weather events at 121 NICRA KVKs

2.2.1. Meteorological Drought in *Kharif* during 2011-2019

The occurrence of mild (-20% to -25%), moderate (-26% to -50%) and severe (<-50%) droughts in *kharif* season (June-Sep) across the 121 TDC NICRA KVKs during 2011-2019 are presented in **Fig 2.3**. It was observed that the frequency of severe drought was highest at Kushi Nagar, Uttar Pradesh (6 times) followed by Chamba, Himachal Pradesh (5 times), Ribhoi, Meghalaya and West Siang (4 times each) during this period. The severe drought occurred for 1 to 3 times at 23 KVKs during 2011-2019. The moderate drought in *kharif* occurred 5 and 4 times at 7 KVKs each, while it happened 1 to 3 times at 86 KVKs during this period. The mild drought was observed 1-2 times at 53 KVKs during 2011-2019.

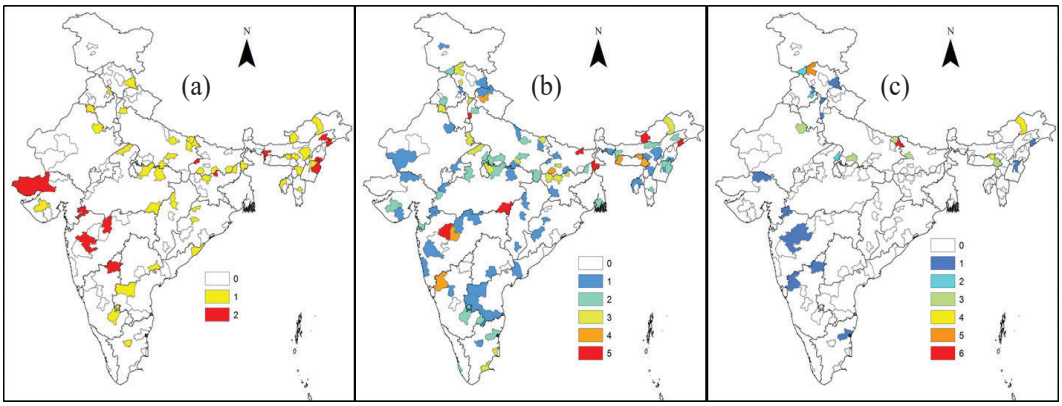


Fig 2.3: Occurrence of (a) mild, (b) moderate and (c) severe droughts in kharif crop season at NICRA- KVKs during 2011-2019

2.2.2. Heat wave and cold wave during 2011-2018

The occurrence of heat wave and cold wave across the 121 TDC-NICRA-KVKs during 2011-2018 are presented in **Fig 2.4**. The criteria for declaring heat wave are: In hill areas, *if the normal maximum temperature of the location is less than or equal to 40°C and the normal maximum temperature is 5°C higher than normal and in plain areas: if the normal maximum temperature of the location is greater than 40°C and the temperature is 4°C higher than normal"*. The criteria for declaring cold wave are: In hill area: *if the normal minimum temperature of the location is less than 10°C and the temperature is 4°C less than normal and in plains if the normal maximum temperature of the location is greater than or equal to 10°C and the temperature is 5°C less than normal.* It was observed that 23 KVKs experienced heat wave 6 times and 20 KVKs experienced 5 times during the period 2011-2018. The heat wave occurred 1 to 4 times at 29 KVKs during this period. It was observed that, Dibrugarh (Assam) experienced highest frequency of cold waves (5 times) followed by Bilaspur (Chhattisgarh) and Maharajganj (Uttar Pradesh) 4 times each. The cold wave occurred between 1 to 3 times in 58 KVKs during this period.

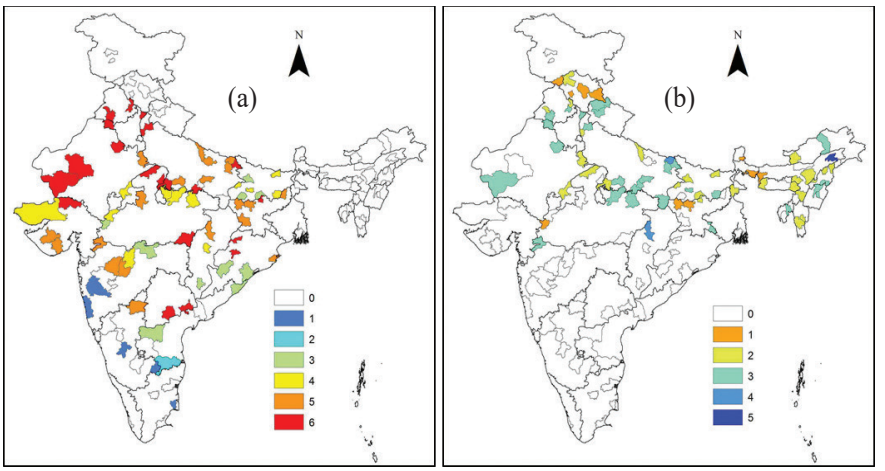


Fig 2.4: Occurrence of (a) heat and (b) cold waves over NICRA KVKs during 2011-2018

2.3. Yield variability in maize under future climate change scenarios (Simulated by DSSAT Maize model) across major maize growing districts of India

The genetic coefficients were calibrated, for a medium duration variety, with respect to district-wise observed yield (1997-2013) sourced from the Department of Agriculture and Cooperation across major *kharif* maize growing districts in the country. A minimum of 15 years were considered for calibration of the genetic coefficients in DSSAT Maize model (with respect to yield) and selected 121 districts in accordance with this criteria **(Fig 2.5)**. The ensemble CMIP-5 models' output (maximum temperature, minimum temperature and rainfall) in RCP 4.5 and 6.5 scenarios were considered to simulate maize yield for future climatic scenarios (mid 21st century) at selected states **(Fig 2.6)**. The results showed that, in the state of erstwhile Andhra Pradesh, the highest yield decline was projected in mid 21st century at Adilabad District followed by Warangal and Karimnagar in both the scenarios. The districts of Rangareddy, Medak and Mahabubnagar are likely to get sustainable yield in future scenarios. Across the state, normal sowing window projects highest yield in comparison with early and late sowings. In Rajasthan, it was observed that early sowing of crop well sustain / enhance the productivity in all districts during future climates. On the other hand, in Uttar Pradesh the maize yields are projected to have a drastic decline in future climates and changing the sowing window not likely to help in maintaining the productivity. Thus, additional adaptation measures like irrigation/ nutrient management may be required to sustain maize productivity in this state in future climates or need to look for an alternate crop in those areas.

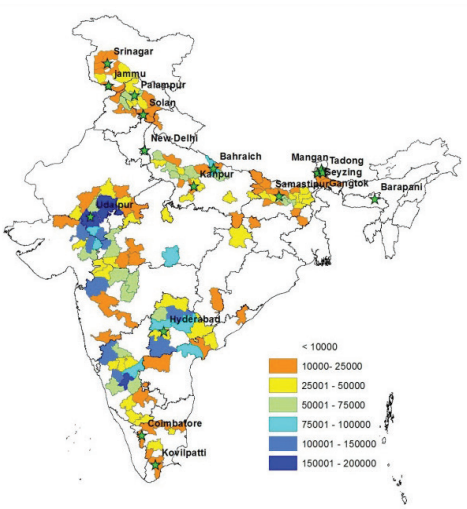


Fig 2.5: Distribution of maize area (in ha) across the selected districts

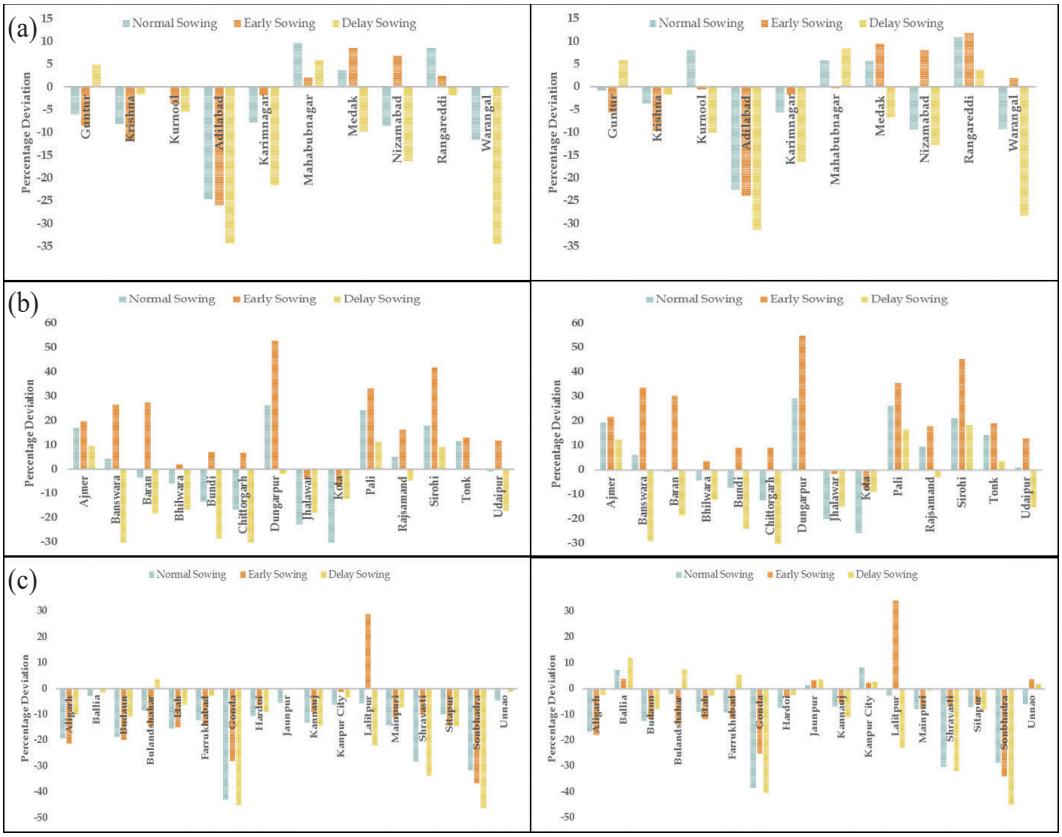


Fig 2.6: Simulation in maize yield (% deviation from baseline values) in future climates over (a) erstwhile Andhra Pradesh, (b) Rajasthan and (c) Uttar Pradesh states under the scenarios RCP 4.5 (left pane) and RCP 6.5 (right pane)

2.4. Mobile applications

Two centres of the AICRPAM - NICRA project viz., Anantapur and Thrissur developed Android applications in vernacular languages of thier respective states, Andhra Pradesh and Kerala for disseminating agromet advisory services to farming community.

Vyavasaya Vathavaranam by Anantapur Centre

An Android application "Vyavasaya Vathavaranam", was developed by Anantapur Centre **(Fig 2.7)** in which the information on weather, medium range weather forecast, agromet advisories, alerts, archives of weather data for all the 13 districts of Andhra Pradesh are available. It is useful to the farmers for timely planning of various operations in agricultural, horticultural crops and animal husbandry. The information is available in Telugu and English languages. Alerts on extreme weather events, nowcast and short range forecast of IMD are also being updated. The registered users can ask queries related to weather forecast and agromet advisories and all the users can see the answers provided by scientists.

Fig 2.7: Vyavasaya Vathavaranam by Anantapur Centre

Agromet Services Kerala (ASK) by Thrissur centre

ASK (Agromet Services for Kerala) is a mobile application developed by Thrissur Centre (**Fig 2.8**). It supports Malayalam and English languages and provides advisory bulletins. The agromet advisory will be prepared by the centre on the basis of medium range weather forecast by IMD for the next 5 days. It supports farmers to take right decision under the ongoing and predicted weather conditions. The advisory bulletins will be updated separately for each district in Kerala on every Tuesday and Friday. The updates and alerts are also available round the clock. The registered users can interact with scientists regarding weather and crops.

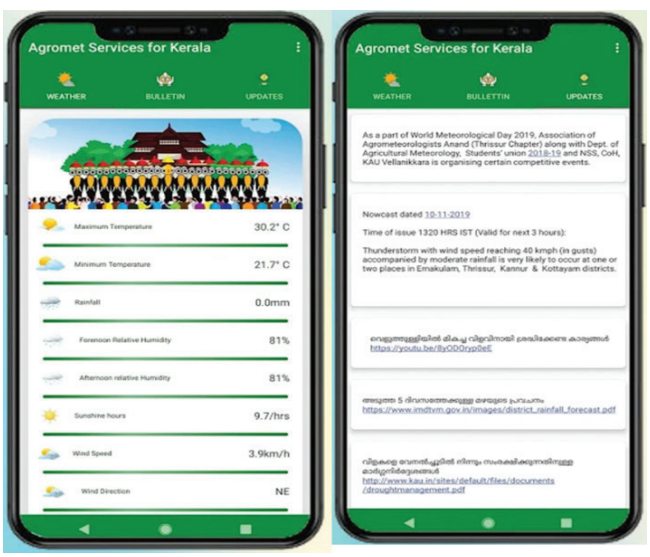


Fig 2.8: Agromet Servises Kerala by Thrissur Centre

3. Micro-level Agroclimatic Characterization

The characterization of crop growing environment is a pre-requisite for crop planning and evolving strategies to overcome climate/weather induced changes in the meso/micro climate. Thus, enhanced understanding of variability in climatic elements needs to be properly done to make agricultural sector resilient to climate change. Thus, historic data on climatic variables have to be analyzed using appropriate statistical tools for the development of location specific technologies/ adaptive strategies. The agroclimatic analysis carried out by different centres using block-level weather data is reported as under;

Akola

The cumulative rainfall (annual and south-west monsoon (SWM)) and extreme daily rainfall events viz., 10-25 mm, 25-50 mm, 50-75 mm, 75-100 mm, ≥100 mm as well as highest single day rainfall and rainy days (annual and south-west monsoon) were analyzed during the period 1971-2018 and presented in **Table 3.1**. None of the talukas showed statistically significant increasing / decreasing trends in annual or SWM rainfall. However, annual and SWM rainy days were found to be increasing significantly at four (Akot, Telhara, Balapur and Barshitakli) and five (Akot, Telhara, Balapur, Patur and Barshitakli) talukas, respectively. In the context of single-day rainfall events, 4 talukas (Telhara, Patur, Barshitakli and Murtijapur) showed significant increasing trend in 10-25 mm category while Mehkar taluka showed significant decreasing trend in single day rain events of 75-100 mm rainfall. For maximum daily rainfall, Balapur and Akola talukas exhibited significant decreasing trend. It can be concluded from the study that in spite of increasing trend of rainy days, rainfall trend remains decreasing (though non-significantly) in majority of talukas which could be consequent to the decreasing trend in 50-100 mm and >100 mm highest single-day rainfall events in majority of the talukas.

Table 3.1: Trends in rainfall, rainy days and extreme events at different talukas of Akola district (1971-2018)

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	Highest single day
Akot	0.990 (NS)	1.220 (NS)	1.937 (0.1)	2.396 (0.05)	0.116 (NS)	-1.21 (NS)	0.098 (NS)	-0.561 (NS)	0.240 (NS)	0.972 (NS)
Telhara	-0.230 (NS)	-0.147 (NS)	2.549 (0.05)	2.901 (0.01)	2.469 (0.05)	0.137 (NS)	-0.19 (NS)	-0.696 (NS)	-0.314 (NS)	-1.14 (NS)
Balapur	-0.046 (NS)	0.339 (NS)	2.205 (0.05)	1.966 (0.05)	1.102 (NS)	1.101 (NS)	-1.83 (0.1)	-1.102 (NS)	-0.615 (NS)	-1.92 (0.1)

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	Highest single day
Patur	-0.625 (NS)	-0.454 (NS)	1.237 (NS)	1.737 (0.1)	3.026 (0.01)	-0.32 (NS)	-0.20 (NS)	0.432 (NS)	-0.524 (NS)	-0.597 (NS)
Akola	-0.935 (NS)	-1.229 (NS)	0.945 (NS)	0.845 (NS)	0.175 (NS)	-0.791 (NS)	-0.330 (NS)	-0.992 (NS)	-1.258 (NS)	-2.027 (0.05)
Barshitakli	-0.428 (NS)	-0.357 (NS)	1.912 (0.1)	1.788 (0.1)	3.053 (0.01)	0.538 (NS)	0.134 (NS)	0.045 (NS)	0.535 (NS)	0.482 (NS)
Murtijapur	0.124 (NS)	-0.248 (NS)	1.521 (NS)	1.458 (NS)	2.051 (0.05)	-0.55 (NS)	0.170 (NS)	-0.052 (NS)	-0.236 (NS)	-0.248 (NS)

Samastipur

Probability of occurrence of consecutive weeks of dry spell

Probabilities of occurrence of dry spells for consecutive two-weeks with weekly rainfall lessthan threshold rainfall of 10 mm and 20 mm at Saran district was worked out and the results are presented in **Fig 3.1**. The study revealed that the probability for occurence of consecutive two-week dry spells increases significantly after 37th Standard Meteorological Week (SMW). The probability for occurence of dry spells of consecutive two-weeks and three-weeks remains very low (<10 percent) during major period of *kharif* season. However, the chances for occurence of dry spell of consecutive two-weeks and three-weeks duration were high during summer and *rabi* seasons. It is evident from the results that the phenomenon of consecutive two-week dry spells in this zone occurs at considerably higher probability from 37 to 38 SMW onwards. Hence, the standing rice crop, which is in late reproductive and maturity stages during 37 to 38 SMW and beyond, has higher chances to face moisture stress.

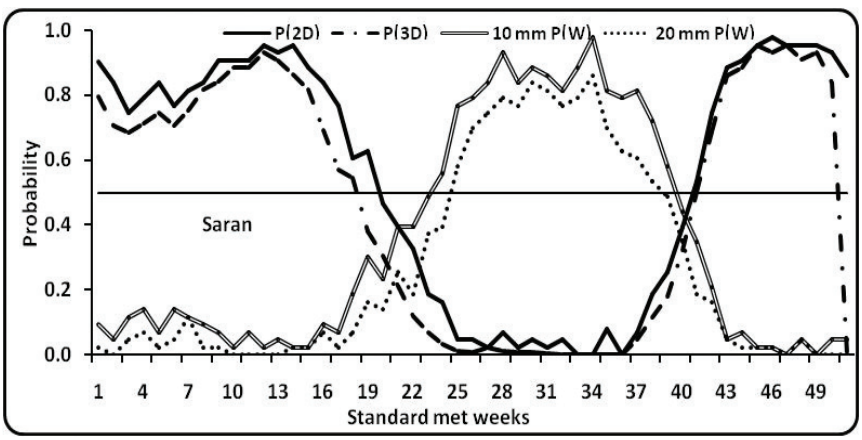


Fig 3.1: Probabilities of receiving dry spell for consecutive two weeks, P(2D) and three weeks, P(3D) along with initial probability, P(W) for 10 and 20 mm threshold rainfall over Saran district.

Jharkhand

The rainfall data of 59 years (1961-2019) from Palamu district was analyzed for 2 periods viz., historic (1961-1990) and recent (1991-2019) periods. The results showed that the average annual rainfall of Palamu during recent period was 966.2 mm against the value of 1327.8 mm during historic period. Coefficient of variation increased from 26.5% in historic period to 29.4 % in recent period, which indicated large variation in rainfall in recent years (**Fig 3.2**). Under such circumstances, cropping pattern should be changed from rice cultivation in *kharif* season to less water requiring crops like maize and pigeon pea etc. From the Fig. 3.2 it is observed that mean CV was more during 1991 - 2019 as compared to 1961 - 1990, which in turn confirms the increased uncertainity in rainfall amount. Similarly, the decadal rainfall amount also showed a decreasing trend (93 mm per decade).

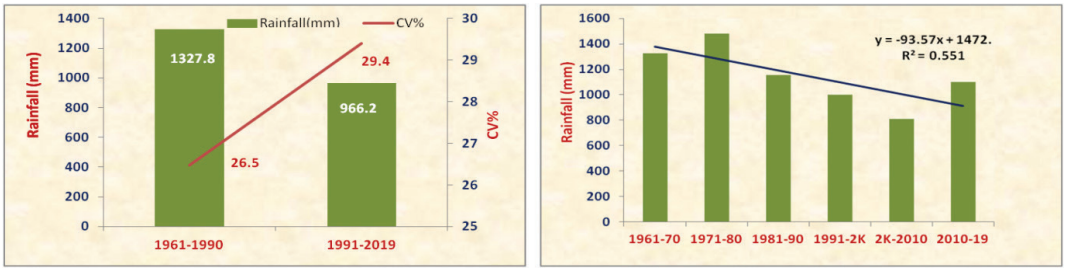


Fig 3.2: Change in rainfall during recent years vs historic period (left pane) and decadal average rainfall variability in Palamu

Meteorological drought

As per the classification by IMD, meteorological droughts in Palamu were classified as Mild (20-25% less than normal), Moderate (26-50% less than normal) and Severe (>50% less than normal) droughts. During 1961-2019, 34 out of 59 years were prone to drought of different intensities as per the devation of annual rainfall. The probability for the occurrence of mild, moderate drought and severe drought were 34, 22 and 1.6 %, respectively. It is observed from the decadal variation that drought intensity has increased in recent decades from mild to moderate and even severe in recent years (**Fig 3.3**).

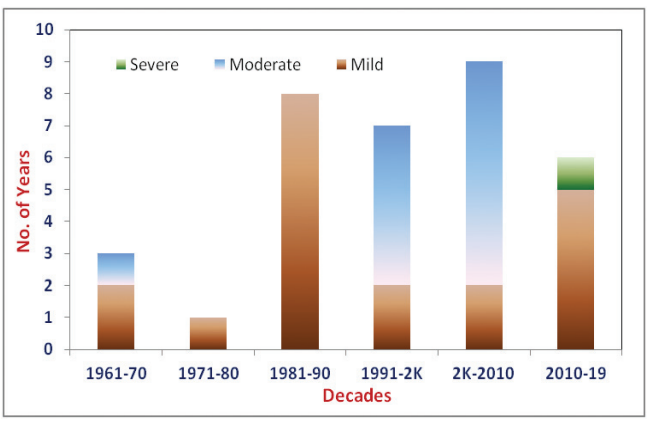


Fig 3.3: Decadal variation in drought intensity at Palamu

Kanpur

The average monthly rainfall data for Kanpur Dehat district has been prepared from the time series daily data during the period 1993-2018 and presented in **Fig 3.4**. It indicates that the annual normal of the Kanpur Dehat district is 680.5 mm. The wettest month is July with 211.4 mm rainfall followed by August (189.7 mm) and September (146.0 mm). Among the seasons, south-west monsoon season receives highest rainfall (626.0 mm) followed by Post-monsoon (20.0 mm), winter (18.3 mm) and Summer (16.1 mm) seasons.

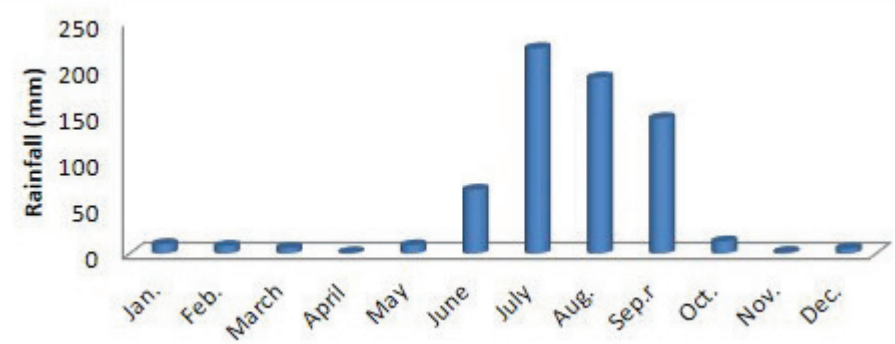


Fig 3.4: Monthly Normal rainfall (mm) at Kanpur Dehat district

Rainfall probability at Kanpur Dehat district

Rainfall probability estimation for any location is useful for agricultural planning. In order to estimate the rainfall probability, long term weekly rainfall data during the period 1993-2018 of Kanpur district was analyzed by employing Incomplete Gama distribution at different probability levels. As indicated in **Fig 3.5**, at 90% probability, more than or equal to 2.5 mm rainfall can be expected during 27 to 37 SMW and highest rainfall (18.5 mm) can be expected in 29 SMW. Results also revealed that at 75 percent probability, more than 2.5 mm rainfall was expected during 24 to 38 weeks and the highest rainfall (29.4 mm) can occur in 29 week followed by 28 and 33 weeks.

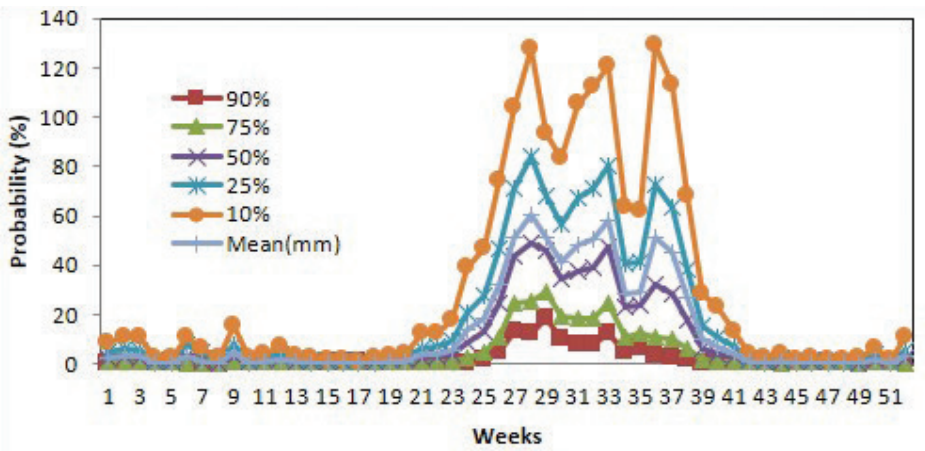


Fig 3.5: Weekly rainfall expected at 10, 25, 50, 75 and 90% probabilities at Kanpur Dehat district

Similarly, at 50% probability, more than or equal to 2.5 mm rainfall can be expected during 21 to 41 weeks and the highest rainfall (49.1 mm) can occur in 28 week followed by 33 and 29 weeks. At 25% probability, occurrence of more than 2.5 mm rainfall can be expected during all the weeks except 4-5, 8-10, 13-18, 43-49 and 51 weeks, whereas highest rainfall (84.4mm) can be expected in 28 week followed by 33 and 36 weeks. At 10% probability, all the weeks were expected to receive more than 2.5 mm rainfall except 15-17,45, 47-49 and 51 weeks and the highest rainfall (127.7 mm) can be expected in 28 week.

Dapoli

The variability of annual rainfall and rainy days during the project period (2011-2019) at Dapoli are presented in **Fig 3.6**. It was observed from the analysis that above normal rainfall was received during the years 2011, 2013, 2016 and 2019, while below normal values are recorded during 2014, 2015, 2017 and 2018. The highest annual rainfall was recorded in 2011 (4932 mm) and the lowest in 2015 (2113 mm). In the context of rainfall distribution within the year, the rainy days are found above normal in 2011, 2013, 2016, 2017 and 2019 and below normal in 2012, 2014 and 2015. The highest number of rainy days occured in 2019 (115 days) and the lowest in 2015 (84 days).

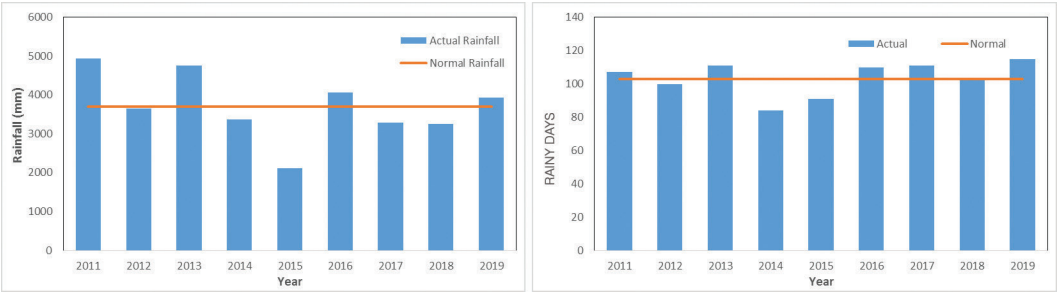


Fig 3.6: Comparison of annual rainfall and rainy days during 2011-2019 at Dapoli.

Faizabad

Annual rainfall variability of district Bahraich during 1976-2019 is presented in **Fig 3.7**. It was observed that the annual rainfall of district decreased at the rate of 7.7 mm per year during this period.

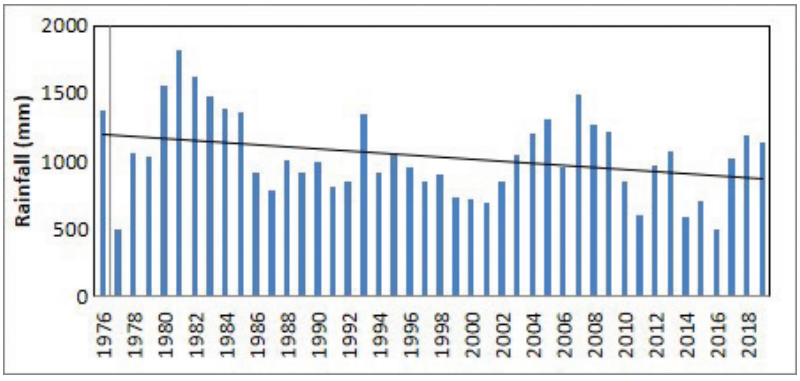


Fig 3.7: Annual rainfall variability at Bahraich during 1976-2019

Anantapur

Daily rainfall data of Banaganapalle block from 1966 to 2015 revealed that the normal annual rainfall of the Banaganapalle block is 663 mm with a standard deviation of 171 mm and CV of 27.8 mm (**Fig 3.8**). The normal annual rainy days in the block are 38, with an SD of 7 and a CV of 19.7. During the last 50 years (1966 to 2015), 9 years received excess rainfall, 23 years received normal rainfall, 17 years received deficit rainfall and 1 year received scanty rainfall. South-west monsoon is the major rainfall season in the block contributing 66% of the annual rainfall (437.7mm), followed by North-East monsoon which is contributing 22% of the annual rainfall (147.6mm). Summer contributes 11% and winter contributes 1% of the annual rainfall. The Man-Kendall trend analysis (1966-2015) indicated that there is a significant increasing trend (P=0.1%) in the winter rainfall.

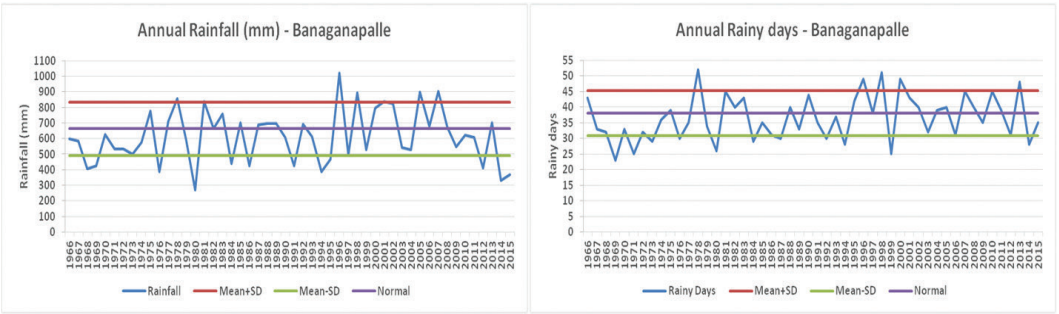


Fig 3.8: Annual rainfall and rainy days variability at Banaganapalle during 1966-2015

Bijapur

Rainfall variabilities over 110 years (1901 to 2010) for Athani and Gokak Taluks of Belagavi district were analyzed and variability patterns for annual rainfall are presented in terms of 5-year moving averages, with the mean value plotted against the last data point. These analyses are made for annual and seasonal viz., pre-monsoon (Mar to May), southwest monsoon (June to September) and post-monsoon (October to December) rainfall series. The variability in annual rainfall at Athani during 1901-2010 indicates a considerable decrease from 620 mm to 450 mm on linear scale (**Fig. 3.9**). Even though the variability pattern through 5-year moving averages indicates large dips in rainfall in 1920s, 1970s and 2000s, it does not suggest any fixed periodicity.

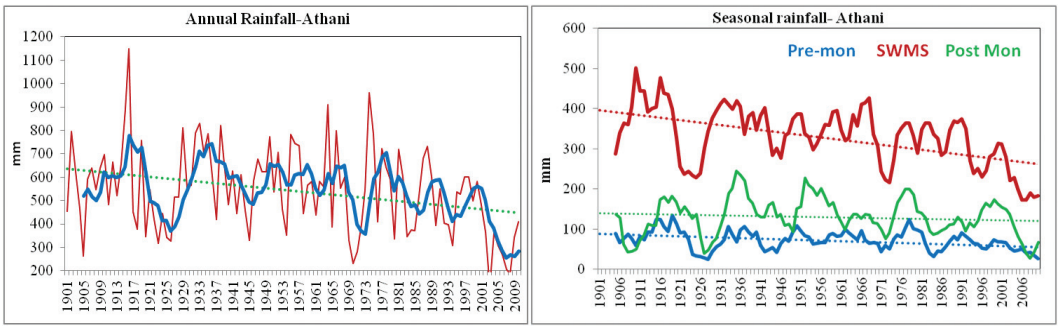


Fig 3.9: Annual and seasonal rainfall variability at Athani during 1901-2010

Decrease in the peak epoch values of 5-year mean annual rainfall from 780 mm to 580 mm and lowest epoch values from 380 mm to 280 mm are also noticed. It was noticed that monsoon season rainfall decreased from 400 mm to 270 mm. The rainfall during pre-monsoon and post-monsoon seasons did not exhibit any lenear trend during this period. It was observed that there was a sharp decreasing trend in annual and south-west monsoon rainfall during the last two decades. The long-term trend in annual rainfall at Gokak Taluk indicates considerable decrease from 600 mm to 480 mm on linear scale. Even though the variability pattern through 5-year moving average indicates large dips in rainfall around 1910, 1925, 1945 and 1985 and 2005, it does not suggest any fixed periodicity. It was noticed that the variability pattern changed after 1960s, with larger inter-annual fluctuations after 1970s (**Fig. 3.10**). It was also noticed that was a decrease in monsoon raifall from 320 mm to 270 mm.

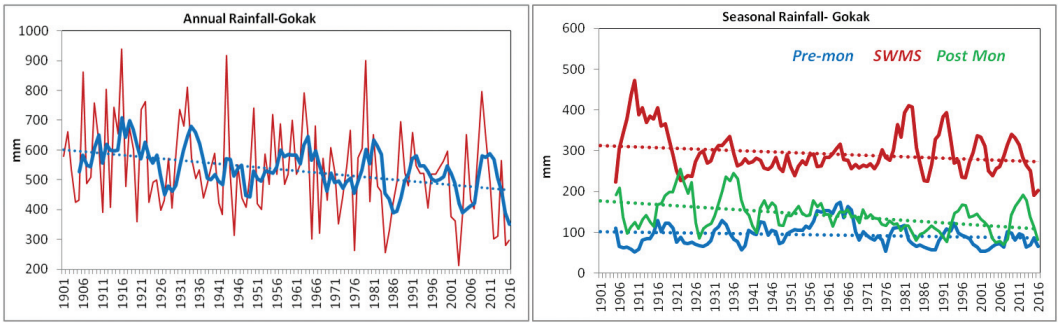


Fig 3.10: Annual and seasonal rainfall variability at Gokak during 1901-2010

Hisar

The trends in extreme rainfall and temperature indices during each month of the year at Sirsa during 1985-2014 were analyzed and the results are furnished in **Table 3.2**. A strong significant positive trend was observed in minimum temperature at 90th Percentile (TN90p) during all months of the year. A strong significant positive trend was noticed for maximum temperature at 10th Percentile (TX10p) during January. Significant increasing trend was noticed in lowest minimum temperature (TNn) during April, and highest minimum temperature (TNx) during January, February, May, June and September. Similarly, significant decreasing trend was detected in maximum temperature at 90th Percentile (TX90p) during October and lowest maximum temperature (TXn) during December and January. The minimum temperature at 90th percentile (TN90p) exhibited significant increasing trend during all the months. The Diurnal Temperature Range (DTR) showed significant decreasing trend during January, February, April, August, September October and November. The rainfall indices viz., Maximum daily rainfall (RX1day) and Maximum 5-day rainfall (RX5day), minimum temperature at 10th percentile (TN10p), lowest minimum temperature (TNn) and highest maximum temperature (TXx) for each month did not exhibit any trends during this period.

Table 3.2: Monthly trend of extreme rainfall and temperature indices at Sirsa (1985-2014). Bold values denotes significance at different levels of significance.

Month	RX1day	RX5day	TN10p	TX10p	TN90p	TX90p	TNn	TXn	TNx	TXx	DTR
Jan	-0.80	-1.19	0.63	**2.59**[c]	**1.88**[e]	-1.56	-0.89	**-2.02**[d]	**1.80**[e]	-0.80	**-3.23**[c]
Feb	-0.04	-0.25	0.47	1.49	**2.90**[d]	-0.18	-1.04	-0.43	**2.22**[d]	-0.43	**-1.89**[e]
Mar	-0.27	-0.86	-0.12	-0.20	**1.70**[e]	0.07	0.89	-0.04	1.45	-0.39	-1.48
Apr	0.96	1.07	-1.60	0.59	**1.91**[e]	0.18	**2.22**[d]	0.46	-0.31	0.00	**-2.11**[d]
May	0.00	-1.16	-0.22	0.46	**1.79**[e]	1.89	0.20	-0.70	**3.30**[a]	1.39	-1.55
Jun	-0.37	-0.73	1.47	1.43	**2.72**[c]	-0.14	0.84	-1.19	**2.46**[d]	-0.88	-1.32
Jul	-0.37	-0.99	-1.19	-0.60	**1.65**[e]	0.59	1.34	0.28	0.74	1.05	-0.02
Aug	1.14	1.53	-0.98	-0.29	**2.01**[d]	-0.13	1.64	1.38	1.27	-0.29	**-2.62**[c]
Sep	1.36	0.84	-0.80	0.36	**3.53**[b]	-0.94	0.77	0.80	**2.49**[d]	-0.82	**-2.14**[d]
Oct	-0.84	-0.56	-1.35	-0.46	**2.68**[c]	**-2.01**[d]	1.45	0.18	1.75	-0.41	**-2.44**[d]
Nov	-0.31	-0.31	-0.08	-0.08	**2.40**[d]	-0.73	0.00	0.27	1.77	-1.66	**-1.71**[e]
Dec	0.61	0.33	0.04	0.17	**2.04**[d]	-0.45	-0.30	**-1.84**	1.25	0.25	-1.53

MKT = [c]Significance level ± 95%, [d]Significance level ± 90%; [c]Significance level ± 85%

Jammu

The annual rainfall deviation from normal during the period 1985-2019 for Kathua district has been analyzed to detect any changes in annual rainfall pattern. Analysis showed that there were six deficit rainfall years (<25% of the normal) and three excess rainfall years (>25% of the normal). The remaining years were placed under the normal rainfall category (Fig. 3.11).

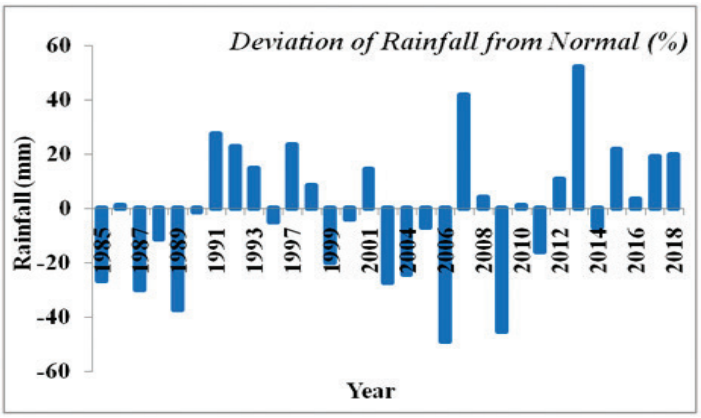


Fig 3.11: Annual Rainfall variability at Kathua during 1985-2015

Jorhat

The rainfall data of Golaghat district during the period 1981-2018 has been analyzed and the results showed that, the average annual rainfall of Golaghat is 1653.5 mm with a seasonal distribution of 420.5 mm, 1045.4 mm, 134.0 mm and 53.5 mm during pre-monsoon, monsoon, post-monsoon and winter season, respectively (**Fig 3.12**). The annual average rainfall recorded at Sonitpur district is 1978.7mm during the period 1981-2018 with the seasonal distribution of 1290.7 mm, 490.3 mm, 140.2 mm and 57.5 mm during southwest monsoon, pre-monsoon, post-monsoon and winter season, respectively (**Fig 3.13**). The decadal variability during the last three decades showed that the annual rainfall decreased gradully to 1587 mm duriung 2001-2010 from 1760 mm during 1981-1990 (**Fig 3.14**), while at Sonitpur, it increased substantially to 1813 mm (during 2001-2010) from 1543 mm (during 1981-1990) (**Fig 3.15**).

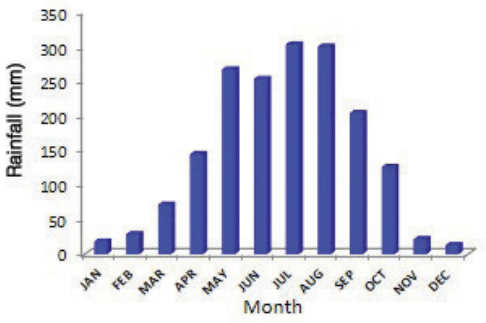


Fig 3.12: Monthly rainfall distribution in Golaghat district

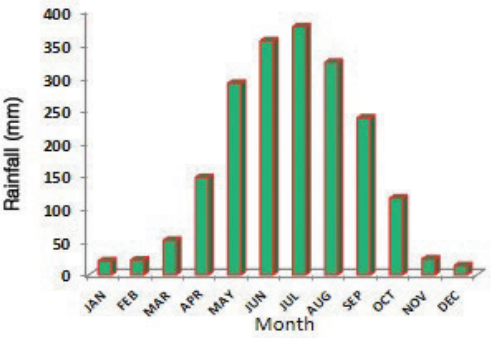


Fig 3.13: Monthly rainfall distribution in Sonitpur district

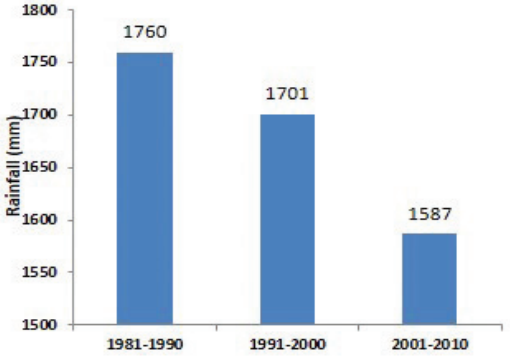


Fig 3.14: Decadal change of rainfall and rainy days in Golaghat district

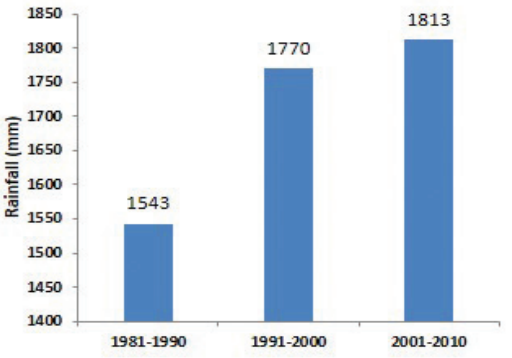


Fig 3.15: Decadal change of rainfall and rainy days in Sonitpur district

Raipur

Analysis of daily rainfall data for different blocks of Mahasamund district of Chhattisgarh revealed that rainfall received during the *Kharif* paddy season is adequate, subjected to the efficient rainwater management. The average of annual rainfall ranged between 1094.3 mm in Bagbahara to 1348.4 mm

in Saraipali, CV of annual rainfall being highest in Mahasamund (29.4%) and lowest in Saraipali (23.3%) block (**Table 3.3**). The average coefficient of variation (CV) recorded was 25.9 percent. The average number of rainy days ranged between 51.0 at Pithora to 63.6 at Saraipali. The overall district average rainy days were found to be 56 days.

Table 3.3: Annual rainfall and rainy days in different blocks of Mahasamund district.

Block name	Rainfall			Rainy days		
	Mean	SD	CV	Mean	SD	CV
Mahasamund (1973-2017)	1139.6	335.2	29.4	58.6	16.9	28.9
Pithora (2001-2017)	1254.2	302.2	24.1	51.0	9.3	18.1
Saraipali (1981-2017)	1348.4	314.5	23.3	63.6	16.4	25.8
Bagbahara (1984-2017)	1094.3	280.9	25.7	57.1	10.1	17.7
Basna (1990-2017)	1239.1	319.1	25.8	57.8	8.74	15.1
District Average	1224.2	317.9	25.9	55.5	11.9	21.5

Udaipur

The daily rainfall data for the period from 1970 to 2016 were used to compute mean annual, seasonal, monthly and weekly rainfall of Rajsamand and Kota districts. Rainfall features of different tehsils of Rajsamand district revealed that, the highest amount of rainfall (685.8 mm) was received at Kumbhalgarh tehsil (standard deviation (SD) of 234.1 mm and coefficient of variation (CV) of 34.1%) followed by 596.5 mm at Nathdwara tehsil (with SD of 194.6 mm and 32.6% CV) (**Table 3.4**). The lowest annual rainfall of 527.4 mm was received in 26.4 rainy days at Bhim tehsil. With regards to rainy days, Kumbhalgarh tehsil experienced maximum rainy days (34.3) followed by Nathdwara (32.2).

Among the tehsils, the highest amount of rainfall (904 mm) was received at Ramganj Mandi tehsil (SD, 260 mm and CV, 29%) followed by 789 mm in Sangod tehsil (SD, 263 mm and CV 33%). The lowest annual rainfall of 718 mm was received in 34 rainy days at Kota tehsil (**Table 3.5**). Ramganj Mandi tehsil also had maximum rainy days (36) followed by Ladpura, Piplada and Sangod (35) each tehsils. At Rajsamand, increasing trends in rainfall and rainy days was observed while at Kota decreasing trend was observed.

Table 3.4: Annual rainfall (mm)characteristics of different *tehsils* of Rajsamand district (1970-2016)

Tehsil	Annual rainfall			Annual rainy days		
	Mean (mm)	SD (mm)	CV (%)	Mean	SD	CV (%)
Amet	534.2	145.9	27.3	29.9	6.7	22.3
Bhim	527.4	177.5	33.7	26.4	7.5	28.3
Deogarh	544.7	211.8	38.9	28.6	8.3	29.0
Kumbhalgarh	685.8	234.1	34.1	34.3	9.2	26.7
Nathdwara	596.5	194.6	32.6	32.2	7.2	22.5
Relmangra	584.7	200.3	34.3	30.5	6.8	22.4
Rajsamand	562.4	180.3	32.1	30.4	6.9	22.7

Table 3.5: Annual rainfall (mm) characteristics of different tehsils of Kota district (1970-2016)

Tehsils	Annual rainfall			Annual rainy days		
	Mean (mm)	SD (mm)	CV (%)	Mean	SD	CV (%)
Kota	718	251	35	34	9	26
Ladpura	742	226	30	35	8	22
Piplada	746	233	31	35	8	22
Ramganj Mandi	904	260	29	36	8	23
Sangod	789	263	33	35	7	21

4. Validation of block level weather Forecast

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

Dapoli

Comparison between actual and forecasted weekly rainfall at Dapoli and Khed tehsils and Natunagar village during year 2018 and 2019 is presented in **Fig. 4.1 and 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 August in both Dapoli and Khed tehsils. The south-west monsoon rainfall was comparatively higher than the forecasted rainfall during the months of July to September in NICRA-village Natunagar. On the basis of different statistical indices viz., Root Mean Square Error (RMSE), D-Index, Normalized Orthogonal Function (NOF), Mean Bias Error (MBE), Mean Absolute Error (MAE) and R^2, the forecast of Natunagar was found most accurate with high D-Index, R^2 and low values of RMSE, MBE, NOF and MAE during 2018 (**Table 4.1**). However in 2019, according to these norms the forecast for Khed tehsil was observed to be having better accuracy.

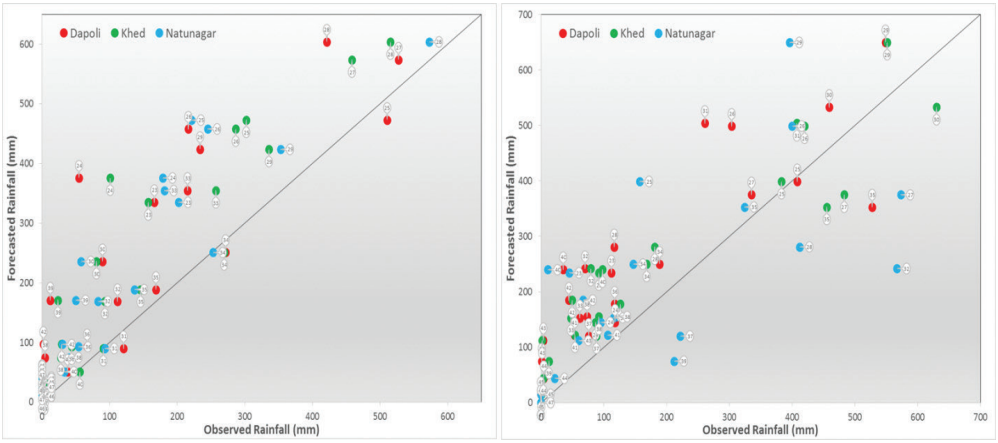


Fig 4.1: Comparison between predicted and actual weekly rainfall at Dapoli and Khed tahsils and Natunagar village during 2018 and 2019

Table 4.1: Accuracy of forecasted weekly rainfall at Dapoli and Khed tahsils and Natunagar village during 2018 and 2019 based on statistical indices

Index	2018			2019		
	Dapoli	Khed	Natunagar	Dapoli	Khed	Natunagar
RMSE	119.18	104.40	105.45	114.38	90.23	194.72
D-Index	0.88	0.91	0.91	0.89	0.94	0.77
NOF	0.92	0.79	0.77	0.73	0.50	0.76
MBE	78.68	76.30	70.32	77.81	54.18	-21.52
MAE	85.80	78.23	77.28	92.53	78.70	140.64
R^2	0.66	0.72	0.77	0.76	0.88	0.71

Palampur

The validation of block level rainfall forecast issued by IMD for Bhranj and Nadaun blocks was done for the period 2015-2019 and the forecast for NICRA district, Hamirpur was carried out during 2018-2019 (**Table 4.2**). It was observed that the forecasts for the events of <10 mm day^{-1} were performed well with a true cases of >60%. In the case of high rainfall events (>30 mm day^{-1}), the performance of the forecast was unpromising. It can be concluded that the accuracy of the forecast decreased with increase in rainfall intensity. The results revealed the need for improving forecast of high intensity rainfall over these regions.

Table 4.2: Validation of block level rainfall forecast for Bhranj and Nadaun blocks

Block/ Years/ Rainfall category	Bhranj				Nadaun				Sujanpur	
	2015	2016	2018	2019	2015	2016	2018	2019	2018	2019
0 mm	66.7[#]	75.2	64.5	71.6	60.8	61.9	68.5	71.8	67.2	82.1
1-10 mm	53.1	64.6	66.7	23.1	25.0	50.0	62.8	55.6	60.7	38.9
11-30 mm	13.3	6.9	16.7	52.0	12.5	11.8	25.0	11.1	23.1	7.7
>31 mm	40.0	10.0	6.7	16.7	0.0	0.0	0.0	12.5	0.0	13.3

[#] per cent true cases

Udaipur

The 5-day medium range micro-level daily weather forecast during the period 1 June to 30 September 2019 received from Regional Meteorological Centre, Jaipur (IMD) on every Tuesday and Friday for next five days was validated through a qualitative analysis on “Success” or “Failure” basis. The highest success rate was observed at Chomakot (62.3%) followed by Jorawar Singh Ji

Ka Kheda (55.7 %) and Bagatpura (53.3%) (**Table 4.3**). The accuracy of forecast for no rainfall event was above 90% over all the three locations and gradually decreased with increase in rainfall intensity. The validation of weekly rainfall forecast with observed rainfall at Udaipur during 2018 and 2019 using different statistical indices is presented in **Fig 4.2** and **Table 4.5**. It was found that the forecast predicted lower values than the actual for the weeks with more than 70 mm rainfall and over estimated for the weeks with rainfall 30 - 70 mm in both 2018 and 2019. It was also observed that the accuracy of the forecast improved substantially in 2019 in comparison with 2018 with higher values of D-Index and R^2 and lower values of RMSE, NOF and MAE.

The per cent success of forecast for no rainfall, light rainfall and moderate rainfall was 95.0, 4.3 and 17.4% at Jorawar Singh Ji Kheda, 91.7, 5.0 and 18.2% at Bagatpura, and 94.4, 18.9 and 11.4% at Chomakot, respectively (**Table 4.4**). The per cent success forecast for heavy rainfall during the season was 8.3% in Jorawar Singh Ji ka Kheda, 18.2% in Bagatpura and 14.3% in Chomakot.

Table 4.3: Success and failure of weather forecast for rainfall

Village/ Tehsil	Probability		No. of observations
	Success	Failure	
Jorawar Singh Ji Kheda (Rajsamand)	68 (55.7%)	54 (44.3%)	122
Bagatpura (Relmangra)	65 (53.3%)	57 (46.7%)	122
Chomakot (Kota)	76 (62.3%)	46 (37.7%)	122

Table 4.4: Success and failure of rainfall forecast during 1 June to 30 September, 2019

Rainfall Range (mm/day)	0 mm (No rain)			Trace - 10 mm (Light)			11-30 mm (Moderate)			>30 mm (Heavy)			Total	
	No. of Obs	Success	Failure	No. of Obs	Success	Failure	No. of Obs	Success	Failure	No. of Obs	Success	Failure	Success	Failure
Jorawar Singh Ji Kheda (Rajsamand)	40	38 (95.0%)	2 (5.0%)	47	2 (4.3%)	45 (95.7%)	23	4 (17.4%)	19 (82.6%)	12	1 (8.3%)	11 (91.7%)	45 (36.9%)	77 (63.1%)
Bagatpura (Relmangra)	48	44 (91.7%)	4 (8.3%)	40	2 (5.0%)	38 (95.0%)	23	2 (8.7%)	21 (91.3%)	11	2 (18.2%)	9 (81.8%)	50 (41.0%)	72 (59.0%)
Chomakot (Kota)	36	34 (94.4%)	2 (5.6%)	37	7 (18.9%)	30 (81.1%)	35	4 (11.4%)	31 (88.6%)	14	2 (14.3%)	12 (85.7%)	47 (38.5%)	75 (61.5%)

The per cent success of rainfall (yes/no) in village Jorawar Singh Ji Ka Kheda (Rajsamand), Bagatpura (Relmangra) and Chomakot (Sangod) were 55.7%, 53.3% and 62.3%, respectively (**Table 4.4**). The per cent success forecast for no rainfall, light rainfall and moderate rainfall was 95.0, 4.3 and 17.4% at Jorawar Singh ka Kheda, 91.7, 5.0 and 18.2% at Bagatpura, and 94.4, 18.9 and 11.4% at Chomakot, respectively. The per cent success forecast for heavy rainfall during the season was 8.3% at Jorawar Singh Ji ka Kheda, 18.2% at Bagatpura and 14.3% at Chomakot.

Table 4.5: Validation of weekly rainfall forecast with observed rainfall at Udaipur

Index	2019	2018
RMSE	24.2	25.7
D-Index	0.89	0.75
NOF	1.16	2.28
SD-Actual	41.3	27.3
SD-Forecast	37.3	31.2
MAE	10.99	10.75
R^2	0.66	0.34

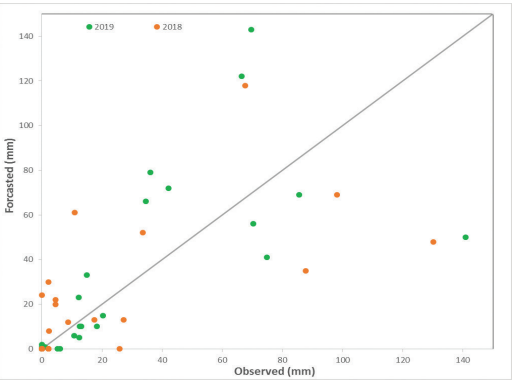


Fig 4.2: Observed and forecasted weekly rainfall at Udaipur during 2018 and 2019

Anantapur

The inter comparison between actual and forecasted weekly rainfall at Anantapur centre during year 2018 and 2019 using different statistical indices is presented in **Fig 4.3** and **Table 4.6**. Comparison showed that the forecast predicted lower values for the weeks with more than 40 mm rainfall during 2018 and 2019. However, the performance of forecast during both years was satisfactory with higher D-Index (>0.8) and R^2 values. It was observed that the forecast during 2018 was more accurate compared to 2019 with substantial lower RMSE and MAE.

Table 4.6: Validation of weekly rainfall forecast with observed rainfall at Anantapur

Index	2019	2018
RMSE	21.6	13.4
D-Index	0.86	0.84
NOF	1.27	1.81
SD-Actual	34.8	22.9
SD-Forecast	30.2	14.5
MAE	11.78	7.24
R^2	0.54	0.58

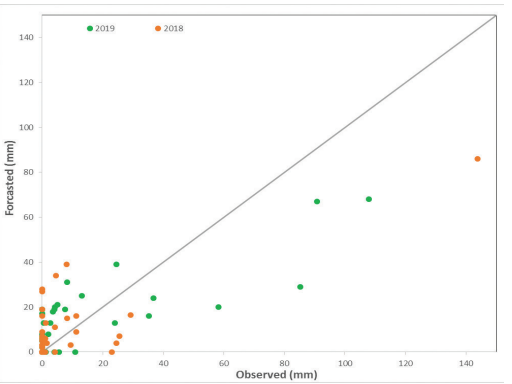


Fig 4.3: Observed and forecasted weekly rainfall at Anantapur during 2018 and 2019

Jorhat

The inter comparison between actual and forecasted weekly rainfall at Jorhat Centre during year 2018 and 2019 using different statistical indices is presented in **Fig. 4.4** and **Table 4.7**. In 2018, the forecast predicted lower values for all the weeks with rainfall more than 100 mm, while in 2019 it over-estimated the values for few weeks with rainfall between 50-100 mm. Overall, the performance of the forecast during both years was satisfactory with high values of D-Index (>0.8) and R^2 (>0.55) along with lower values of RMSE, NOF and MAE.

Table 4.7: Validation of weekly rainfall forecast with observed rainfall at Jorhat

Index	2019	2018
RMSE	47.2	35.2
D-Index	0.85	0.81
NOF	1.03	0.94
SD-Actual	52.8	44.8
SD-Forecast	75.8	40.8
MAE	29.11	22.1
R^2	0.61	0.55

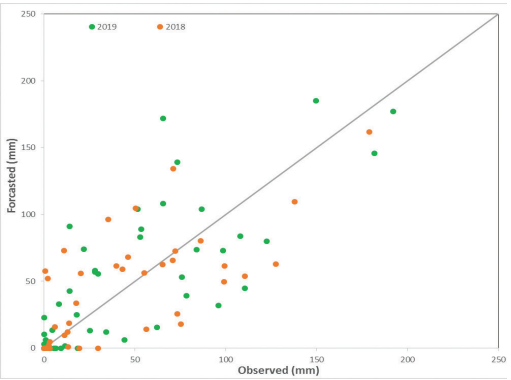


Fig 4.4: Observed and forecasted weekly rainfall at Jorhat during 2018 and 2019

Faizabad

The comparison of actual and forecasted weekly rainfall at Faizabad Centre during year 2018 and 2019 using different statistical indices is presented in **Fig 4.5** and **Table 4.8**. It was observed that the forecast predicted lower values for all the weeks with rainfall more than 100 mm during both 2018 and 2019. The performance of the prediction was acceptable in 2018, while the accuracy decreased drastically in 2019 with lower values of D-Index and R^2 along with higher RMSE, NOF and MAE. Except couple of weeks, the forecast always predicted lesser values for the weeks with more than 50 mm rainfall. Thus the accuracy of the prediction need to be improved for better forecast of high rainfall events.

Table 4.8: Validation of weekly rainfall forecast with observed rainfall at Faizabad

Index	2019	2018
RMSE	35.2	16.8
D-Index	0.78	0.92
NOF	1.65	1.05
SD-Actual	49.6	35.1
SD-Forecast	33	30.4
MAE	14.82	7.84
R^2	0.45	0.73

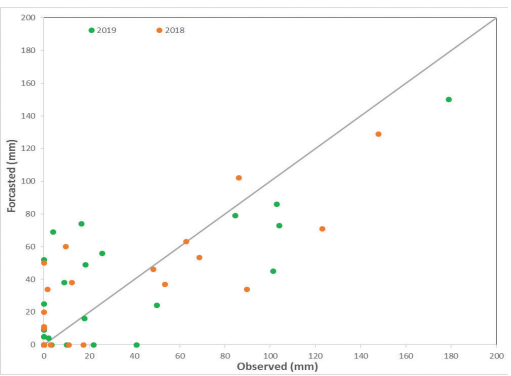


Fig 4.5: Observed and forecasted weekly rainfall at Faizabad during 2018 and 2019

Solapur

The comparison of forecasted weekly rainfall with actual values at Solapur during the years 2018 and 2019 using different statistical indices is presented in **Fig 4.6** and **Table 4.9**. It was observed that the forecast underestimated the weekly values with rainfall more than 60 mm during both 2018 and 2019. The accuracy of the forecast was very high during both years with high values of D-Index (>0.9) and R^2 and lower values of RMSE, NOF and MAE.

Table 4.9: Validation of weekly rainfall forecast with observed rainfall at Solapur

Index	2019	2018
RMSE	12	10.4
D-Index	0.94	0.95
NOF	0.72	1.02
SD-Actual	28	23
SD-Forecast	23.4	23.8
MAE	6.47	5.09
R^2	0.81	0.82

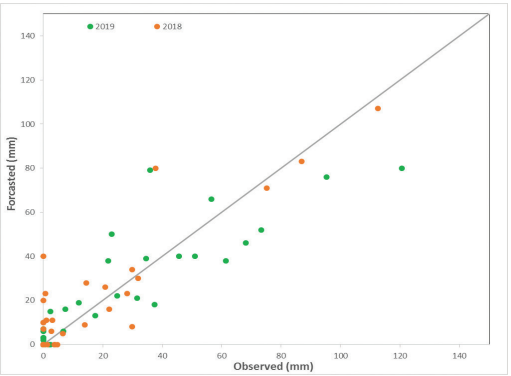


Fig 4.6: Observed and forecasted weekly rainfall at Solapur during 2018 and 2019

Ludhiana

The evaluation of weekly rainfall forecast with actual rainfall at Ludhiana during 2018 and 2019 using different statistical indices is presented in **Fig 4.7** and **Table 4.10**. It was noticed that the forecast underestimated the values of the weeks with rainfall more than 60 mm during both the years. At Ludhiana also the forecast was acceptable with high values of D-Index and R^2 and lower values of RMSE, NOF and MAE.

Table 4.10: Validation of weekly rainfall forecast with observed rainfall at Ludhiana

Index	2019	2018
RMSE	22.9	21.8
D-Index	0.9	0.87
NOF	1.01	1.14
SD-Actual	42.4	38.9
SD-Forecast	33.5	22.9
MAE	13.22	10.72
R^2	0.71	0.8

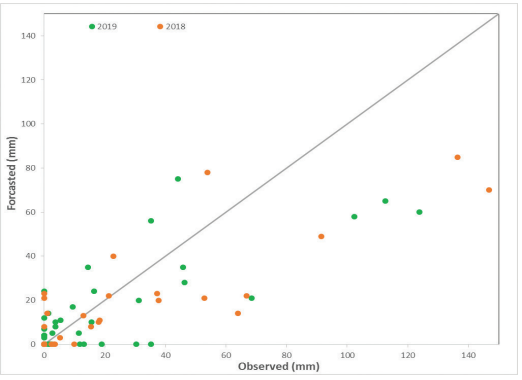


Fig 4.7: Observed and forecasted weekly rainfall at Ludhiana during 2018 and 2019

Bangalore

Comparison of weekly rainfall forecast with actual rainfall at Bangalore during 2018 and 2019 using different statistical indices is presented in **Fig 4.8** and **Table 4.11**. It was observed that the forecasted rainfall was over-estimated in 2018 and under-estimated in 2019 for the events with weekly rainfall more than 30 mm. Even though, the forecast during 2019 exhibited better D-Index and R^2 values with a marginal change, the forecast during 2018 was found to be more accurate with substantially lower RMSE, NOF and MAE.

Table 4.11: Validation of weekly rainfall forecast with observed rainfall at Bangalore

Index	2019	2018
RMSE	13.1	18.8
D-Index	0.89	0.85
NOF	0.8	1.34
SD-Actual	23.9	20.2
SD-Forecast	18.8	30.3
MAE	8.1	8.47
R^2	0.66	0.63

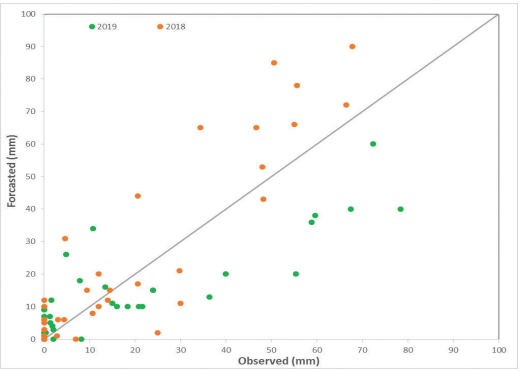


Fig 4.8: Observed and forecasted weekly rainfall at Bangalore during 2018 and 2019

Mohanpur

The validation of weekly rainfall forecast with observed rainfall at Mohanpur during 2018 and 2019 using different statistical indices is presented in **Fig 4.9** and **Table 4.12**. It was observed that the forecast predicted lower values for all the weeks with rainfall more than 50 mm in 2019, while in 2018 it over-estimated the weekly rainfall between 50-100 mm and under-estimated the values of weeks with rainfall more than 200 mm. The overall performance of the forecast was improved during 2019 compared to 2018 with relatively higher values of D-Index and R^2 as well as lower values of RMSE, NOF and MAE.

Table 4.12: Validation of weekly rainfall forecast with observed rainfall at Mohanpur

Index	2019	2018
RMSE	18.9	31.7
D-Index	0.88	0.73
NOF	0.79	1.67
SD-Actual	32.3	35.3
SD-Forecast	24.2	34.6
MAE	10.72	14.78
R^2	0.57	0.36

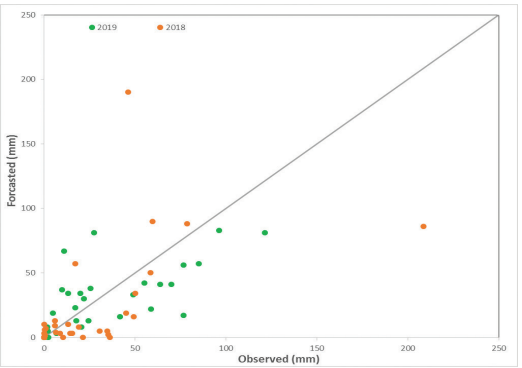


Fig 4.9: Observed and forecasted weekly rainfall at Mohanpur during 2018 and 2019

Kanpur

The evaluation of weekly rainfall forecast with actual rainfall at Kanpur during 2018 and 2019 using different statistical indices is presented in **Fig 4.10** and **Table 4.13**. The results showed that the forecast predicted lower values for the weeks with more than 100 rainfall during both years. In the case of weekly rainfall between 60 to 100 mm, the forecast overestimated in 2019 and underestimated in 2018. Altogether the performance of the forecast was decreased substantially in 2019 compared to 2018 with a substantial decrease in D-Index and R^2 values even though there was a marginal improvement in RMSE, NOF and MAE.

Table 4.13: Validation of weekly rainfall forecast with observed rainfall at Kanpur

Index	2019	2018
RMSE	23.3	27.9
D-Index	0.87	0.92
NOF	1.44	1.5
SD-Actual	33.1	53.1
SD-Forecast	35.7	51.8
MAE	11.5	12.47
R^2	0.59	0.73

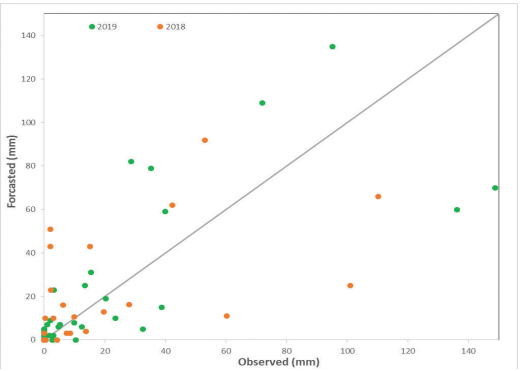


Fig 4.10: Observed and forecasted weekly rainfall at Kanpur during 2018 and 2019

Bhubaneswar

The validation of rainfall forecast during the year 2019 for Sorada, Phulbani and Pattamundai locations are furnished in **Table 4.14**. It was observed that the forecast under-estimated the monthly rainfall at Soirada and over-estimated at Phulbani. At Pattamundai, it over-estimated June and August rainfall and under-estimated July and September rainfall.

Table 4.14: Validation of monsoon rainfall forecast with observed Data

Monsoon 2019 Rainfall Forecast validation									
Month	Sorada		Phulbani		Pattamundai		Sorada Dev%	Phulbani Dev%	Patta-mundai Dev%
	Actual (mm)	Forecast (mm)	Actual (mm)	Forecast (mm)	Actual (mm)	Forecast (mm)			
June	101.1	92.0	156.2	209.0	98.0	161.0	9.9	-25.3	-39.1
July	236.2	42.0	281.2	454.0	204.0	110.0	462.4	-38.1	85.5
August	269.6	129.0	503.0	510.0	335.0	345.0	109.0	-1.4	-2.9
September	403.7	130.0	425.2	585.0	331.0	286.0	210.5	-27.3	15.7
Monsoon	1010.6	393.0	1365.6	1758.0	968.0	902.0	157.2	-22.3	7.3

Thrissur

The block level and district level rainfall forecast for Malappuram district during the south-west and north-east monsoon season (2019) was verified with the observed rainfall data at Anakkayam, Malappuram District. A comparison of district (Malappuram) and block (Ponnani) level forecast during southwest monsoon season reveals that the block level forecast of rainfall is higher than the district level forecast in most of the times at Thavanur. The district level forecast matches reasonably well with observed rainfall than with block level forecast with better values of skill score, RMSE, Probability of detection, False Alarm Ratio and correlation values (**Table 4.15**). The quantitative

analysis of rainfall forecast during southwest monsoon (SWM) season is shown in **Fig.4.11**. The correctness of forecast is more in block level forecast (18.85%) compared to district level forecast (21.31%). The usable forecast is 17.21% and 14.75% in the case of block level and district level forecast, respectively. The unusable forecast is same in the case of block level forecast and district level forecast (63.93%).

Table 4.15: Validation of district level and block level forecast

Parameter	Block level forecast	District level forecast
Total number of days	122	122
No: of days when rain was forecasted and also observed	120	121
No: of days when rain was not observed but forecasted	0	0
No: of days when rain was observed but not forecasted	2	1
No: of days when rain was not observed and also not forecasted	0	0
No: of matching cases	120	121
Skill Score or Ratio Score of rainfall	98.36	99.18
Probability of detection (POD)	0.98	0.99
False Alarm Ratio (FAR)	0	0
Root mean square Error (RMSE)	22.85	16.91
Correct forecast	18.85	21.31
Usable	17.21	14.75
Unusable	63.93	63.93

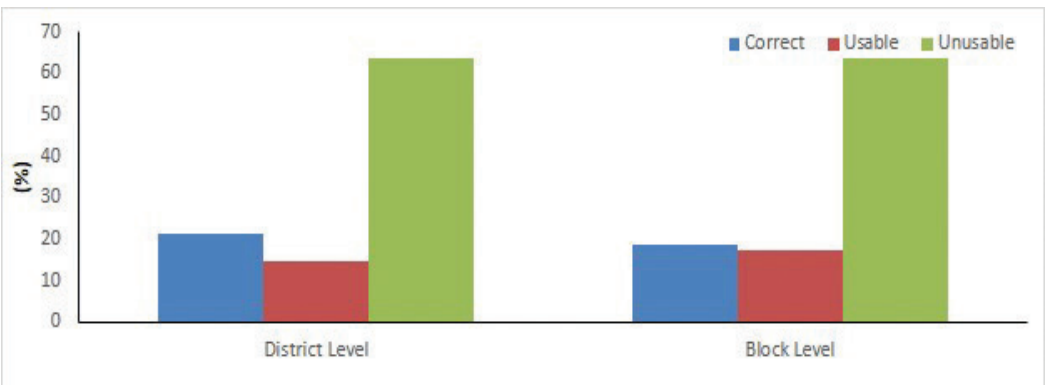


Fig 4.11: Quantitative analysis of rainfall forecast during SWM season at Anakkayam

Kovilpatti

Verification of block level rainfall forecast during the year 2019 at Chellampatti and Usilampatti blocks were carried out. The forecast under-estimated the monthly rainfall for all the months at both places except for the months of June and August at Usilampatti (**Fig. 4.12**). The aggregate of correct and usable forecast is high (>80%) during the months of April, May, June, July and January months and relatively low during September, October, November and December months (**Table 4.16**).

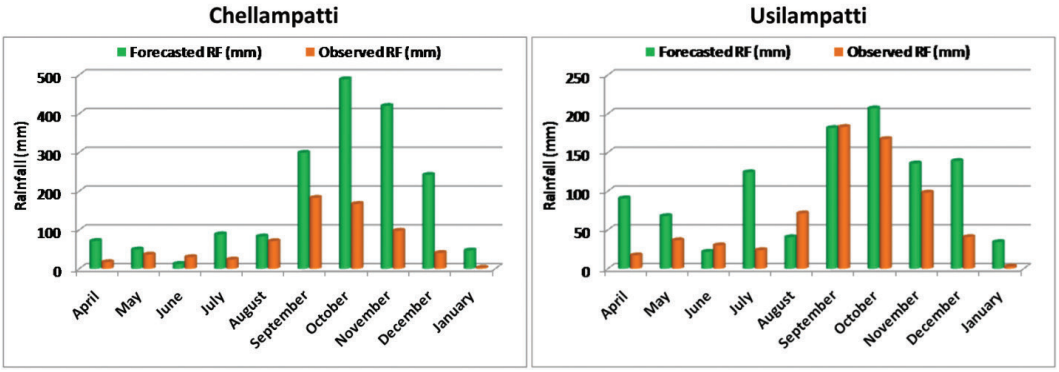


Fig 4.12: Comparison of block level rainfall forecast with observed data during the year 2019 at Chellampatti and Usilampatti blocks

Table 4.16: Evaluation of block level rainfall forecast during the year 2019 at Chellampatti and Usilampatti blocks

Month	Chellampatti						Usilampatti					
	Error Structure			RMSE	Ratio score	H.K. score	Error Structure			RMSE	Ratio score	H.K. score
	Correct	Usable	Unusable				Correct	Usable	Unusable			
April	86.36	9.09	4.55	7.32	73.33	0.5	78.95	5.26	15.79	7.57	63.33	0.4
May	76.47	11.76	11.76	3.91	54.84	0	72.73	18.18	9.09	4.07	35.48	-0.3
June	84.21	10.53	5.26	2.63	63.33	0.1	82.35	5.88	11.76	2.73	56.67	0
July	78.26	0	21.74	6.94	74.19	0.6	75	12.5	12.5	9.84	77.42	0.6
August	52.94	11.76	35.29	8.4	54.84	0.1	50	22.22	27.78	5.48	58.06	0.2
September	38.1	14.29	47.62	20.99	70	0.4	27.27	22.73	50	9.43	73.33	0.4
October	9.52	4.76	85.71	16.04	67.74	0.2	5.88	17.65	76.47	11.98	54.84	-0.1
November	0	10.53	89.47	16.04	63.33	-0.1	19.05	23.81	57.14	7.64	70	0.2
December	31.58	15.79	52.63	10.33	61.29	0.3	38.46	23.08	38.46	7.04	41.94	-0.1
January	86.96	0	13.04	4.34	74.19	0.5	93.33	6.67	0	2.18	48.39	-0.2

Ranchi

Evaluation of rainfall forecast during the year 2019 at Ghagra and Daltonganj blocks were carried out. The results pointed out that the forecast exhibited a success ratio more than 75% for annual rainfall and more than 65% for Southwest monsoon rainfall (**Table 4.17**).

Table 4.17: Evaluation of rainfall forecast with observed data during the year 2019 at Ghagra and Daltonganj blocks

Block	Annual Rainfall			SWM Rainfall		
	Percentage (%)		No. of observations	Percentage (%)		No. of observations
	Success	Failure		Success	Failure	
Ghaghra (Gumla)	77.25	22.74	343	67.25	32.74	171
Daltonganj (Palamu)	79.3	20.69	343	68.42	31.57	171

Parbhani

The block-level medium range weather forecast issued by IMD was compared with the rainfall data from Parbhani block and the results are presented in **Fig. 4.13**. It is observed that during the months of southwest monsoon season, the difference between actual and predicted data was relatively high, except on few dates. The July and September forecast of rainfall was slightly better, although the daily rainfall is under-predicted. It is observed that during monsoon, especially in June, the difference between actual and predicted minimum and maximum temperature was more.

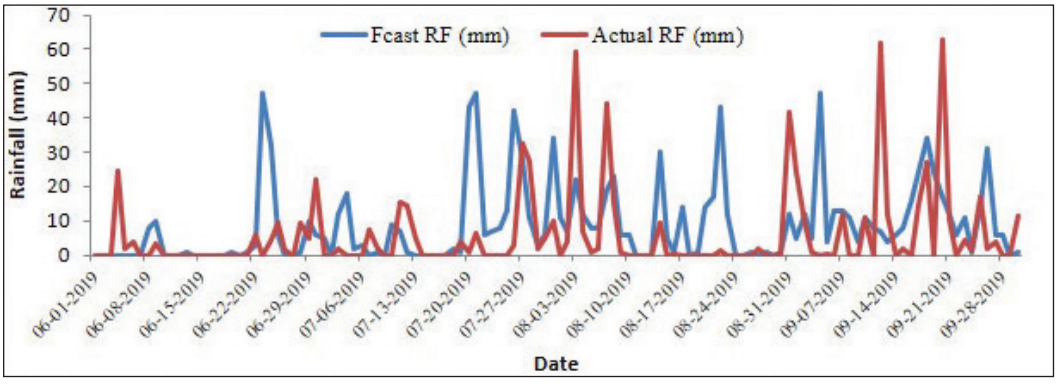


Fig 4.13: Comparison of predicted and observed daily rainfall at Parbhani block

5. Micro-level Agromet Advisory Services

Agromet Advisory Services (AAS) have been issued at district-level since 2008 by India Meteorological Department (IMD) and continued even now. The district-level AAS is provided to farmers making use of medium range weather forecast of National Center for Medium Range Weather Forecast (NCMRWF) and IMD. However, the validity of blanket advisories disseminated at district-level has limitations, particularly in view of the large variability in terms of crops, varieties and spatial weather anomalies at this level.

Under this project, AICRPAM initiated block-level AAS in Belgaum district of Karnataka through its Vijayapura center. Using district-level forecasts after three years of experimentation it was concluded that the district-level forecasts were indeed not sufficient to answer the demands of the block-level crop and weather variability within the district. To overcome this constraint, on request, IMD has been providing block-level weather forecasts for identified districts since 2014. This has now enabled.

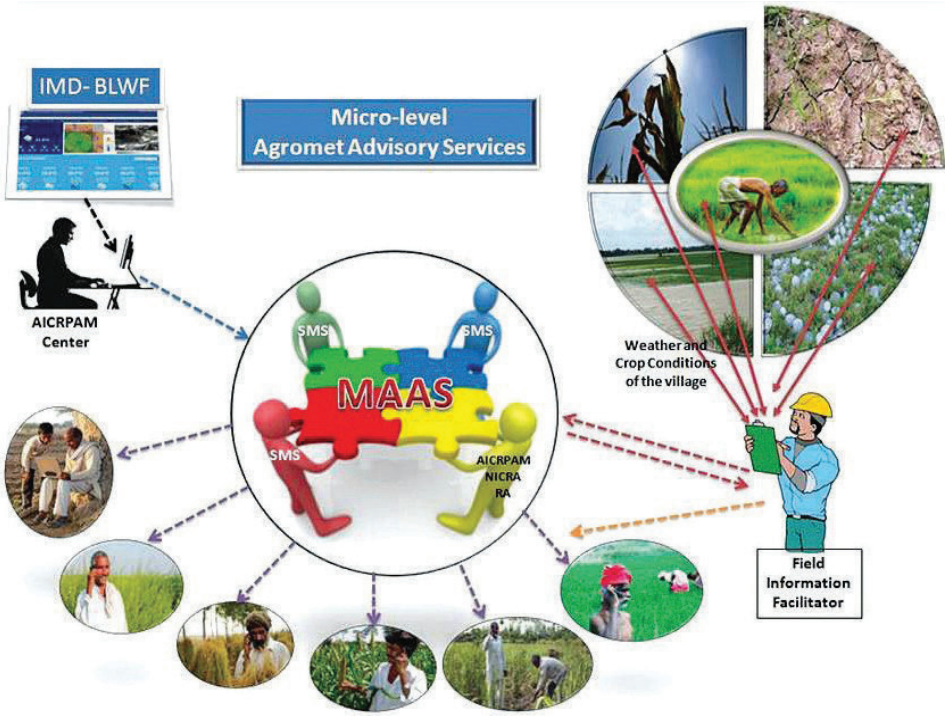


Fig 5.1: Conceptual diagram of block-level AAS

AICRPAM to ingeniously develop and disseminate AAS at block-level through all its 25 cooperating centers and Krishi Vigyan Kendras (KVK) of the respective districts. The conceptual process diagram of block-level AAS developed by AICRPAM is presented in **Fig 5.1**.

Such advisories are now designated as micro-level AAS. AICRPAM centers have initiated micro-level AAS on pilot basis at 50 villages across India under this project in the past three years. The scientific staff receives block-level weather forecasts from IMD website, and advisories are developed in consultation with Subject Matter Specialists of respective KVKs. Another important and useful concept 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 weather and crop 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 selected village is identified for this purpose. Feedback from FIF provides real situation at village level based on which and the block-level forecast, micro-level advisories are prepared. Thus, the Agrometeorologist of the AICRPAM center develops the Agromet advisory bulletins with the help of SMS at KVK using the field level crop information blended with weather forecasts and communicated 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 as well as voice SMS, display at public places, personal contact etc. The feedback obtained from the farmers is being evaluated for improving as well as expanding services for the benefit of farming community.

5.1. Selection of AICRPAM-NICRA villages

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

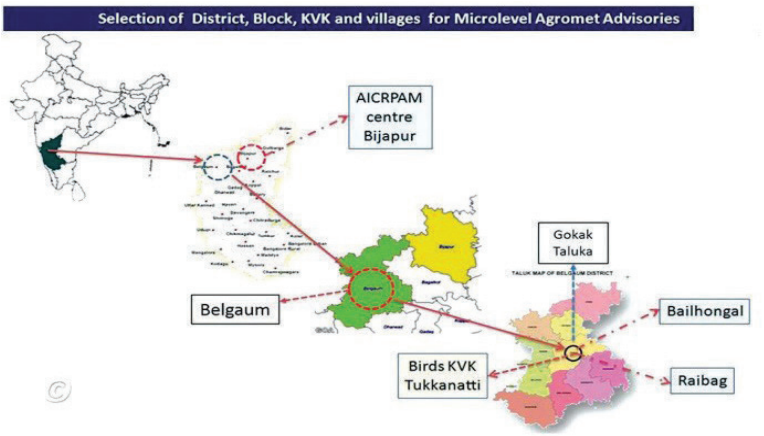


Fig. 5.2 Selection of district, block, KVK and villages for micro-level AAS

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 AICRPAM-NICRA project, both conventional and latest ICT tools are used for dissemination of micro-level AAS. A pictorial representation of various methods of dissemination used in AICRPAM- NICRA project is given in **Fig 5**.

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
- Nowadays, many government and private agencies allow bulk SMS facilities.
- Voice SMS: AAS is send 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 Whatsapp group for tech-savvy farmers.
- Dandora method: It is followed by Anantapur 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 Agromet Advisory Services

The crucial objective of weather based AAS is to help the farmers in decision making in their day to day activity as well as in the judicious input use. Regulating the erratic weather on a large scale is beyond the human control. However, it is possible to adapt or mitigate the ill effects of weather through appropriate Agromet advisory. Further, it will increase the economic benefit of the farmers 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 centres. Economic impact of individual advisories is discussed here and the cumulative impact of block-level AAS issued throughout the crop season is detailed in the case study section. There were mixed impacts, some farmers gained from the agromet advisories while others suffered losses. Some of the examples from different NICRA villages collected and compiled by the individual centres is discussed below.

Table.5.1: Micro-level Agromet Advisories and their economic benefits in different crops at various locations during the year 2019-2020

Akola

Soybean

Date of issue of advisory	Crop condition/ Crop stage	Forecast	Agromet Advisory issued	Observed weather	Action taken by farmer	Remarks
30/07/19	Soybean: Late vegetative stage	Forecast of cloudy and light to moderate rainfall of 8 to 10 mm in next 5 days	Undertake hoeing/ weeding operation before interlocking of canopy growth between rows to make crop weed free and facilitate better surface tilth, aeration and improve rain infiltration	13.4 mm rainfall received on 5 August	Followed the advisory and weeding/ Hoeing undertaken	Weed free condition enhanced crop vigour and subsequent growth and improved surface soil tilth, ensured better soil aeration and rain water conservation
06/08/19	Late Vegetative stage, Infestation of leaf eating caterpillar	Light to moderate rainfall expected in next 5 days	After notifing leaf eating caterpillars, undertake spraying of Chlora-ntraniliprole 18.5 % SC @3.0 ml/10 litres of water along with stickers and adjuvant	46.4 mm rainfall on 09 August	Spraying of Chlorantranili-prole along with stickers undertaken	Significantly reduced the infestation of leaf eating caterpillars
20/08/19	Peak flowering to pod initiation stage.	Forecast of cloudy weather with light to moderate rainfall in next 5 days	Do not undertake any plant protection/foliar spray. Drain out excess water due to water logging	53 mm rainfall on 23 August	Drained out water in waterlogged areas immediately	Adequate drainage of excess water improved field/crop condition

Date of issue of advisory	Crop condition/ Crop stage	Forecast	Agromet Advisory issued	Observed weather	Action taken by farmer	Remarks
27/08/19	Pod formation stage	Cloudy weather and forecast of moderate rainfall	Do not undertake any plant protection/foliar spray. Drain out excess water in the event of water logging	45.6 mm rainfall received between 27 Aug-02 Sept	No other operations undertaken. Drained out water from scattered patches	Better field conditions prevailed for further crop growth and development
03/09/19	Peak pod formation stage	Forecast of light to moderate rainfall (61 mm) in next 5 days	Drain out excess water from water logged areas of crop field	34.3 mm rainfall received between 03-09 September	Drained out excess water from waterlogged areas across the crop field	With drainage of excess water better field conditions prevailed for crop growth and development
10/09/19	Seed develop-ment stage	Cloudy weather and light to moderate rainfall (25 mm) expected in next 5 days.	Recommended foliar spray of 2% urea (200g/10 litres of water)	33.5 mm rainfall received between 10-16 September	Foliar spray of urea was done on 14 September	Foliar spray benefited the crop by providing crop nutrition during pod formation stage
17/09/19	Seed develop -ment stage	Forecast of light to moderate rainfall (42 mm) in next 5 days	Advisory given to drain out water in water logged areas of crop field	89 mm rainfall received between 17-23 September	Drained out water in waterlogged areas immediately	Better field conditions for subsequent crop development

Date of issue of advisory	Crop condition/ Crop stage	Forecast	Agromet Advisory issued	Observed weather	Action taken by farmer	Remarks
08/10/19	Harvest maturity stage	Dry weather expected in next 5 days	Undertake harvesting of the crop and keep the harvest produce safely to protect against rains	No rain occurred in next 5 days	Soybean was harvested on 12th October	Obtained yield of 21.2 q ha^{-1}, net profit of Rs. 50615/ha

Akola

Cotton

Date of issue of advisory	Crop condition/ Crop stage	Forecast	Agromet advisory issued	Observed weather	Action taken by farmer	Remarks
30/07/ 2019	Vegetative stage	Cloudy weather & light rainfall (8-10 mm) expected	Keep the crop weed free during critical period of crop weed competition.	13.4 mm rainfall received on 5 August	Advisory was followed and weeding undertaken	Weed free conditions facilitated better crop vigour and subsequent growth
06/08/ 2019	Vegetative stage	Light to moderate rainfall expected in next 5 days	Recommended furrow opening between rows at the time of hoeing	46.4 mm rainfall on 09 August	Advisory of hoeing with furrow opening followed	Hoeing and furrow opening ensured better soil aeration and in-situ rain water conservation
13/08/ 2019	Vegetative stage / square formation: Sap sucking pest (aphid/jassid) infestation	Cloudy weather and forecast of moderate rainfall (50 mm rainfall) in next 5 days	With incidence of sap sucking pest undertake spraying of acetamaprid	2.3 mm rainfall on 17 August	Spraying of acetamaprid 20% SP @ 4 g /10 litres of water was undertaken	Notably reduced the infestation and Improved crop condition

Date of issue of advisory	Crop condition/ Crop stage	Forecast	Agromet advisory issued	Observed weather	Action taken by farmer	Remarks
20/08/ 2019	Vegetative stage, Dry weather since 27 July. Field level mid-day stress	Forecast of cloudy weather with light to moderate rains in next 5 days	Apply protective irrigation in view of continued and further forecast of dry weather.	53 mm rainfall on 23 August	Advisory adopted and protective irrigation provided on 13 August	Timely irrigation benefitted crop development
27/08/ 2019	Square formation stage	Cloudy weather and forecast of moderate rainfall	Drain out excess water due to water logging	45.6 mm rainfall received between 27 Aug-02 September	Advisory adopted. Timely drained out excess water	Adequate drainage improved field/crop condition
03/09/ 2019	Square formation and flower initiation	Forecast of Light to moderate rainfall (61 mm) in next 5 days	Drain out excess water in the event of water logging	34.3 mm rainfall received between 03-09 September	Drained out few waterlogged patches across crop field	Timely drainage of excess water benefitted subsequent crop growth
10/09/ 2019	Square formation and flowering stage	Cloudy weather and light to moderate rainfall (25mm) expected in next 5 days	Recommended foliar spray of 2% Urea (200g/10 litres of water)	33.5 mm rainfall received between 10-16 September	Foliar spray of 2% urea was applied on 11 September	Foliar spray would benefit in providing crop nutrition and better yield
17/09/ 2019	Square formation/ flowering /first boll initiation	Forecast of light to moderate rainfall (42 mm) in next 5 days	In view of the weed growth in crop field, undertake weeding to prevent weed competition during subsequent crop growing period	89 mm rainfall received between 17-23 September	Advisory was followed and weeding undertaken	Weeding facilitated better crop vigour and further growth/ development

Date of issue of advisory	Crop condition/ Crop stage	Forecast	Agromet advisory issued	Observed weather	Action taken by farmer	Remarks
24/09/ 2019 and 01/10/ 2019	Vegetative stage / square formation, Sap sucking pest (white fly) infestation	Cloudy weather & light to moderate rainfall expected	With incidence of sap sucking pest –white fly, undertake spraying of Triazophos 40% EC @30 ml OR Diafenthiuron 50 % WP 12.0 g /10 litres of water on a clear day, avoiding rainy weather. Drain out water in water logged areas in crop field due to 58 mm rainfall received on 14 September.	42.3 mm rainfall occurred during 24 September -01 October	Plant protection not undertaken. Drained out water from waterlogged areas across crop field	Cost saving of one plant protection measure. Timely drainage improved field/crop condition
15/10/ 2019	Incidence of White fly	Forecast of dry weather	Advisory to undertake spraying of Triazophos 40% EC @30 ml OR Diafenthiuron 50 % WP 12.0 g /10 litres of water on a clear day , avoiding rainy weather.	No rainfall received during the week	Plant protection undertaken on 28 September	White fly infestation reduced improving crop vigour
22/10/ 2019	Boll formation/ development stage	Forecast of dry sunny weather	Recommended foliar spray of 2% (200g DAP/10 litres of water)	Dry weather prevailed with no rains in next 6 days	Foliar spray of 2% DAP was applied on 04 October	Foliar spray would benefit in terms of crop nutrition during boll formation phase, reflecting in final yield
05/11/ 2019	First picking stage	Forecast of dry weather	Real time advisory during cotton harvest to ensure clean collection of fully opened burst bolls for better market grade of the produce	Dry weather prevailed	First picking undertaken	--

Date of issue of advisory	Crop condition/ Crop stage	Forecast	Agromet advisory issued	Observed weather	Action taken by farmer	Remarks
12/11/ 2019	Mild incidence of Pink boll worm in later developing bolls	Forecast of dry sunny weather	Undertake spraying of Quinolphos 25% EC @ 25 ml OR Deltamethrin *2.8%* EC @ 9.0 ml /10 litres of water.	Dry weather prevailed	Plant protection by Quinolphos spray undertaken	Intensity of pest reduced improving the development of bolls
19/11/ 2019 - 14/01/ 2020	Second, third and fourth picking stages	Forecast of dry sunny weather	Undertake harvesting of cotton. Ensure clean collection of fully opened burst bolls and storage at dry place for better market grade of the produce	Dry weather prevailed	Picking wise harvest undertaken	Obtained total seed cotton yield of 14.5 q ha^{-1}

Samastipur

Paddy

Date	Crop stage	Weather forecast	Advisory given in NICRA bulletin	Actual rainfall happened	Action taken by the farmer	Loss/profit
12-13 June, 2019	Nursery sowing	Chances of light rainfall during 12-13 June	Nursery sowing of medium duration paddy was advised	About 26.2 mm rainfall occurred	The farmer acted as per the Agromet advisory	He saved the cost of irrigation charge of Rs. 2000/ha
7 July, 2019	Transplanting	Due to active monsoon, chances of rainfall during next 3-4 days	In view of rainfall forecast, transplanting of paddy was advised.	About 277.2 mm rainfall occurred during 7-14 July	With very good rainfall, the farmer went for transplanting.	He saved irrigation cost of Rs. 2000/ha

Date	Crop stage	Weather forecast	Advisory given in NICRA bulletin	Actual rainfall happened	Action taken by the farmer	Loss/profit
23-25 July, 2019	Early transplanting	Chances of rainfall during next 2-3 days	In view of rainfall forecast, postpone irrigation in transplanted paddy crop	About 117.2 mm rainfall occurred during 23-25 July	Waited for rain and acted as per the Agromet advisory	Healthy crop was realized
7 August, 2019	Tillering stage	Chances of rainfall in coming 1-2 days	In view of rainfall forecast, farmers were advised to postpone irrigation in paddy crop	About 60.6mm rainfall occurred on 7 and 9 August	Waited for rain and acted as per the Agromet of NICRA advisory	He saved irrigation cost of Rs. 2000/ha
15 August, 2019	Late tillering stage	Chances of rainfall in coming 1-2 days	In view of rainfall forecast, Postpone irrigation in paddy crop	About 53.1mm rainfall occurred during 15-16 August	Waited for rain and acted as per the Agromet advisory	He saved cost of irrigation @ 2000/ha
02 September, 2019	Reproductive stage	Chances of dry weather in next 3-4 days	Farmers were advised to give life saving irrigation in paddy crop.	No rainfall occurred during this period (23 August to 11 September)	Farmer applied life saving irrigation in paddy crop	Saved his paddy crop from ill effects of water stress condition
12 September, 2019	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 74.2mm rainfall occurred during 12-16 September	Waited for rain and acted as per the Agromet advisory	He saved irrigation cost of Rs. 2000/ha
26 September, 2019	Late Reproductive stage	Chances of medium rainfall at many places and heavy rainfall at 1-2 places	In view of rainfall forecast, postponement of irrigation in paddy crop was suggested	About 250.6.mm rainfall occurred during 26-29 September	Waited for rain and acted as per the Agromet advisory	He saved irrigation cost of Rs. 2000/ha

Samastipur

Paddy

Specific Response of Farmers to NICRA Advisory disseminated in NICRA villages

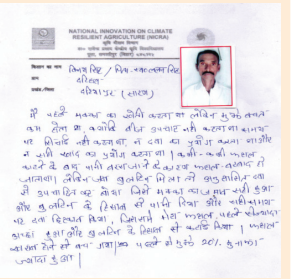
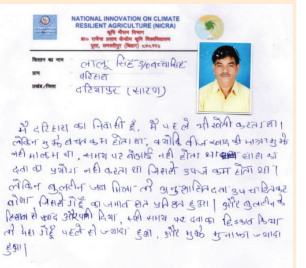
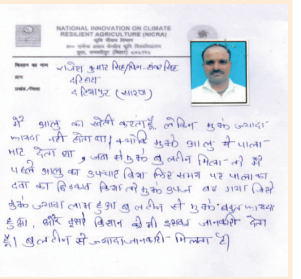
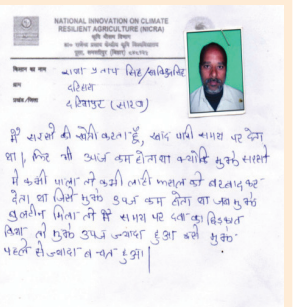
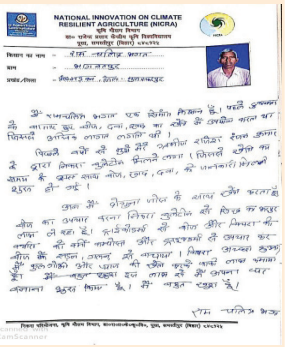
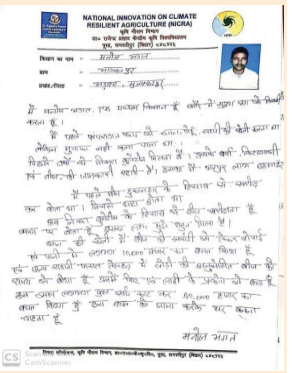
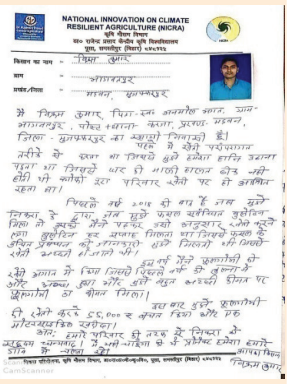
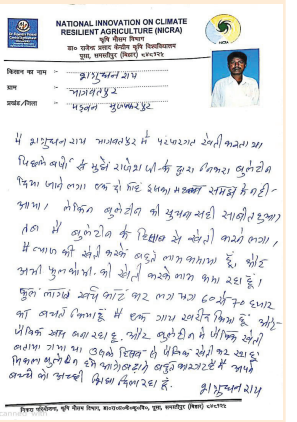
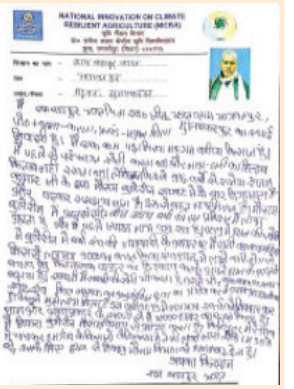
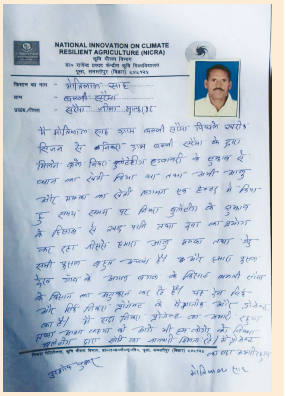
S.No.	Farmer's name	Comments	Photographs
1.	Sri Vinay Singh	• Germination of maize crop was good, as it was planted as per sowing dates given in agromet advisory. Plant protection and irrigation schedules were also followed for raising crops • I got 20% extra benefit by following weather based NICRA advisory	
2.	Sri Lalu Singh	• Sowed wheat at optimum time after seed treatment given in agromet advisory, which I did not know earlier • Also I provided irrigation and applied fertilizer based on agromet advisory	
3.	Rajesh Kumar Singh	• I am a potato farmer. Earlier, I did not treat potato tubers before planting • Ever since, I started potato farming according to NICRA bulletin, I got lots of benefits. Now I inform my fellow farmers in the area about the information that I get from advisory bulletins.	
4.	Sri Rana Pratap Singh	• I cultivate mustard and earlier I used to get low yield, because of aphid attack and low temperature. I started applying pesticides according to bulletin and got good saving	

Table 13: Farmers Response' to the utility of NICRA bulletins in crop production at Saraiya block of Muzaffarpur District

S.No.	Farmer's name	Comments	Photographs
1.	Sri Ram Chalit Bhagat	• Used information from NICRA advisory in farming. Treated seeds before nursery sowing. • Got information about seed treatment with Trichoderma. Used vermi-compost • Advisory helped in getting good harvest of cauliflower and onion	
2.	Sri Manoj Bhagat	• Earlier I used to get information about seed from agricultural input shop. Now I get it from NICRA bulletin and sow crops as per the information given in bulletin. • From paddy cultivation, I got profit of about Rs.10,000 ha^{-1}. • Applied spray against aphids and got lot of benefits. Also I now use recommended varieties of crops as suggested in the advisory	
3.	Sri Vikram Kumar	• I followed NICRA bulletin in my farming from 2018. Following these advisories, I cultivated early varieties of cauliflower, which gave me high profits. Advisories given in the bulletins helped in proper management of crop. • I want NICRA project to continue in my village.	

S.No.	Farmer's name	Comments	Photographs
4.	Sri Satroghan Roy	I understood the utility of NICRA advisory in succesful crop management.	
5.	Sri Ram Bahadur Bhagat	• Saved the irrigation as per Agromet advisory • Altogether, I saved Rs.9000 ha^{-1} from rice cultivation by saving irrigation cost and protecting rice against insect pests.	
6.	Sri Moti Lal Sahu	I was immensely benefited by following agromet advisory bulletins	

Bengaluru

Crops : Red gram, Finger millet, Sesamum, Groundnut and Cowpea

Sl. No.	Dates of Agromet Advisory Issued	Name of the village	Weather event / forecast	Agromet Advisory given to different crops	Amount of rain received (mm)
1	1-5 June 2019	Nayanahalli	Light to Moderate rain forecasted during next 5 days	Ploughing across the slope will make *in-situ* soil moisture conservation and take up land leveling so that more rain water is conserved in the soil.	32.5
		Kuthanagere		Tank silt application will improve the soil texture and soil fertility.	132.0
		D. Nagenahalli		The farmers should procure good quality of seeds and fertilizers. Take up the germination test before sowing. The following crops are suggested for sowing. **Under monocropping (long duration crops):** Redgram : TTB-7, BRG-1,2,4&5, Finger millet MR-1,6, L-5 Rhizobium seed treatment to the pulse crops before sowing and spray Actra (1g/l) or Lancer gold against sucking pests. **Under double cropping (short duration crops):** Finger millet: Indaf -9, ML-365, Seasamum : Navile-1, T-7, Groundnut: TMV-2, JL-24, KCG-6, Cowpea: TVX-944, KBC-1,	82.0
2	6-11 June 2019	Nayanahalli	Light to Moderate rain expected	Take up sowing of small millets	45.0
		Kuthanagere		Recommend varieties: **Foxtail**: R.S -118, K-221-1, P.S-4, S.I.A-326 and	0.6
		D. Nagenahalli		**Little millet** :C.O-2, P.R.C-3, O.L.M-203 Avare: HA-3,4 Treat the pulse seeds with rhizobium inoculation before sowing and spray Actra (1g/l) or Lancer gold against sucking pests.	22.0

Sl. No.	Dates of Agromet Advisory Issued	Name of the village	Weather event / forecast	Agromet Advisory given to different crops	Amount of rain received (mm)
3	12 -14 June 2019	Nayanahalli	Light rain expected	Wind speed is high; provide staking support to Banana and vegetable crops to protect from lodging of crops.	0
		Kuthanagere			0
		D. Nagenahalli			0
4	15-18 June 2019	Nayanahalli	Cloudy conditions and light rainfall expected during this period	To conserve the moisture, control the weed and to make best use of underground water go for plastic mulching on raised beds underneath drip irrigation and go for high value crops like fruits and vegetables.	0
		Kuthanagere			0
		D. Nagenahalli			0
5	19-21 June 2019	Nayanahalli	Light rain forecasted, wind speed is expected around 10-12 km/hr	In mango trees, thinning of canopy is suggested for proper penetration of sunlight. Due to high humidity (warm and humid weather) possibility of pest and disease build up is more in the already sown crop. Take prophylactic measures depending on the crop.	0
		Kuthanagere			5.6
		D. Nagenahalli			0
6	22-25 June 2019	Nayanahalli	Light rain forecasted	Spray rose plants with score @2.25 g/lit for the control of black spot. Protect against wind speed by providing staking support to tomato and other vegetables.	24.2
		Kuthanagere			7.8
		D. Nagenahalli			48.0
7	26-28 June 2019	Nayanahalli	Mostly cloudy conditions, chances of light rain	Take up deep ploughing to expose the soil to kill the soil born insects. Advised for inter-cultivation in mango to conserve soil moisture in the field. Recommended pruning in June-July months to facilitate better penetration of sunlight. Apply micronutrients for flower and vegetable crops.	0
		Kuthanagere			0
		D. Nagenahalli			0

Sl. No.	Dates of Agromet Advisory Issued	Name of the village	Weather event / forecast	Agromet Advisory given to different crops	Amount of rain received (mm)
8	29 June -02 July 2019	Nayanahalli	Light rainfall expected	Grow barrier crops around the vegetable fields to restrict sucking pests. Advised to take up sowing of finger millet with akkadi crops in 8:1(finger millet +redgram) ratio.	0
		Kuthanagere			0
		D. Nagenahalli			10
9	03 -05 July 2019	Nayanahalli	Likely chances of light rains	Postpone sowing operation until soaking/sufficient rainfall received.	0
		Kuthanagere		Wherever, long duration crops like Redgram has been sown, undertake earthing up operation in addition to the above agronomic measures. Earthing up makes better availability of soil moisture to crop rows through conversion of the land into ridges and furrows.	0
		D. Nagenahalli			0
				Wherever, over population of crop plants is existing, undertake thinning operation for better availability of scarce soil moisture to the reduced population of crop plants.	
10	6-9 July 2019	Nayanahalli	Mostly cloudy conditions, chances of light rain	Take up inter cultivation operation in redgram. Take up the medium duration varieties of finger millet like GPU-28,66 and sowing of medium duration crops (wherever rain has occurred).	0
		Kuthanagere			2.0
		D. Nagenahalli			0
11	10-12 July 2019	Nayanahalli	Light rains expected	Sowing of cabbage /cauliflower as inter or border crop with mustard /tomato to reduce diamond back moth population.	0
		Kuthanagere		Take up inter cultural operation ‘wherever crops are established’ for better weed management and aeration.	11.2
		D. Nagenahalli			0
				Go for top dressing with recommended dose of nitrogen after the weeding.	

Sl. No.	Dates of Agromet Advisory Issued	Name of the village	Weather event / forecast	Agromet Advisory given to different crops	Amount of rain received (mm)
12	13-16 July 2019	Nayanahalli	Light rains expected	Agro-forestry on the bunds involving *Meliadubia* (Hebbevu), Silver oak and Causurina is recommended for sustainable income under abnormal extreme rainfall events. Sericulture: Flacherie diseases: This is found in all seasons of the year, particularly its incidence are high in summer and rainy seasons. Care to be taken that infections should not enter from outside, recommended bed disinfectants like Suraksha, Vijetha, Ankush, Samrakshak etc., as per recommended dose are to be dusted at each stage in the bed.	24.0
		Kuthanagere			17.0
		D. Nagenahalli			0
13	17-23 July 2019	Nayanahalli	Light rains expected	Make use of farm pond water and this may be used for protective irrigation during the prevailing dry spell.	22.0
		Kuthanagere			2.6
		D. Nagenahalli			0
14	24 – 30 July 2019	Nayanahalli	Likely chances of light rains	Wherever over population of crop plants are existing, undertake thinning operation for better availability of scarce soil moisture to the reduced population of crop plants. If Wilt diseases are noticed in Redgram crop- Spray Carbendazim 50 WP 2 g/litre of water.	35.5
		Kuthanagere			40.6
		D. Nagenahalli			37.0
15	31 July -2 August 2019	Nayanahalli	Likely chances of light rains	Recommended to sow medium to short duration crops like finger millet (Indaf-5, 9, GPU-28, 45 and 48,KMR-202,KMR-301, ML-365), maize (Ganga, Deccan, Vijaya composite and Composite NAC), groundnut (JL-24, KCG-2, GBBD-4), cowpea (C-152, KM-5 and PKB-4 for vegetable purpose), Field bean-HA-3 and 4	0
		Kuthanagere			0
		D. Nagenahalli			0

Sl. No.	Dates of Agromet Advisory Issued	Name of the village	Weather event / forecast	Agromet Advisory given to different crops	Amount of rain received (mm)
16	3- 6 August 2019	Nayanahalli	Rainfall expected, mostly cloudy weather prevails	Grow contingent short duration crops such as cowpea, horse gram, green gram, black gram and foxtail millet.	14.0
		Kuthanagere			11.4
		D. Nagenahalli			0
17	4- 8 August 2018	Nayanahalli		Due to high humidity (warm and humid weather), possibility of pest and disease build up is more in already sown crop. Take prophylactic measures depending on the crop. Removal of dead and decomposed twigs and unwanted excessive branches in grapes helps in preventing diseases and pest build up through proper light penetration. Maintain optimum plant population in July sown crops to conserve soil moisture and take up harrowing to control weeds. Mulching by using crop residues and weeds in between rows is also recommended.	18.7
		Kuthanagere			26.8
		D. Nagenahalli			20.0
18	9- 12 August 2019	Nayanahalli	Light rains expected	Crops/varieties suggested:Finger millet- Indaf-7,9,15, Horse gram: K.B.H-1, P.H.G-9, field bean- H.A- 3,4, Baby corn-Amber, Cow pea-T.V.X – 944, P.K.B (Vegetable purpose). Wherever farmers have taken first crop of sesamum/ fieldbean / cowpea, harvest before first fortnight of August. Go for second crop of horsegram/ niger immediately.	3.0
		Kuthanagere			1.8
		D. Nagenahalli			0
19	13- 20 August 2019	Nayanahalli	Light to medium rains expected. Min temperature of 21°C and RH of 82-84 %	Foliar spray of micronutrients in flower crops.	45.1
		Kuthanagere			124.0
		D. Nagenahalli			46.0

Sl. No.	Dates of Agromet Advisory Issued	Name of the village	Weather event / forecast	Agromet Advisory given to different crops	Amount of rain received (mm)
20	21 - 30 August 2019	Nayanahalli	Cloudy weather prevails, light rains expected	To avoid the lodging due to high wind speed provide staking for vegetable crops. Take up the contingent crops viz., horsegram, black gram, Cowpea, Field bean and fodder maize.	0
		Kuthanagere			35.2
		D. Nagenahalli			30.0
21	31 August - 6 September 2019	Nayanahalli	Cloudy weather prevails, light to rains expected	Postpone the plant protection measures in next couple of days due to high wind speed, cloudy and light rainfall.	9.5
		Kuthanagere			15.4
		D. Nagenahalli			12.0
22	5-9 September 2018	Nayanahalli	Light rains expected	Drench the carbendazim (1ml/l) to redgram fields for controlling wilt and Spray NSKE (4%) or neem oil to control sucking pests.	16.0
		Kuthanagere			4.2
		D. Nagenahalli			12.0
23	10-13 September 2019	Nayanahalli	Light rains expected	Continue sowing of late *kharif* crops. In case of over population of crop plants, undertake thinning operation for better availability of soil moisture.	1.0
		Kuthanagere			13.2
		D. Nagenahalli			0
24	14-17 September 2019	Nayanahalli		Once rain is received, top dress in maize crop @ 25 kg N/ha.	7.5
		Kuthanagere		To control stem borer in maize, spray Quinolphos-25 EC @ 2ml/liter of water or Chlorophyriphos -20 EC @ 2ml/liter of water.	15.6
		D. Nagenahalli		Spray metalaxyl + mancozeb for controlling downy mildew in grapes and advised foliar spray of micronutrients in flower crops. Apply gypsum (10 kg/acre) to groundnut crop.	7.0

Sl. No.	Dates of Agromet Advisory Issued	Name of the village	Weather event / forecast	Agromet Advisory given to different crops	Amount of rain received (mm)
25	18-20 September 2019	Nayanahalli	Light rains expected	Wherever pre-monsoon short duration crops are sown in the month of May, harvest the late *kharif* crops in August, like Finger millet (Indaf-5, 9, HR-911, GPU-26,28, 45&48, ML-365), Horse gram (PHG-9, KBH-1), Niger, Field bean (HA-3 and 4), sunflower (KBSH-1,41,42, 44 & 53) and cowpea (KBC-1, TVX-944 and PKB-4) for vegetable purpose. Recommended to take up gap filling and other cultural operations like thinning, mulching and earthing up in already sown crops.	37.7
		Kuthanagere			0
		D. Nagenahalli			8.0
26	21-24 September 2019	Nayanahalli		Recommended to take up gap filling and other cultural operations like thinning, mulching and earthing up in already sown crops.	50.2
		Kuthanagere			37.8
		D. Nagenahalli			34.0
27	25-27 September 2019	Nayanahalli	Mostly cloudy weather with Light to moderate rains expected	Remove excess rainwater from already sown crop	3.0
		Kuthanagere		If blast disease noticed in finger millet, spray Mancozeb @ 2gm/litre (100 gm/acre) or Zainab @2.5 gm/litre (500 g/acre).	0
		D. Nagenahalli		If pod borer is noticed, spray indoxycarb 14.5 SC @ 0.5 ml/litre or Spynosad 45 SC @ 0.15 ml/litre or Chloropyrifos 20 EC @ 2ml/litre. If Wilt disease is noticed in field, recommended Drenching with Carbendazim 50 WP 2 g/litre of water. Remove and burn wilt infected plants in field.	61.0
28	28 September -01 October 2019	Nayanahalli	Light to moderate rains expected	Remove excess rainwater from already sown crop field. Apply	0
		Kuthanagere		Flubendiamide (0.2ml/l) for the control of Helicoverpa in red gram. Put Yellow/blue sticky traps to monitor sucking pests in cabbage, cauliflower. Practice the top dressing in ragi and maize.	16.0
		D. Nagenahalli			23.0

Sl. No.	Dates of Agromet Advisory Issued	Name of the village	Weather event / forecast	Agromet Advisory given to different crops	Amount of rain received (mm)
29	02-04 October 2019	Nayanahalli	Mostly cloudy weather with intermittent showers	Imidocloprid or neem oil to control thrips and mealy bugs in grapes. Take up the contingent crops viz., horse-gram, sunflower, fodder maize.	71.3
		Kuthanagere			27.8
		D. Nagenahalli			44.0
30	5-8 October 2019	Nayanahalli		Take up the contingent crops viz., horse gram, sunflower, fodder maize. Apply chlorpyriphos (4ml/l) to red gram field for the control of termites, Spray Curzate in cool hours to manage downy mildew in grapes	16
		Kuthanagere			48
		D. Nagenahalli			30
31	9-11 October 2019	Nayanahalli	Mostly Light to moderate rainsexpected during evening/ night	Remove excess rainwater from already sown crop field	232
		Kuthanagere		Since there was enough moisture in the soil, advised not to irrigate the crops.	2.6
		D. Nagenahalli			0
32	12-15 October 2019	Nayanahalli		Prepare the land for sowing of *rabi* crops	21.1
		Kuthanagere		Finger millet: Top dress Nitrogen @ 12.5 kg ha^{-1} immediately after rainfall is received.	7.6
		D. Nagenahalli			46.0
33	16-18 October 2019	Nayanahalli	Light rainfall occurs	Take up the short duration crops viz., horse-gram, fodder maize. Apply chlorpyriphos (4ml/l) to red gram field for controlling termites, Spray Curzate in cool hours to manage downy mildew of grapes	17
		Kuthanagere			2
		D. Nagenahalli			34
34	19- 22 October 2019	Nayanahalli	Medium to high rains expected	Due to continuous rainfall received during last couple of weeks, weeds competition in crop field is observed, intercultural operation is recommended to overcome weed infestation.	23.5
		Kuthanagere			41
		D. Nagenahalli			0
35	23- 29 October 2019	Nayanahalli	Medium to high rains expected	Take up weed control measures in *rabi* crops and other rainfed crops. spray Quinolphos (2ml/1) to control against red gram leaf folder	5
		Kuthanagere			43.2
		D. Nagenahalli			78.0

Sl. No.	Dates of Agromet Advisory Issued	Name of the village	Weather event / forecast	Agromet Advisory given to different crops	Amount of rain received (mm)
36	30 October – 05 November 2019	Nayanahalli	Cloudy weather with minimum temperature of 19-20°C and RH of 84-85%.	Spray Flubendiamide (0.2ml/l) to control pod borer in red gram.	0
		Kuthanagere		Postpone the pruning methods in grape crop due to medium rainfall and cloudy weather	3.4
		D. Nagenahalli			0
37	6 to 8 November 2019	Nayanahalli	Light rain expected in this week.	Since there is a possibility of rain during next 5 days, farmers are advised to take up sowing *rabi*/ winter crop.	0
		Kuthanagere			0
		D. Nagenahalli		Provide protective irrigation to crops. Spray growth regulators in grapes.	0
38	9-12 November 2019	Nayanahalli	Cloudy weather with light showers expected	Farmers were advised to take up harvesting and other activities by taking necessary safety measures.	0
		Kuthanagere		Give protective irrigation to crops.	0
		D. Nagenahalli			0
39	13-15 November 2019	Nayanahalli	Cloudy weather with light rainfall expected	Take up the sowing of horse gram (KBH-1, PHG-9) in un-sown area. Advised to sow potato, postpone harvesting, sun drying and winnowing of *kharif* crops like finger millet, maize and groundnut in next couple of days due to cloudy and light rainfall forecasted by IMD. Postpone the pruning methods in grapes due to light rainfall and cloudy weather. Take precautionary measures while harvesting of *kharif* crops due to light rainfall forecasted by IMD.	11.0
		Kuthanagere			0
		D. Nagenahalli			0
40	16-19 November 2019	Nayanahalli	Dry weather prevails	Give protective irrigation to crops. Spray growth regulators in grapes.	0
		Kuthanagere			0
		D. Nagenahalli		Give protective irrigation to crops and advised to take up harvesting	13
41	20-22 November 2019	Nayanahalli	Occurrence of dry spells	Prune the unwanted branches of mango to reduce fruit fly damage. Take control measures for powdery mildew in mango.	12
		Kuthanagere			5.0
		D. Nagenahalli			0

Sl. No.	Dates of Agromet Advisory Issued	Name of the village	Weather event / forecast	Agromet Advisory given to different crops	Amount of rain received (mm)
42	23-26 November 2019	Nayanahalli	Dry weather prevails	Since there will be no rain during next 5 days, finger millet and maize farmers are advised to harvest the crops. spray metalaxyl (2g/l) to control late blight in tomato. Ideal condition for harvesting, sun drying and winnowing of *kharif* crop like ragi, maize and groundnut.	0
		Kuthanagere			0
		D. Nagenahalli			0
43	27-29 November 2019	Nayanahalli		Maintain constant temperature in sericulture and poultry. Grow potato and other vegetables.	0
		Kuthanagere			0
		D. Nagenahalli			0
44	30 November to 3 December 2019	Nayanahalli	Cloudy weather with light showers expected	To control UJI fly, use nylon mess to control the entering of fly in sericulture units. Use recommended chemical to control UJI fly. Give protective irrigation to crops.	17.0
		Kuthanagere			2.0
		D. Nagenahalli			25.0
45	4-10 December 2019	Nayanahalli	Light rain forecasted by IMD	Chances of occurrence of powdery mildew in mango, rose and other crops. Crops/varieties suggested: Sunflower-Modern, KBSH-1, 41, 42, 44.	0
		Kuthanagere			0
		D. Nagenahalli			0
46	11-13 December 2019	Nayanahalli		Clear weeds in mango /Guava/Sapota orchards and place them under the basin as mulch. The shoots/branches touching ground may be pruned and clear the ground of the canopy main field to prevent the incidence of pests/ disease. Give protective irrigation to crops.	0
		Kuthanagere			0
		D. Nagenahalli			0
47	14-17 December 2019	Nayanahalli	Dry weather prevails	Right time for harvesting of crops and cleaning, drying of ragi crop. If already harvested, the straw may be collected and stacked. Advised for spraying of sulphur dust @2g/litre of water for management of powdery mildew disease.	0
		Kuthanagere			3
		D. Nagenahalli			0

Sl. No.	Dates of Agromet Advisory Issued	Name of the village	Weather event / forecast	Agromet Advisory given to different crops	Amount of rain received (mm)
48	18-20 December 2019	Nayanahalli	Dry weather continues	Take protection measures to control powdery mildew in mango and grapes. Spray ridomil gold (2g/l) to control severe late blight in potato.	0
		Kuthanagere			0
		D. Nagenahalli			0
49	21-24 December 2019	Nayanahalli	Occurrence of dry spells	The shoots/branches touching ground may be pruned and ground clearance of the canopy main field may be taken up to prevent the incidence of pests and disease. Grapes: Take plant protection measures to control powdery mildew disease	0
		Kuthanagere			0
		D. Nagenahalli			0
50	25-27 December 2019	Nayanahalli	Dry weather continues	The following crops are suggested for *Rabi* sowing in this month Recommended short duration crops like cowpea (KBC-1, TVX-944 and PKB-4); Sunflower: (Morden, KBSH-1, 41, 44 & 52) and Niger: (KBN-1, No-71). In black soils, Bengal gram (Annigeri-1, J.J-11, KAK-2, Vishal) Field bean (Avare): HA-1,3 and 4 are recommended. Give protective irrigation to crops.	0
		Kuthanagere			0
		D. Nagenahalli			0
					0
51	28 -31 December 2019	Nayanahalli	Dry weather continues, night will be cooler with Min. temperature of 17ºC	Farmers are advised to carryout post-harvest practices like drying under sunlight, winnowing and cleaning for ragi, jowar and other harvested grains. Well dried finger millet grains should be stored in gunny bags. Poultry: Provide artificial brooding to chicks to maintain adequate temperature. Sides should be covered with curtains during cool hours of the day. Wet litter material should be removed regularly Ensure proper cross ventilation to avoid ammonia accumulation	0
		Kuthanagere			0
		D. Nagenahalli			0

Dapoli

1) Crop : Rice

Advisory Date	Forecasted Weather/Reason	Advisory given	Observed Weather	Action taken by farmer	No. of farmers adopted out of 50	Benefit or Loss
06/09/2019	Heavy rainfall	Postpone application of third split dose of nitrogenous fertilizers i.e. urea @ 43 kg ha^{-1} to rice crop at flowering stage.	Rainfall of 390.8 mm in one meteorological week	Farmers not post-poned the application of third split dose of nitrogenous fertilizers.	38	Loss up to Rs.400/- per ha
13/09/2019	Rainfall of 130 mm was forecasted during the next 5 days with increase in relative humidity.	Due to forecast of increase in humidity, there is a possibility of incidence of false smut fungal disease in rice during panicle initiation stage. For management of disease spray hexaconazole 5% SC @ 10 ml per 10 liter of water at panicle initiation stage	Rainfall of 192.8mm, RHI: 98-99% and RHII: 93-95% in two meteorological weeks.	Spraying of hexaconazole 5%SC @10 ml per 10 liter of water at panicle initiation stage was followed by AAS farmer.	26	Earned Rs. 2000/- per ha more due to avoiding deterioration of grain by false smut.
17/09/2019	Light to medium rainfall, high humidity and cloudy weather condition during 18/09/2019 to 22/09/2019	Due to intermittent rainfall and cloudy weather condition, incidence of brown plant hoppers is likely to occur in lowline area where stagnation of water is observed. Hence observe crop regularly for infestation of pest. If incidence of brown plant hopper is observed above the threshold level (5-10 hopper/hill), spray Acephate 75%WP @ 2.25 g or Imidacloprid 17.8% SL @ 0.2 ml per liter of water. Make provision for replacing stagnated water with fresh water for every 2-3 days.	Rainfall of 49.2 mm, RH-I: 90-98% and RH-II: 92-97% in one meteorological week	Spraying of Imidacloprid17.8% SL @ 0.2 ml per liter of water and replace stagnated water with fresh water at 2-3 days interval.	26	Saved loss of yield due to insect incidence and earned Rs.500/- per quintal.

Advisory Date	Forecasted Weather/Reason	Advisory given	Observed Weather	Action taken by farmer	No. of farmers adopted out of 50	Benefit or Loss
24/09/2019	Medium to heavy rainfall	Due to intermittent rainfall and cloudy weather condition, there is a possibility of incidence of blue beetle in low land rice. If incidence of blue beetle is noticed on rice crop, spray Quinalphos 25% EC @ 40 ml or Lambda cyhalothrin 5% EC @ 5 ml per 10 liter of water.	Rainfall 52.2 mm, RH-I: 88-99% and RH-II: 47-88% in one meteorological week	Spraying of Lambda cyhalothrin 5%EC @ 5 ml per 10 liter of water.	31	Saved loss of yield due to insect incidence and earned Rs.500/- per quintal
18/10/2019 To 22/10/2019	Medium to heavy rainfall	There is forecast of rainfall for next five days. Hence, postpone harvesting of early matured rice varieties, if possible, harvest the crop in morning hours and store harvested produce at safe place.	According to weather condition recorded at Department of Agronomy, COA, Dapoli, the total rainfall was observed 125.4 mm in two meteorological weeks.	Farmer has postponed harvesting.	43	Earned Rs. 3500-4000/- per ha. Some farmer not followed the advisory lost Rs.2000-3000 /- ha.

Crop : Vegetable crops

Advisory Date	Forecasted Weather/ Reason	Advisory given	Observed Weather	Action taken by farmer	No. of farmers adopted out of 50	Benefit or Loss
20/08/2019	In few farmers fields incidence of downy mildew disease and aphid on cucurbitaceous crops was noticed.	Due to forecast of cloudy weather and increase in relative humidity, there is a possibility of incidence of downy mildew in cucurbitaceous vegetables. If incidence is noticed' remove and destroy infected leaves and spray Mancozeb or Zineb 2.5 g / lit of water at an interval of 10 to 15 days.	Max. temp.: 27.4-29.6^{0}C, Min. temp.: 23.5-24.2^{0}C., RHI: 97-98% and RHII: 86-92% in forecasted period, which is favourable for incidence of disease and aphid.	Farmers taken spraying of Mancozeb or Zineb 2.5 g /lit of water.	24	Reduction in the intensity of downy mildew disease. Economic benefit of Rs. 3000/- per ha
31/12/2019	In some farmers fields incidence of fruit fly and aphid on cucurbitaceous crops was noticed.	Install 'Rakshak Trap' @ 4 numbers per ha in cucurbitaceous crop for effective control of fruit fly. Use yellow stick card against aphids in chilli and brinjal	Max. temp.: 31-32.2^{0}C, Min. temp.: 16.6-19.8^{0}C., RHI: 91-96% and RHII: 51-65% during forecasted period, which is congenial for development of aphids and fruit fly.	Farmers installed 'Rakshak Trap' in the field. Farmer used yellow stick card in the field.	26	'Rakshak traps' attracted fruit flies resulted in reduced infestation. 'Yellow stick card' controlled aphids in chilli and brinjal. benefit of Earn Rs. 5000/- per ha.

2) Crop : Fruit crops

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
13/08/2019	Mango	Continuous heavy rain during the period 14/08/2019 to 18/08/2019.	Apply Paclobutrazol (cultar) for regular flowering in mango trees of 10 years old and above. Then uniform quantity of solution be drenched into holes, followed by closing or plugging of holes with soil. Before application weeds be removed.	The rainfall recorded: 233 mm in two meteorological weeks.	Avoided the application of Paclobutrazol during period of heavy rains.	14	Saved the cost of Paclobutrazol- i.e., Rs.3600/- per liter
20/08/2019	Cashew-nut Stage: Seedling	Prediction of heavy rainfall, high humidity and low sunshine hrs. Favorable for incidence of fungal disease.	Fungal disease caused leaf drop and branch rot in cashew, for control spray Metalaxyl 8% + Mancozeb 64% combination fungicide @ 20 g per 10 liter of water	Max temp.: 24.4-26.6^{0}C , Min. temp: 23.5-24.1^{0}C ., RH-I: 96-98% and RH-II:76-85% cloudy cover i.e. 5 to 8 octa, Rainfall-168mm,sunshine hrs.: 0.0-3.8 in 2 SM weeks	Spraying of Metalaxyl 8% + Mancozeb 64% combination fungicide @ 20 g per 10 liter of water applied	20	The advice was helpful for protection from fungal disease of cashew plants. Economic Benefit: (200 Cashewnut Trees)

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
18/10/2019	Cashew Stage: Flowering	Continuous cloudy weather i.e. 3 to 8 Octa was forecasted during 18/10/2019 to 25/10/2019.	There is a possibility of tea mosquito bug incidence and thrips on the inflorescence of cashewnut. If incidence is noticed, spray Profenophos 50% EC @10 ml per 10 liter of water. (insecticide is not under label claim)	Max temp.: 30.5-34°C , Min. temp: 9.4-17°C. RH-I: 80-90 %, RH-II: 60-71% and cloud cover 2 to 4 Octa during forecasted period.	Spraying of Profenophos 50% EC @10 ml per 10 liter of water.	38	This increased Cashew yield up to 20-60 % by saving flowering flush of cashew. Economic Benefit: (300 Cashewnut Trees)
01/11/2019 To 27/12/2019	Mango Stage: Vegetative flush & flower bud initiation	Continuous cloudy weather i.e. 5 to 8 Octa cloud cover was forecasted during period 01/11/2019 to 05/11/2019.	Due to cloudy and humid weather condition, there is a possibility of incidence of hoppers, midge fly and shoot borer on vegetative flush of mango. To protect the flush of mango Spray Lambda cyhalothrin 5% EC @ 6ml or Quinalphos 25% EC @ 25 ml per 10 liter of water.	Max temp.: 31.2-32.2°C, Min. temp: 20.5-24.5°C . RH-I: 86-96 %, RH-II: 63-98 % and cloud cover 5 to 7 octa.	Sprayed as per the AAS	26	This increased yield of mango up to 30-40 % by saving flowering flush from mango hopper incidence.

Mohanpur

Crop: Rice (*kharif*)

Date of issuance of forecast	Forecast given and realised weather	Advisory given	Action taken by the farmer	Type of saving/ benefit	Benefit in term of cost (Rs. per ha)
28.6.2019	Rainfall (Forecast= 65 mm, Actual= 89 mm)	Start seed bed preparation and sowing for paddy.	80 percent farmers followed the advisory	Substantial yield increase	Saving of Rs. 1500 ha^{-1}.
16.8.2019	High humidity, high temperature and cloudy sky	Apply chemical to prevent from brown spot, sheath blight and stem rot disease	65 percent farmers followed the advisory	Yield increase for the farmers who followed the spraying schedule	Saved crop in monetary value of around Rs.1700 ha^{-1} (calculated through yield comparison)
03.9.2019	Good rainfall forecast (70 mm) was given (actual also very close to forecast amounting to 60 mm)	Application of fertilizer as top dressing and no need of irrigation	60 percent farmers followed the advisory	Irrigation was saved. Yield increase was also observed for better fertilizer utilization,	One irrigation was saved. (Rs.550 ha^{-1} as irrigation cost).
5.11.2019	Severe cyclone may hit within a week	Harvest *kharif* rice as early as possible, if it is mature	60 percent farmers could harvest. Rest could not as the transplanting was late	The crop was totally saved for the farmers who could harvest rice and could transfer the produce for storage.	Monetary savings of Rs. 28,000 to Rs. 30,000 ha^{-1} land

Crops: Moong, Lathyrus, Chilli and Vegetables *(Rabi)*

Date of issuance of forecast	Forecast given	Advisory given	Action taken by the farmer	Type of saving/ benefit	Benefit in term of cost (Rs. per ha)
11.10.2019	Rainfall (45 mm) forecast was given and more than 30 mm rainfall was received	Introduce moong and Lathyrus as a pulse crop to utilize residual soil moisture and alternative supply of nitrogen fertilizer into the soil	80 percent farmers followed the advisory	Utilization of moisture and land where rice cannot be grown	Monetary benefit of Rs. 35000 ha^{-1} for the moong producing farmers.
03.12.2019	Low temperature and high humidity forecast.	Leaf curl of Chilli may occur & to control apply pesticides immediately	65 percent farmers followed the advisory	Disease was controlled	Monetary benefit of Rs. 4000 ha^{-1}
17.12.2019	cloudy weather and light rainfall	Seed treatment for late sown vegetables. Take chemical control measure to avoid seedling rot for early sown vegetables	50 % farmers followed the advice	Plant disease was controlled	Monetary benefit of Rs. 6000 - 8000 ha^{-1}

Udaipur

Crops: Maize, Soybean and Gram

Name of the Farmer	Date of Issue	Crop	Rainfall/ Temperature Forecast	Advisory given	Observed Rainfall/ Temperature	Action taken by farmer	Profit/Loss
Sh. Mangi Lal, Jorawar Singh Ji Ka Kheda	30.7.2019	Maize	Medium rainfall	Remove excess rain water from the crop field	Medium to heavy rainfall received	No action taken by farmer	Loss: crop failed due to water logging condition
Sh. Omkar Singh, Jorawar Singh Ji Ka Kheda	30.8.2019	Soybean	Moderate rainfall on 30.8.2019	Postpone plant protection measures in crop	67.1 mm	Postponed the spray schedule till dry weather	Profit: Save of Rs. 500/- as insecticide cost and labour charge
Sh. Himmat Singh, Jorawar Singh Ji Ka Kheda	30.08.2019	Soybean	Moderate rainfall on 30.8.2019	Postpone plant protection measures in crops	67.1 mm	Sprayed imazethapyr in soybean	Loss of Rs. 800/- including labour charge
Sh. Kalu Gurjur, Jorawar Singh Ji Ka Kheda	03.09.2019	Soybean	Moderate rainfall in next 5 days	Remove excess rain water from the crop field	Total 58.6 mm rainfall received in next 5 days	Removed excess water from the field	Got yield of 1700 kg ha^{-1}.
Sh.Ratan Lal Nayak, Bagatpura	03.09.2019	Maize	Moderate rainfall in next 5 days	Remove excess rainfall water from the crop field	Total 63.0 mm rainfall received in next 5 days	No action taken by farmer	Loss: crop failed due to water loging condition

Name of the Farmer	Date of Issue	Crop	Rainfall/ Temperature Forecast	Advisory given	Observed Rainfall/ Temperature	Action taken by farmer	Profit/Loss
Sh. Rajesh Meena, Chomakot	23.08.2019	Soybean	Moderate rainfall in next five days	Withhold application of fertilizer & pesticides	Light rainfall received	Waited for dry weather to spray triazophos	Saved Rs. 300
Sh Dariyav Singh ji. Jorawar Singh ji ka Kheda	04.01.2019	Gram	Temperature forecast for 5, 6, 7, 8 & 9 January 2019 was 7, 5, 1, 2 and 4°C, respectively	Apply light irrigation or spray 0.1 % sulphuric acid or produce smoke for protection against frost in gram	Minimum temperature of 1, 0 and 1 °C was recorded on 7, 8 & 9 Jan 2019	Applied irrigation in gram and also produce smoke in the field	Escaped from frost injury and got 18 q ha^{-1} grain yield of gram

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

6.1. Case study- Paddy, Valavannur, Kerala

Mr. Kunjali, from Valavannur NICRA Village (Tanur) has 10 acres of land under paddy (Uma variety) cultivation. During the crop growing period, a series of AAS bulletins/real time advisories were issued.

The details of cost and benefit obtained by the farmer Mr. Kunjali (AAS Farmer), for growing paddy in response to the AAS issued and timely actions taken have described in Table 6.1. The expenditure on different operations and returns received through sale of produce and other details were collected from farmer's feedback. Table also contains the cost of cultivation and benefit cost (B:C) ratio of non-adopted farmers of AAS.

Table 6.1: Analysis of B:C ratio in paddy of both AAS farmers and non AAS farmers at Valavannur NICRA Village

Input Details (ha^{-1})	Paddy Crop (Uma) (In Rs.)	
	AAS Farmer (Kunjali)	Non AAS Farmer (Alavi)
Field Preparation cost	9669/-	14625/-
Seed cost	2603/-	2625/-
Fertilizer cost	14453/-	10500/-
Cost of plant protection	5603/-	9250/-
Hired Human Labour	19834/-	20000/-
Harvesting (cutting, Threshing, winnowing & marketing cost)	5888/-	7500/-
Cost of cultivation	54080/-	64500/-
Paddy yield (kg ha^{-1})	5455	4750
Price of Paddy (Rs. kg^{-1})	26/-	26/-
Total Income	141818/-	123500/-
Net profit	87738/-	59000/-
Benefit cost ratio	2.62	1.91

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

- Timely adoption of agromet advisories issued
- Followed the advisory to control thrips in paddy during the dry spell during monsoon period. Applied 3 ml Imidacloprid per 10 litre of water to control them.
- Followed the advisory to control leaf folder attack during cloudy weather; controlled by using Trichogramma cards (2CC per one acre). Sprayed Quinalphos @ 2ml per one liter of water during severe attack.
- Controlled bacterial leaf blight as per the advisory; Sprayed cow dung slurry by mixing with 20g of Pseudomonas in one litre of water.
- Leaf folder was controlled by applying 2CC Trichogramma chilonis card per acre to control leaf folder and 2CC Trichogramma japonicum card per acre to control stem borer in paddy. Sprayed 3ml chlorantraniliprole per 10 litre of water.
- Followed the advisory to control rice bug; sprayed 2 ml Malathion per one litre of water. Pesticides application was made either before 9 am or after 3 pm.

6.2. Case study- Paddy, Thavanur, Kerala

Mr. Jaffer, from Thavanur NICRA Village has 4 hectares of land under paddy cultivation (Ponmani variety) at Koottumundakan in 2019. During the crop growing period, a series of AAS bulletins/ real time advisories were issued. B:C ratio obtained in case of paddy by the farmer Mr. Jaffer, in response to the AAS issued and timely actions taken by him are described in Table 6.2. The expenditure on different operations and returns received on sale of produce and other details were collected from farmer's feedback. Table 6.2 also contains the cost of cultivation and B:C ratio of non-adopted AAS farmers.

Table 6.2: Analysis of B:C ratio in paddy of AAS farmers and non AAS farmers at Thavanur, the NICRA Village

Input Details (ha^{-1})	Paddy Crop (Ponmani)	
	AAS Farmer (Jaffer)	Non AAS Farmer (Muhammed)
Field Preparation cost	2970	13500
Seed cost	4050	3000
Seed treatment	75	-
Fertilizer cost	13225	16368
Weed management	7200	-
Cost of plant protection	5700	5125

Input Details (ha^{-1})	Paddy Crop (Ponmani)	
	AAS Farmer (Jaffer)	Non AAS Farmer (Muhammed)
Hired Human Labour	16000	20000
Harvesting (cutting, threshing, winnowing & marketing cost)	7175	6562
Cost of cultivation	56395	64555
Paddy yield (kg ha^{-1})	6100	5025
Price of Paddy (Rs. kg^{-1})	26	26
Total Income (Rs. ha^{-1})	158600	130650
Net profit (Rs. ha^{-1})	102205	66095
Benefit cost ratio	2.81	2.02

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/litre per kg of seeds.
- Postponement of foliar spray due to rainfall forecast.
- Followed the advisory to control thrips in paddy during the dry spells in monsoon season. Applied 3 ml Imidacloprid per 10 litres of water to control thrips.
- Followed the advisory to control leaf folder attack during cloudy weather; controlled by using Trichogramma cards (2CC per one acre). Sprayed Quinalphos @ 2ml per one litre of water during severe attack.
- Controlled bacterial leaf blight as per the advisory; sprayed the cow dung slurry by mixing with 20g of Pseudomonas in one litre of water.
- Timely adoption of control measures against the leaf folder, stem borer and rice bug as per the agromet advisory.

6.3. Case study- Introduction of new crops, Bongheri village, Mohanpur, West-Bengal

Five farmers viz. Vabotaron Halder, Badal Sardar, Asim Mondal, Debasish Sardar, Sharad Naskar were selected under AICRPAM-NICRA component and issued several Micro-level agromet advisories. The farmers were advised to use poly-shade (in home-garden) in Bongheri village to

grow radish and gourd (bitter, ash, snake, bottle, ridge) cultivation. This suggestion was made to improve the economic condition of the farmers of the village as more profit can be achieved within a short period of time in addition to the income from rice. The farmers got a monetary benefit of about Rs. 3000-6000 per shed (30 m x 6 m).

6.4. Case study- Introduction of new crops, Gopalganj village, Mohanpur, West-Bengal

Five farmers namely Porshuram Mondol, Khokon Sardar, Sashi Mondol, Lakkhan Haldar, Nagendranath Mondol were given adequate training on vertical farming of vegetables which needs scaffolding (like cucumber, bitter gourd). The scaffolding vertical farming was introduced by the AICRPAM-NICRA team in Gopalganj village. The benefit of this suggestion was to maximize the use of unit area of land (Fig. 6.1). Due to this practice, farmers achieved an extra income of about Rs. 5000/- ha^{-1}.

Fig.6.1: Scaffolded plants of cucumber, bitter gourd under vertical farming of vegetables at Gopalganj NICRA village in Mohanpur, West Bengal

6.5. Case study- Soybean, Ujalmba NICRA Village, Parbhani, Maharashtra

Shri. Bhimrao Sonaji Mogle, from Ujalmba NICRA Village (Parbhani) under AICRPAM Parbhani Centre has 5 acres land under soybean cultivation (MAUS-71 variety) during *kharif* 2019. During the crop growing period, a series of AAS bulletins/real-time advisories were issued to the above farmer. The B:C ratio obtained in case of the soybean farmer Shri. Bhimrao Sonaji Mogle, due to taking actions by the farmer in response to the AAS issued is described in Table 6.3. The expenditure

on different operations and returns received on sale of produce and other details were collected from farmer's feedback. The table 6.3 contains the cost of cultivation and benefit: cost ratio of both AAS and non-AAS adopted farmers.

Table 6.3: Comparison of cost of cultivation and B:C ratio of AAS adopted and Non-adopted farmers in soybean and cotton + pigeon pea at Ujalmba village

Input Details (ha^{-1})	Soybean Crop	
	AAS Farmer	Non-AAS Farmer
1. Field Preparation cost	3500	3500
2. Seed cost	7750	7750
3. Seed treatment	400	00
4. Fertilizer cost	3500	4500
Sowing cost	1750	1750
5. Weed management	4000	4500
6. Cost of plant protection	1700	3500
8. Harvesting (cutting, Threshing, winnowing Marketing cost)	7500	8000
9. Cost of cultivation	30, 100	33500
10. Soybean yield (ton. ha^{-1})	2.2	1.8
11. Price of soybean (Rs. 100 kg^{-1})	3200	3000
12. Total Income	70,400	54,000
13. Net profit	40,300	20,500
14. Benefit cost ratio	2.34	1.61

Higher profit obtained by Shri. Bhimrao Sonaji Mogle is attributed to

- Adoption of issued advisories and farm operations accordingly.
- Postponement of pesticides/foliar spraying due to rainfall forecast.
- Foliar spray of 2% urea at pod formation stage.
- Spray of KNO_3 during dry spell
- Timely intercultural operations coinciding with soil moisture stress period.
- Immediate drainage of excess water in waterlogged areas in crop fields
- Timely harvest of the crop during rain-free weather avoiding any delay and its safe drying and storage.

6.6. Case study- Paddy and Maize, NICRA villages Belagadha and Jorkut in Ranchi disrict, Jharkhand

Total 15 farmers from two NICRA villages, 8 from Belagadha and 7 from Jorkut were selected under AICRPAM-NICRA component for issuing the timely micro-level Agromet Advisory Services bulletins for crops paddy and maize during *kharif* 2019. Series of AAS bulletins were issued during crop sowing to harvesting period and the same were followed by the selected farmers. Yield of crops as well as B:C ratio were compared between AAS and non-AAS farmers of Belagadha and Jorkut villages (Tables 6.4 to 6.5). In both the villages and crops AAS adopted farmers had slightly higher B:C ratio than the non AAS farmers.

Table 6.4: Comparison between AAS and non-AAS farmers cultivating different crops at village Belagadha

Paddy	Farmer's Name	Crop Variety	Yield (q ha^{-1})	Price (₹ q^{-1})	Gross return (₹ ha^{-1})	Cost of cultivation (₹ ha^{-1})	Net return (₹ ha^{-1})	B:C ratio
AAS Former	Shunil Oraon	Naveen	25.0	1400	35000	15225	19775	2.3
	Bandhna Oraon	Sahbhagi	24.50	1400	34300	14900	19400	2.3
Non-AAS Former	Sitaram Oraon	Local	18.0	1300	23400	13000	10400	1.8

Maize	Farmer's Name	Crop Variety	Yield (q ha^{-1})	Price (₹ q^{-1})	Gross return (₹ ha^{-1})	Cost of cultivation (₹ ha^{-1})	Net return (₹ ha^{-1})	B:C ratio
AAS Former	Teeja Oraon	Kanchan	21.0	1300	27300	11300	16000	2.4
	Santosh Mahto	Kanchan	22.0	1300	28600	12300	16300	2.3
Non-AAS Former	Geeta Devi	local	15.0	1000	15000	7200	7800	2.1

Table 6.5: Comparison between AAS and non-AAS farmers cultivating Paddy and maize at village Jorkut

Paddy	Farmer's Name	Crop/ Variety	Yield (q ha^{-1})	Price (₹ q^{-1})	Gross return (₹ ha^{-1})	Cost of cultivation (₹ ha^{-1})	Net return (₹ ha^{-1})	B:C ratio
AAS Former	Pravesh Singh	Naveen	45.0	1750	78750	31200	47550	2.5
	Ramesh singh	Sahbhagi	30.0	1750	52500	22000	30500	2.4
Non-AAS Former	Ravinder Singh	Local	22	1500	33000	18000	15000	1.8

Maize	Farmer's Name	Crop/ Variety	Yield (q ha^{-1})	Price (₹ q^{-1})	Gross return (₹ ha^{-1})	Cost of cultivation (₹ ha^{-1})	Net return (₹ ha^{-1})	B:C ratio
AAS Former	Amola Devi	Kanchan	19.0	1620	30780	11800	18980	2.6
	Suresh Singh	Kanchan	20.0	1620	32400	12200	20200	2.7
Non-AAS Former	Manoj Singh	Local	12.0	1300	15600	7000	8600	2.2

Table 6.6: Intervention in other allied activities under NICRA in the above villages and the benefits accrued by the farmers

S.No.	Activities	Cost (Thousand)	Benefit (Thousand)
1.	Mango orchard (1/2 acre)	5-7	35-40
2.	Guava orchard (1/2 acre)	4-5	20-25
3.	Goat –Farming (10-15 goat)	2-5	40-45
4.	Fish farming (20decimal)	4	16
5.	Poultry farming (10-15 Chicks)	2-3	10-12
6.	Pig farming (17-19 pig)	40-45	1.50 lac

Vaccination, well deepening, pond formation, vermicompost production etc. are also initiated in NICRA villages.

6.7. Case study- Soybean, Kanshivani village of NICRA, Akola district, Maharashtra

Shri. Dinesh Bahakar, who is from Kanshivani NICRA Village (Akola) under AICRPAM Akola Centre has 5 acres of irrigated land under soybean cultivation. JS-335 variety was grown in *kharif* 2019. Crop was sown on 26 MW (28 June). During the crop growing period, a series of AAS bulletins/real time advisories were issued, which were followed by the farmer. B:C ratio was computed (Table 6.7) for the soybean farmer Shri. Dinesh Bahakar along with other four farmers who also followed the AAS issued and accordingly had taken timely actions. The expenditure on different operations and returns received on sale of produce and other details were collected from farmer's feedback.

Table 6.7: Analysis of B:C ratio in soybean (Rs.) cultivated by AAS farmers at Kanshivani village of NICRA

Input Details (ha^{-1})	Ramhari Kale	Sharad Waghmare	Sanjay Metkar	Dinesh Bahakar	Bhashkar Sable
Land preparation	2950	3450	3650	3900	2800
Fertilizer cost	4790	4850	5050	5200	4200
Seed cost	4400	5100	4600	4700	4440
Planting cost	2790	3250	2800	2900	3250
Weeding	1800	1800	1650	1800	1500
Hoeing	990	950	1050	1000	900
Plant protection	2960	3450	3390	2700	3380
Irrigation	0	0	0	0	0
Foliar spray of 2% urea	380	380	380	380	380
Miscellaneous	1540	1450	1400	800	1650
Harvesting cost	3705	4200	4446	4445	4560
Threshing cost	2880	3294	3456	4240	3510
Cost of cultivation	29185	32174	31872	32065	30570
Seed yield (q ha^{-1})	19.2	18.3	19.2	21.2	19.5
Price of soybean	74880	71370	74880	82680	76050
Net Profit	45695	39196	43008	50615	45480
Benefit cost ratio	**2.57**	**2.22**	**2.35**	**2.58**	**2.49**

Benefit -Cost ratio was further computed for the selected five non AAS farmers in the same village and presented in the table 6.8.

Table 6.8: Analysis of B:C ratio in soybean (Rs.) cultivated by Non-AAS farmers at Kanshivani village of NICRA

Input Details (ha^{-1})	Kailash Dhore	Gajanan Ganeshpure	Dyaneshwar Kale	Punjaji Waghmare	Raju Waghmare
Land preparation	4200	2100	3850	3050	3510
Fertilizer cost	5150	5450	5232	5200	4915
Seed cost	4500	4800	4680	4600	4690
Planting cost	3550	3360	2800	3450	2900

Input Details (ha^{-1})	Kailash Dhore	Gajanan Ganeshpure	Dyaneshwar Kale	Punjaji Waghmare	Raju Waghmare
Weeding	1950	2100	1750	1650	2260
Hoeing	900	900	0	1050	0
Plant protection	3800	3850	4200	3050	2380
Irrigation	0	0	0	0	0
Foliar spray of 2% urea	0	0	0	0	0
Miscellaneous	1100	600	1300	900	1300
Harvesting cost	4200	4320	4600	4446	4400
Threshing cost	2592	2952	2856	3230	2720
Cost of cultivation	31942	30432	31268	30626	29075
Seed yield (q ha^{-1})	16.2	16.4	16.8	18.2	16
Price of soybean	63180	63960	65520	70980	62400
Net Profit	31238	33528	34252	40354	33325
Benefit cost ratio	**1.98**	**2.10**	**2.1**	**2.32**	**2.15**

Higher profit obtained by Shri. Dinesh Bahakar and other selected AAS farmers are mainly attributed to

- Adoption of issued advisories and farm operations accordingly.
- Timely weeding and hoeing
- Postponement of pesticides/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 in waterlogged areas in crop field
- Timely harvest of the crop during rain free weather avoiding any delay and its safe drying and storage.

6.8. Case study- Cotton, Kanshivani village, Akola, Maharashtra

Shri. Chandu Waghmare, from Kanshivani (Akola taluka) Village has 8.0 acres of rainfed land under cotton cultivation. Bt cotton Ajeet 155 was grown during *kharif* 2019. Crop was sown on 27 SMW (24 June). During the crop growing period, a series of AAS bulletins/real time advisories were issued, which were followed by the farmer. Details of the AAS issued are given in Table 6.9.

Table 6.9. Analysis of B:C ratio in cotton (Rs.) cultivated by AAS and non-AAS farmers at Kanshiwani village

Input Details (ha^{-1})	AAS farmers			Non AAS farmers		
	Punjaji Waghmare	Pramod Shelke	Chandu Waghmare	Ramdas Pathak	Manik Waghmare	Avdhutra OKale
Land preparation	4850	4200	3900	4100	4700	3900
Fertilizer	5120	5180	5460	5400	5400	5350
Seed cost	4960	4750	4800	4800	5100	5100
Seed treatment	4960	4750	4800	4800	5100	5100
Planting	2970	3250	3000	3100	3200	3350
Gap filling	300	1500	1300	1350	1350	1400
Weeding	4400	4350	4750	4800	3600	4500
Hoeing (*with furrow opening)	1880	2000	1800	1900	2000	2100
Plant protection	5530	4950	4850	4400	4950	4600
Irrigation	0	0	0	0	0	0
Spraying of 2% Urea and 2% DAP	1100	1100	1100	0	0	0
Miscellaneous	1400	1300	1400	1100	1800	900
Harvesting cost	7100	6950	7250	6300	6700	6300
Threshing cost	0	0	0	0	0	0
Cost of cultivation	39610	39530	39610	37250	38800	37500
Seed cotton yield (q ha^{-1})	14.2	13.9	14.5	12.6	13.4	12.6
Price	76680	75060	78300	68040	72360	68040
Net Profit	37070	35530	38690	30790	33560	30540
Benefit cost (B:C) ratio	1.94	1.90	1.98	1.83	1.86	1.81

All the three AAS farmers, including Mr. Chandu Waghmare obtained higher B:C ratio than the three non AAS farmers.

Higher profit obtained by Mr. Chandu Waghmare is mainly due to:

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

6.9. Case study- rice, Ballisariaya NICRA village, Samastipur, Bihar

Farmer Sri Maheshwar Prasad Yadav of Ballisariaya village cultivating rice in his field followed AAS, provided by the AICRPAM-NICRA Samastipur center, from sowing to harvest. Benefit cost analysis was done for AAS and non AAS farmers and presented in the Table 6.10.

Table 6.10: Benefit cost analysis in rice cultivated by AAS and non AAS farmers at Ballisariaya village

Sl. No.	Farmers who did not follow AAS	Cost (Rs. ha^{-1})	Farmers who followed AAS	Cost (Rs. ha^{-1})
1	Nursery bed raising	500	Nursery bed raising	500
2	Seed cost 30 kg@ Rs. 40/kg	1200	Seed cost 25kg@40/kg	1000
3	Land preparation	3000	Land preparation	3000
4	Transplanting cost (25 Man days@Rs.200)	5000	Transplanting cost (25 Man days@Rs.200)	5000
5	Weeding cost (30Man days @ Rs.200)	6000	Weeding cost 1. Spraying cost of herbicides @1500 2. Manual weeding (in later stage of crop) 15 Man days @ Rs.200	4500
6	Fertilizer cost of N:P:K (100:40:30 kg /ha)	4500	Fertilizer cost of N:P: K (100:40:30 kg /ha)	4500
7	Method of fertilizer application 1. Basal before pudling 2 Man days@ Rs.200 2. Top dressing 2 Man days @ Rs.200	800	Method of fertilizer application 1. Basal before pudling 2 Man days @ Rs.200 2. Top dressing 2 Man days @ Rs.200	800
8	Irrigation	12000	6 irrigations were saved	
9	Harvesting and transport to threshing floor cost (25 man-days @ Rs.200)	5000	Harvesting and transport to Threshing floor cost (30 man-days @ Rs.200)	6000

Sl. No.	Farmers who did not follow AAS	Cost (Rs. ha^{-1})	Farmers who followed AAS	Cost (Rs. ha^{-1})
10	Plant protection cost (A) Pesticides cost 1. To control Stem borer- Cartap hydrochloride granules (Caldan) @ 25 kg ha^{-1} 2. To control gundhi bug- Folidol dust @ 20 kg /ha 3. To control blight disease -Carbendazime +mancozeb spray@2.5 gram /liter of water (B) Spraying cost 1. 6 Man-days @ 200=Rs.1200	4000	Plant protection cost (A) Pesticides cost 1. To control Stem borer- Cartap hydrochloride granules (Caldan) @ kg ha^{-1} 2. To control gundhi bug- Folidol dust@20 kg /ha (B) Spraying cost 1. 4 Man-days @ 200=800	3000
11	Threshing	2000	Threshing	2500
12	Total cost of cultivation	44000	Total cost of cultivation	30800
13	Grain yield (q ha$^{-1)}$ cost 33 q ha^{-1} @ Rs.1300	42900	Grain yield (q ha-1)-40 q ha^{-1} @ Rs.1300	52000
14	Straw yield (q ha^{-1}) cost 40 q ha^{-1} @ Rs300	12000	Straw yield (q ha^{-1}) -50 q ha^{-1} @ 300.00	15000
15	Gross income	54900	Gross income	67000
16	Net income	10900	Net income	36200
	B:C ratio	**1:1.25**		**1:2.17**

The net income and B:C ratio of AAS farmers were significantly higher than these parameters observed in non AAS farmers due to higher gross returns and lower cost of cultivations.

6.10. Case study - Soybean, Jorawar Singh Ji Ka Kheda NICRA village, Udaipur, Rajasthan

Shri Omkar Singh, who is from Jorawar Singh Ji Ka Kheda NICRA village (Rajsamand) has 2 ha of land under soybean (variety JS-9560) cultivation during *kharif-2019*. During the crop growing period, a series of AAS bulletins / real time advisories were issued which followed as such by him and got B:C ratio of 3.45 compared to other two farmers of the village cultivating same crop soybean.

Table 6.11: Analysis of B:C ratio in soybean (Rs.) cultivated by farmers (AAS adopters) at Jorawar Singh Ji Ka Kheda village

Input Details (ha^{-1})	Himmat Singh	Omkar Singh	Nathu Lal
Land Preparation	6500	6500	6500
Fertilizer cost	2382	3765	2382
Seed cost	4000	4000	4000
Sowing cost	1300	1300	1300
Weeding by weedicide	1600	4600	0

Input Details (ha^{-1})	Himmat Singh	Omkar Singh	Nathu Lal
Hoeing	0	0	0
Plant protection	800	800	800
Miscellaneous	2000	2000	2000
Harvesting cost	6000	6000	6000
Threshing cost	3250	3250	0
Cost of cultivation	**27832**	**32215**	**22982**
Seed yield (q ha^{-1})	25	30	15
Price of soybean (Rs. q^{-1})	3710	3710	3710
Gross Profit	92750	111300	55650
Net Profit	64918	79085	32668
Benefit cost ration	**3.33**	**3.45**	**2.42**

These two farmers, Sh Himmat Singh and Sh Nathu Lal, (Table-6.11) also got higher B:C ratio by adopting Agromet advisories during the crop season as compared to non adopted farmers at the same village (Table 6.12). The non adopted farmers got B:C ratio of 0.79 and 0 for soybean cultivation.

Table 6.12: Analysis of B:C ratio of soybean (Rs.) farmers (Non-AAS adopter) at Jorawar Singh Ji Ka Kheda village

Input Details (ha^{-1})	Mangi Lal	Shankar Lal Gurjur
Land Preparation	6500	6500
Fertilizer cost	2382	2382
Seed cost	4000	4000
Planting cost	1300	1300
Weeding	0	0
Hoeing	0	0
Plant protection	0	0
Miscellaneous	0	0
Harvesting cost	6000	0
Threshing cost	3250	0
Cost of cultivation	**23432**	**14182**
Seed yield (q ha^{-1})	3710	3710
Price of soybean (Rs. q^{-1})	5	0
Gross Profit	18550	0
Net Profit	-4882	-14182
Benefit cost ratio	**0.79**	**0**

Higher profit obtained by Shri Omkar Singh and other is attributed to:

- Followed all the AAS issued and carried out all farm operations in time.
- Used high yielding varieties.
- Maintained proper drainage system in field.
- Proper nutrient and plant protection measures were taken up.

6.11. Case study- Maize, Bagatpura village, Udaipur, Rajasthan

Mr. Lahru Lal from village Bagatpura, Tehsil Relmangra (Rajsamand) has 2 ha of land under maize cultivation. Maize variety Pratap Makka-5 was sown during *kharif*- 2019. During the crop growing period a series of AAS bulletins were issued which were followed as such by the farmer. Cost benefit analysis was worked out and a comparison was made between Mr. Lahru Lal who followed AAS and another farmer Sh Mangi Lal Salvi who did not follow the advisory (Table 6.13) and it was found from the comparison that Sh Lahru Lal got higher B:C ratio (1.95) as compared to Sh Mangi Lal Salvi, a non adopter of AAS (0.33).

Table 6.13: Analysis of B:C ratio in maize (Rs.) cultivated by farmers (AAS adopted and Non-AAS) in Bagatpura village

Input Details (ha^{-1})	AAS adopter	AAS-Non adopter
Land Preparation	7000	7000
Fertilizer cost	3177	2746
Seed cost	500	500
Sowing cost	1300	1300
Weeding weedicide	700	0
Hoeing	4500	6000
Plant protection	4650	0
Miscellaneous Drainage	900	0
Harvesting cost	6000	6000
Threshing cost	2800	2800
Cost of cultivation	31527	26346
Seed yield (q ha^{-1})	35	5
Price of maize (Rs. q^{-1})	1760	1760
Gross Profit	61600	8800
Net Profit	30073	-17546
Benefit cost ratio	**1.95**	**0.33**

Higher profit obtained by Shri Lahru Lal is attributed to:

- Followed all the AAS issued and carried out all farm operations in time.
- Used high yielding varieties.
- Maintained proper drainage system in the field.
- Proper nutrient and plant protection measures followed.

6.12. Case study- Gram crop, Jorawar Singh Ji Ka Kheda village, Udaipur, Rajasthan

Frost advisory

As per advisory issued on 4thJanuary 2019 based on forecasted weather, there is a chance of decrease in temperature in next five days at Jorwar Singh ji ka Kheda village. Due to low temperature and north eastern wind direction, there are chances of occurrence of frost on 7th and 8th January 2019. To avoid frost injuries in crops, farmers were advised to apply irrigation in crops, fumigation at farm, spray 0.1% Sulphur or spray 2-3% Urea. On 7th, 8th and 9th January 2019, the minimum temperature of 1.0, 0.0 and 1.0^{o}C, respectively were recorded and a severe frost was observed in Rajsamand district. Only one farmer, Sh Dariyav Singh of Jorawar Singh ji Kheda followed the advisory and applied light irrigation in gram crop. He got 18 q ha^{-1} grain yield which was 125 to 200 per cent more than non-adoptive farmers. There was 50-70% loss due to frost in case of non- adoptive farmers.

Ananthapuramu

Maize (Kharif)

NICRA Agromet advisories were provided to a group of 12 farmers growing maize in Yagantipalle village of Banganapalle block, Kurnool district (**Table 6.14**). The advisories were given from land preparation to harvest on every Tuesday and Friday. The Data entry operator, Young Professional-I and Field Information Facilitator working in the project have provided these advisories to farmers and helped the farmers in timely planning and execution of various agricultural operations.

Table 6.14: List of the NICRA AAS Farmers along with cultivated area

S.No.	Name of the Farmers	Cultivated Area (Acre)
1	Y. Parthasarathi	2
2	B. Chinna Pulla Reddy	5
3	B. Siva Satyam Reddy	3
4	M. Chandra	2
5	B. Bhaskar Reddy	3
6	B. Manmada Reddy	2
7	Y. Sudhakar Reddy	3

S.No.	Name of the Farmers	Cultivated Area (Acre)
8	D. Sarvanna	2
9	B. Nageswar Reddy	4
10	B. Parameswar Reddy	2
11	B. Siva Reddy	2
12	Y. Madhu Sudhan Reddy	4

All farmers have taken up sowing of maize during 2nd week of July and 2nd week of August 2019 as per the forecast and advisory given regarding sowing. An amount of 37.2 mm rainfall received during the subsequent days helped in crop establishment. During 1 to 27 September, when the crop was at knee high to tasseling stage, there was a wet spell and farmers were advised to immediately drain out the excess water, to avoid water logging and crop damage. Farmers adopted this advice and provided drainage facilities and 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. Further, it was suggested to take up measures to control fall army worm on clear days during the 1st week of October, as there was forecast of intermittent rainfall. Farmers could able to take up spraying for pest control as advised. The Non AAS farmers, who have not adopted advisory could not be able to take up spraying in time and this has resulted in the reduction of yield. The NICRA AAS farmers, who have sown the crop utilizing the forecasted rainfall, adopted agromet advisories like draining out of excess water from fields and timely plant protection measures against fall army worm could get an yield advantage of 37 q/ha and a benefit of Rs. 56930/ha after meeting all the expenses. The NICRA AAS farmers realized B:C ratio of 3.88, against that of non AAS famers (2.65). The details of the economics for NICRA AAS and Non AAS farmers are given below (Table.6.15).

Table. 6.15: Details of cost of cultivation and Economic impact of NICRA AAS on maize at Yagauntipalle

Name of the operation	Cost of Cultivation (Rs/ha)	
	NICRA AAS	NON - AAS
Land preparation, Harrowing and levelling	2500	2500
Sowing and basal application of fertilizers	2250	2250
Cost of seed	4250	4250
Cost of fertilizers	6824	6824
Weeding and Intercultivation	1750	1750
Spraying	3000	2000
Plant protection chemicals	12500	7500

Name of the operation	Cost of Cultivation (Rs/ha)	
	NICRA AAS	NON - AAS
Harvesting, threshing and cleaning	5000	5000
Total Cost of Cultivation	38074	32074
Yield of redgram	87q/ha	50 q/ha
Price of the produce (Rs./kg)	Rs.17 /kg	Rs.17 /kg
Gross returns	Rs.147900/ha	Rs.85000/ha
Net returns	Rs.109856/ha	Rs.52926/ha
B:C ratio	3.88	2.65
Benefit from yield advantage due to NICRA AAS	Rs.56930/ha	

Redgram (*kharif*)

NICRA Agromet advisories were provided to a group of 9 farmers growing redgram in Yagantipalle village of Banganapalle block, Kurnool district (**Table 6.16**). The advisories were provided from land preparation to harvest on every Tuesday and Friday. The DEO, YP-I and FIF working in the project has provided these advisories to farmers and helped the farmers in timely planning and execution of various agricultural operations.

Table 6.16: List of the NICRA AAS Farmers of Yagantipalle village

S.No.	Name of the Farmers	Cultivated Area (Acre)
1	S. Vijay Bhaskar Reddy	3
2	S. Venkata Subba Reddy	4
3	S. Rama Krishna Reddy	3
4	S. Raghu Ram Reddy	2
5	B. Siva Sankar Reddy	3
6	S. Chandra Shakar Reddy	2
7	S. Jagadeswar Reddy	3
8	S. Srinivas Reddy	3
9	D. Dastagiri	2

The farmers have taken up land preparation utilizing rainfall received during the last week of July (27.3 mm). They have taken up sowing during 07-10 August with the rainfall received during 01-04 August, other farmers have waited until 16 August for sowing. They were advised to form conservation furrows during the last week of August after crop establishment for conservation of rain water. Later there were good rain during the month of 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 November (pod initiation), farmers were advised to provide protective irrigation to improve pod development, as there was no rainfall. Farmers provided one protective irrigation. The rainfall received on 19.11.2019 (21.3 mm) has further boosted the pod development. Afterwards, it was advised to take up spraying against spotted pod borer as the infestation was above ETL and the weather was clear. The NICRA AAS farmers have followed this advisory and could be able to control the pest at early stages itself with 1-2 sprays. Non AAS farmers have spent more on pest control due to delayed adoption of spraying. 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.12750/ha. The details of the economics for NICRA AAS and Non AAS farmers is given below (Table 6.17).

Table 6.17: Details of cost of cultivation and Economic impact of NICRA AAS in redgram at Yagantipalle village

S.No.	Name of the operation	Cost of Cultivation (Rs./ha)	
		NICRA AAS	NON – AAS
1	Land preparation, harrowing and levelling	2500	2500
2	Sowing and basal application of fertilizers	2250	2250
3	Cost of seed	750	750
4	Cost of fertilizers	2500	2500
5	Formation of conservation furrows	1750	1750
6	Cost of protective irrigation – One	2500	-
7	Spraying	1250	2500
8	Harvesting, threshing and cleaning	5000	5000
	Total Cost of Cultivation	**18500**	**17250**
	Yield of redgram	**15 q/ha**	**12 q/ha**
	Price of the produce (Rs./kg)	**Rs.45/kg**	**Rs.45/kg**
	Gross returns	**Rs.67500/ha**	**Rs.54000/ha**
	Net returns	**Rs.49000/ha**	**Rs.36250/ha**
	B:C ratio	**3.64**	**3.13**
	Benefit from yield advantage	**Rs. 12750/ha**	

Bengalgram (*rabi*)

Economic impact of Agromet Advisories in bengalgram during *rabi* was studied. NICRA Agromet advisories from sowing to harvest have been provided to a group of 15 farmers growing redgram in Yagantipalle village of Banganapalle block, Kurnool district (Table 6.18).

Table 6.18: List of the NICRA AAS farmers along with the details of cultivated area

S.No.	Name of the Farmers	Cultivated Area (Acre)
1	S. Bala Subba Reddy	2.5
2	G. Nagarjun Reddy	2
3	M. Ramdas	2
4	S. Rama Krishna Reddy	2
5	Y. Rama Krishna Reddy	3
6	B. Siva Sankar Reddy	3
7	B. Ram Gopal Reddy	2
8	B. Maddilety	2
9	M. Chalapathi	2
10	B. Pratap Reddy	3
11	G. Naga Subba Reddy	2
12	M. Bal Thimma Reddy	2
13	Venkateswar Reddy	1
14	Y. Chinna Pulla Reddy	3
15	Y. Pedda Pulla Reddy	3

The crop was sown during the 2nd week of October to 1st week of November depending upon the congenial soil moisture to take up sowing operation. The residual moisture of high rainfall received during the month of September (271mm) has saturated the soil profile and helped in good crop establishment. But, in fields with excess moisture, the crop was infected by diseases like Colletotrichum blight and wet root rot in early stages. Advisory was given regarding control measures and NICRA AAS farmers have taken up spraying of Hexaconazole@2ml/lit. This has helped in preventing further spread of the disease. Due to good vegetative growth and congenial weather conditions, it is advised to take up control measures for Spodoptera exigua and Helicoverpa during vegetative, flowering to pod development stages, respectively. The farmers who have adopted this advice, could control the pest with 2-3 sprays. Due to dry spell conditions, it was advised to provide one light irrigation. This also helped to increase the pod yield. The details of the economics for NICRA AAS and Non AAS farmers are given below (Table 6.19); The AAS farmers could achieve higher B:C ratio of 4.12 compared to that of non AAS farmers (3.22) mainly due to higher gross reduction achieved in bengal gram.

Table 6.19: Details of cost of cultivation and Economic impact of NICRA AAS

Name of the operation	NICRA – AAS Cost of Cultivation (Rs/ha)	NON – AAS Cost of Cultivation (Rs/ha)
Land preparation and Harrowing	2500	2500
Sowing and basal application of fertilizers	2250	2250
Cost of seed	2500	2500
Cost of fertilizers	4000	4000
Weeding	3000	3000
Spraying	5000	4000
Harvesting, threshing and cleaning	5000	5000
Total Cost of Cultivation	**24250**	**23250**
Yield of Bengalgram	**20 q/ha**	**15 q/ha**
Price of the produce (Rs./kg)	**Rs.50/kg**	**Rs.50/kg**
Gross returns	**Rs.100000/ha**	**Rs.75000/ha**
Net returns	**Rs. 75750/ha**	**Rs. 51750 /ha**
B:C ratio	**4.12**	**3.22**
Benefit from yield advantage	**Rs.24000 /ha**	

The benefits attained by NICRA-AAS farmers were mainly attributed to the following of timely advisories on control of pest and diseases and providing light irrigation. Whereas, the non AAS farmers could not prevent spread of pests and diseases in time. Non control of pest and diseases in time has resulted in loss of plant population and reduced yield.

Bangalore

Economic impact of Agromet Advisory Services in different crops

Benefit : Cost (B:C) ratio was worked out by pooling the total cost of cultivation and gross returns of non-AAS-farmers (Table-6.20) from Nayanahalli, NICRA adopted village. Further, categorizing major crops into vegetable crops, fruit crops, flower crops & field crops B:C ratio was worked out separately in each category of crops. Comparison of B:C ratio between AAS farmers and non-AAS farmers has shown (Flow chart-1) that, farmers who have followed Agromet Advisories (AAS) had obtained higher B:C ratio compared to those who have not followed AAS.

Table 6.20: List of the farmers of Nayanahalli village who did not follow agromet advisory services (Non-AAS farmers) and the B:C ratio in different categories of crops

a. Vegetable crops

Name of the farmers	Area (acres)	Vegetables	Total cost (Rs.)	Gross returns (Rs.)	B:C ratio
Srinivas	0.5	Ridge guard	22376	45200	2.02:1
Chandrasekhar	0.3	Carrot	25250	65000	2.57:1
Kyatappa Venkateshappa	0.6	Brinjal	30200	75400	2.50:1
Shivaraj	0.3	Cucumber	13500	11450	0.85:1

b. Flower crops

Name of the farmers	Area (acres)	Flower crop	Total cost (Rs.)	Gross returns	B:C ratio
Manjunatha	0.5	Marigold	30000	48600	1.62:1
Jayachandra	0.5	Rose	24200	35800	1.48:1
Ramareddy	0.5	Rose	32000	43200	1.35:1
Venkateshappa Mahesh	0.75	Marigold	32000	52400	1.64:1
Srinivas	0.5	Chrysanthe-mum	32500	53600	1.65:1

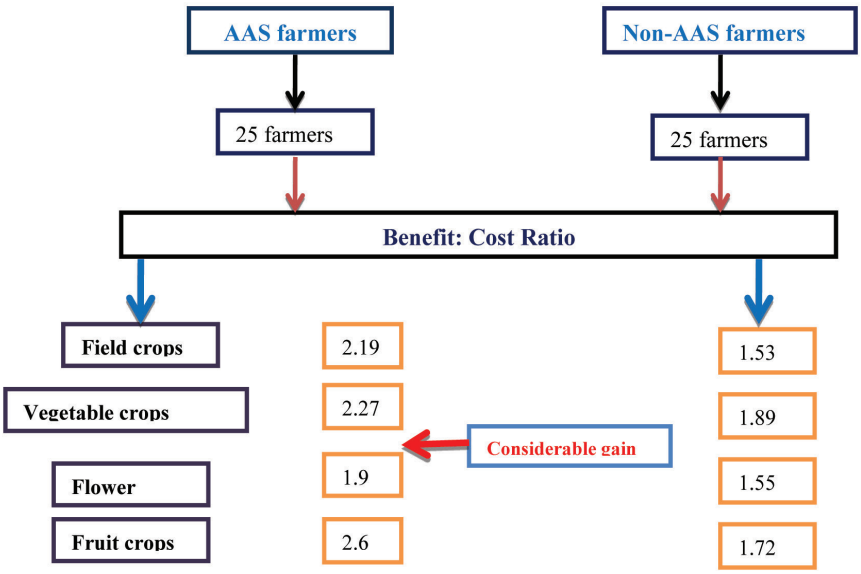
c. Field crops

Field crops	Area in acres	Field crop	Total cost (Rs.)	Gross returns (Rs.)	B:C ratio
C V Rajanna	1	Finger Millet	10200	25400	2.49:1
B N Munukrishna	1	Finger Millet	12600	21600	1.71:1
M Chennappa	1	Popcorn	17800	24200	1.36:1
S Lakshmayya	1	Popcorn	17400	23800	1.37:1
B R Shree Ramayya	1	Popcorn	18200	23200	1.27:1
Varadappa	1.5	Finger Millet	27000	28500	1.06:1
Subbanna	1	Maize	19400	28000	1.44:1

d. Fruit crops

Name of the farmer	Area in acres	Fruits	Total cost (Rs.)	Gross returns (Rs.)	B:C ratio
N.M.Lakshminarayana	2	Grapes	185000	285600	1.54:1
Raveendranath	2	Grapes	72400	142000	1.96:1
T.Krishnamurthy	1.5	Grapes	55200	102500	1.86:1
Seenappa	0.75	Grapes	46500	75000	1.61:1
M.V.Ramesh	3	Grapes	165000	245000	1.48:1
M.V.Nanjappa	1	Grapes	28450	48000	1.69:1
Venkateshappa Mahesh	1	Grapes	30800	57600	1.87:1

Flow chart-1: Economic Impact of Agromet Advisory Services in terms of Benefit: Cost ratio of 25 farmers at AICRPAM-NICRA adopted villages



From the above flowchart it was observed that, among the different crops cultivated at NICRA adapted villages, fruit crops recorded considerable higher gain in terms of B:C ratio (2.6) followed by vegetable crops (2.2), field crops (2.1) and flower crops (1.9) cultivated by AAS farmers against B:C ratio obtained by 'Non-AAS farmers' in vegetable crops (1.89), fruit crops (1.72), flower crops (1.55), and field crops (1.53). These values clearly indicate that, Agromet Advisories have greater role in deciding farm activities like pesticide sprays, fertilizer application, irrigation schedules, weeding, harvesting and many other activities accurately and economically.

Economic returns in terms of savings/benefits due to adoption of AAS in different categories of crops at Nayanahalli (Table 6.21) showed higher net benefit ranging from 1,17,000 to 15,40,000 in grapes and lower benefits ranging from Rs. 3,700 to 29,400 in rose.

Table 6.21: Economic returns and savings/benefits accrued farmers following NICRA-AAS at Nayanahalli during 2019

S. No.	Farmer's Name	Area (Acres)	Crop	Cost of Fertilizers (Rs.)	Cost of Pesticides (Rs.)	Labour Charges (Rs.)	Cost of Production (Rs.)	Gross Returns (Rs.)	Net Profit (Rs.)
1	R Jayaramareddy	0.5	Knol Khol	15000	10000	6200	31200	75000	43800
2	Krishnaswamy K	0.5	Beetroot	20000	5000	12000	37000	82600	45600
3	Mallesh	0.5	Ridge Guard	30000	3500	40000	73500	145800	72300
4	Nandish K	1	Finger Millet	4500	--	5000	9500	26800	17300
5	Yellappa R	1	Finger Millet	4800	--	6000	10800	22000	11200
6	Ramakrishna	1	Maize	6500	--	9000	15500	28500	13000
7	Muniyappa	1	Maize	6800	--	8000	14800	30200	15400
8	Munikrishna	1	Popcorn	5500	2200	8000	15700	26000	10300
9	Lakshmamma	1	Popcorn	7200	2200	5600	15000	29200	14200
10	Jeenanjinappa	1	Popcorn	5200	--	6500	11700	22000	10300
11	N C Jayanna	1	Popcorn	5800	--	5200	11000	25200	14200
12	N M Lakshmi narayana	2	Grapes	175000	65000	35000	275000	545000	270000
13	T Krishnamurthy	1.2	Grapes	160550	52000	41600	254150	425700	171550
14	Anjaneyareddy	2	Grapes	235000	184000	52000	471000	1800000	1540000
15	P Narayanaswamy	2	Grapes	164200	80000	38000	282200	910000	627800
16	N V Srinivas	1.2	Grapes	60600	37000	20200	117800	235000	117200
17	R Srinivas	1.2	Grapes	92000	57600	28000	177600	580600	403000
18	Muniswamy Reddy	1.5	Chrysanthemum	150000	60000	120000	330000	580000	250000
19	R Venkatesh	0.26	Rose	15000	9000	5080	29080	38600	9520
20	Narayanareddy	0.3	Rose	86000	25000	12600	123600	422000	29400
21	Bharatamma	0.22	Rose	15600	3500	--	19100	22800	3700
22	Devaraju	1	Sericulture	10000	--	7000	17000	75000	58000
23	Gollu Ramanna	1	Sericulture	7000	--	5000	12000	28000	16000
24	S Venkatesh	1.2	Sericulture	5500	--	8000	13500	38000	24500
25	N S Hanumantha	1.15	Sericulture	12000	…	11000	23000	47500	24500

Jabalpur

Transplanted Rice

A rice experiment was initiated at Padiya village, Rewa district. The case study was conducted in farmers fields. Cost of cultivation for different field operations and output received with and without following AAS is presented in the table 6.22 and the benefit cost ratio is presented in the **Table 6.23**.

Table 6.22: (A). Variable cost of cultivation of transplanted rice at Padiya village, Rewa district

S. No.	Particulars	Average cost with AAS (Rs)	Average cost without AAS (Rs.)	Average saving with AAS
1	Field preparation	2185.62	2185.62	00
2	Manure & Fertilizer	3240.00	3610.82	370.82
3	Sowing	1610.80	1610.80	00
4	Transplanting	2010.65	2010.65	00
5	Weeding	1390.16	2291.15	900.99
6	Plant protection	1578.23	2460.12	881.89
7	Irrigation	1785.16	2320.64	535.48
8	Harvesting	2180.45	2180.45	00
9	Threshing winnowing Transportation	1990.25	1990.25	00
		17971.32	20660.5	2689.18
(B) Fixed cost				
1	Land rent	7472.54	7472.54	00
2	Interest on working capital	175.86	193.43	00
	Sub total	**7648.4**	**7656.97**	**00**
(C) A+B				
	Total cost (A+B)	**25619.72**	**28317.47**	

Table 6.23: Benefit cost ratio of transplanted rice by farmers following AAS ans non AAS Padiya village, Rewa district

S. No.	Particulars	Average with AAS	Average without AAS	Gross benefit with AAS
1	Cost of Cultivation (Rs/ha)	25619.72	28326.47	2706.75
2	Production (Qt/ha)			
a	Main product	36.12	34.62	1.50
b	By-product	59.63	61.74	-2.11
3	Price (Rs/qt)			

S. No.	Particulars	Average with AAS	Average without AAS	Gross benefit with AAS
a	Main product	1750.00	1750.0	00
b	By-product	42.00	42.00	00
4	Cost of production Rs/Qt			
a	Main product	709.29	818.21	-108.92
5	Return (Rs/ha)			
a	Main product	63210.00	60585.00	2625.00
b	By-product	2504.46	2593.08	-88.62
6	Gross return (Rs/ha)	65714.46	63178.08	2535.92
7	Net return (Rs/ha)	40094.74	34851.81	5242.93
8	Benefit cost ratio	2.56	2.23	0.33

Farmers following AAS obtained slightly higher benefit cost ratio over the non AAS farmers. The profit for the AAS farmer is mainly attributed to the timely application of manure & fertilizer, weeding, plant protection and irrigation to the rice crop based on Agromet Advisory Services.

Kanpur

Sesame (Kharif -2019)

Fifteen Farmers of different categories were selected from village-Barua, cultivating sesame crop. Most of the farmers prefer sesame crop due to its less water requirement than rice. All selected farmers were provided with weather based Agro-met Advisory Services (AAS) during the crop growing season of sesame crop. Most of the farmers nearer to Barua village adopted Hybrid sesame and early maturing sesame varieties.

By the fallowing or not following AAS, grape farmers got slightly higher yield than marginal farmers (**Table 6.24**). By following AAS all three categories of farmers achieved higher yield than non AAS farmers. Cost of cultivation for different operations in Sesame in case of AAS and Non-AAS farmers at Barua village (**Table 6.25**) showed net profit of Rs. 45152.7 and 39208, respectively. Similarly the B:C ratio of AAS (2.8) was found to be higher than the non AAS (2.46) farmers.

Table 6.24: Comparative Sesame yield achieved by three categories of farmers following AAS (AAS) and not following AAS (Non-AAS) at Barua

S. No.	Farmers category	Average yield (kg/ha)		Increased yield (%)
		AAS	Non-AAS	
1.	Large Farmers	540	503	7.14
2.	Small Farmers	528	494	6.88
3.	Marginal Farmers	512	487	5.13
Average		**527**	**495**	**6.46**

Table 6.25: Cost of cultivation in Sesame (AAS) at Barua

Field Preparation i. Ploughing /Rotavator (1) ii. Cultivator with planking (2)	 2 hr @600/hr 2 hr @350/hr	 1200 1050
Compost FYM	5 tones /ha-@ Rs. 500/tone	2500
Fertilizer (30:25:20:20) NPKS (i) SSP (ii) Urea (iii) MOP	 156.25kg/ha-@Rs. 9.0/kg 66.0kg/ha-@Rs5.33/kg 33.33 kg/ha-@Rs.19.0/kg	 1406.25 351.78 633.27
Seed Rate (Variety)	4 kg/ha-@ 180.0/kg	720
Sowing/Fertilizer/weeding/Thinning / irrigation	30 lb/ha-@174/lb	5220
Plant Protection (i) Traichodarmavirdy (Wp)	 5.0 kg/ha (soil treatment) @ Rs. 65.50/kg	 327.5
(ii) Weedicide (Alachlor)	1.50 g/ha-@ Rs.550/kg	825.0
2 Irrigations 8.0 hr/ha / irrigation	Irrigation @ Rs. 150/hr-	2400.0
Harvesting/lifting	12 lb @174/lb	2088.0
Threshing and winnowing	20 lb @174/lb	3480.0
Land rent	Rs. 6000/ year/ha.	3000.0
Cost		25201.8
Seed yield	5.27/ha-@130/kg	68510.0
Straw yield	18.90q/ha-@100/q	1844.50
Income		70354.50
Net Profit		45152.70
B:C ratio		2.80

Table 6.26: Cost of cultivation (Rs.) in Sesame (Non-AAS) at Barua

Field Preparation (i) Ploughing /Rotavator (1) (ii) Cultivator with planking (2)	 3 hr @600/hr 3 hr @350/hr	 1800 1050
Compost FYM	3 tones /ha- @ Rs. 500/tone	1500
Fertilizer (30:25:20:20) NPKS (i) SSP (ii) Urea (iii) MOP	 156.25kg/ha-@Rs. 9.0/kg 66.0kg/ha-@Rs5.33/kg 33.33 kg/ha-@Rs.19.0/kg	 1406.25 351.78 633.27
Seed Rate (Variety)	4 kg/ha-@180/kg	720

Sowing/Fertilizer/weeding /irrigation	35 lb/ha-@174/lb	6090
Plant Protection/ Weeding by (ii) Weedicide (Sulfosulfuran)	1.50g/ha-@ Rs.550/kg	825.0
3 Irrigations 8 hr/ha/irrigation	Irrigation @150/hr-	3600
Harvesting/lifting	15Lb @174/Lb	2610
Threshing and winnowing	20 Lb @174/Lb	3288
Land rent	Rs. 6000/ year/ha.	3000
Cost		26874.3
Seed yield	4.95 q/ha-@130/kg	64350.0
Straw yield	17.33 q/ha-@100/q	1732.50
Income		66082.50
Net Profit		39208.20
B:C ratio		2.46

Table 6.27: Comparative economic impact in sesame between AAS and Non-AAS farmers at village Barua

S. No.	Status of farmer	Cost of cultivation (Rs.)	Gross Return (Rs.)	Net return (Rs.)	B:C ratio
1	AAS	25201.8	70354.50	45152.70	2.80
2	Non-AAS	26874.3	66082.50	39208.20	2.46

The profit of AAS farmers are mainly attributed to timely utilization of the agromet advisory, for manipulating the cultural practices, irrigation scheduling, broadcasting fertilizers and spraying weedicides and pesticides as per the forecasted weather condition prevailed at Barua-village of Hamirpur.

Kovilpatti

Maize

The AAS farmer Mr. K. Seenivasan, of Allikundam village showed interest for adoption of block level forecast based agromet advisories given by the AICRPAM unit, ARS, Kovilpatti. The Agrometeorologist and Junior agronomist counselled the farmers by conducting farmers meeting at Allikundam village. The AAS farmer Mr. K. Seenivasan harvested higher grain yield (29.5 q/ha) of maize grain yield over non AAS farmer Mr. N. Natarajan (17.5 q/ha). The total cost of cultivation incurred by AAS farmer was Rs. 27455/ha. A net income of Rs. 30070/ha was received by the AAS farmer when compared to Non AAS farmer (Rs. 9075/ha). The AAS farmer obtained higher B:C ratio (2.10) over non AAS farmer (1.39) (Table 6.28 and 6.29)

Table 6.28: Analysis of B:C ratio in maize growing AAS farmers at Allikundam village

Input details	C. Meenakshi	S. Muthumanikkam	K. Seenivasan	D. Ayyanar	V. Muniyandi
Field preparation (Rs./ha)	4280	3690	3830	4425	3845
Seed cost (Rs./ha)	3615	3810	3605	4150	3825
Sowing cost (Rs./ha)	4470	3640	3750	4020	3750
Fertilizer and manure cost (Rs./ha)	5855	5645	6055	5725	6450
Weeding cost (Pre-emergence herbicide + one hand weeding) (Rs./ha)	2220	2425	2450	2845	2675
Plant protection cost (Rs./ha)	1850	1710	1925	2150	2050
Labour cost (irrigation, weeding and fertilizer) (Rs./ha)	1825	1650	1640	1855	1820
Foliar spray of micro nutrient (TNAU maize maxim) (Rs./ha)	650	0	950	0	0
Harvesting charges (Combined harvester) (Rs./ha)	3225	4050	3250	4225	4150
Total cost of cultivation (Rs./ha)	27990	26620	27455	29395	28565
Yield (q/ha)	26	23.5	29.5	24.5	25
Price (Rs. /q)	1850	1820	1950	1875	1845
Gross income (Rs./ha)	48100	42770	57525	45937.5	46125
Net income (Rs./ha)	20110	16150	30070	16542.5	17560
B:C ratio	1.72	1.61	2.10	1.56	1.61

Table. 6.29: Analysis of B:C ratio of maize growing non-AAS farmers at Allikundam village

Input details	P. Mariappan	M. Periyakaruppan	N. Natarajan	M. Raju	K. Siva subbu
Field preparation (Rs./ha)	3655	3090	3235	3850	3245
Seed cost (Rs./ha)	3010	3225	3205	3650	3220
Sowing cost (Rs./ha)	4170	3325	3450	3815	3420
Fertilizer and manure cost (Rs./ha)	5325	5045	5820	5615	6125
Weeding cost (Pre-emergence herbicide + one hand weeding) (Rs./ha)	2080	2120	2065	2285	2040
Plant protection cost (Rs./ha)	1620	1540	1125	1815	1625
Labour cost (irrigation, weeding and fertilizer) (Rs./ha)	1225	1420	1375	1455	1410
Foliar spray of micro nutrient (TNAU maize maxim) (Rs./ha)	0	0	0	0	0
Harvesting charges (Combine harvester) (Rs./ha)	3175	3820	2850	3215	3450
Total cost of cultivation (Rs./ha)	24260	23585	23125	25700	24535
Yield (q/ha)	21	18	17.5	21.5	20.5
Price (Rs. /q)	1820	1810	1840	1800	1750
Gross income (Rs./ha)	38220	32580	32200	38700	35875
Net income (Rs./ha)	13960	8995	9075	13000	11340
B:C ratio	1.58	1.38	1.39	1.51	1.46

The profits made by farmers adopting AAS over the non-AAS adopting farmers were mainly due to the adoption of agro advisories viz., timely weeding (pre-emergence application of weedicide), plant protection measures and postponement of spraying due to rainfall forecast and timely application of micro nutrients (TNAU maize maxim). The AAS farmers went for early harvesting of maize crop and gained higher price than the farmers not adopting AAS.

7. Farmer's Awareness Programs on Climate Change

The details of awareness program on climate change conducted for farmers of different states under the project are presented in **Table 7.1**.

Table 7.1: Details of farmer's awareness programs conducted at different locations during 2019-20

Center	Name of Village/Location	Date on which Conducted	Total No. of farmers	Men	Women
Akola	Choutha	01-Jun-19	55	47	08
	Warkhed	22-Nov-19	41	35	06
Bengaluru	Huraliborasandra	15-Oct-19	54	34	20
	Gowdahalli Doddaballapur	18-Oct-19	67	42	25
Dapoli	Kalambani	22-Nov-19	60	35	25
Faizabad	Balarmau, Ayodhya	20-Nov-19	80	70	10
Hisar	Tarrain Kalan	11,12-Sep-19	63		
	Rupana Khurd	12,13-Sep-19	81		
Chatha	Panjgrain, Sherpur	23-Oct-2019	220		
Mohanpur	Shibpur-Kadamtala Village, Nadia	02-Sep-19	47	42	05
	—Do— (FAP plus seed and inputs distribution)	21-Dec-19	45	39	06
	Raidanga village, Nadia	20-Jan-20	52	52	00
Palampur	Patlandar, Hamirpur	24- Jul-19	40	20	20
	Jol, Hamirpur	25-Jul-19	40	25	15
	Darla, Hamirpur	26-Jul-19	40	15	25
	Jangal, Hamirpur	30-Jul-19	30	08	22
	Sapahal, Hamirpur	31-Jul-19	40	23	17
	Chabutra, Hamirpur	01-Aug-19	40	19	21
Raipur	Kapsi	25-Oct-19	61	55	06
Ranchi	Chatra KVK	04-Sep-19	59	46	13
Solapur	Z.P., Solapur	01-Jun-19	105	80	25
	Narotewadi	30-Jun-19	55	35	20
	KVK, Solapur	30-Aug-19	35	30	05

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
Anantapur	KVK, Yagantipalle	Kurnool	Banaganapalle	1. Yagantipalle
	KVK, Reddipalli	Ananthapuramu	Singanamala	2. Peravali
	AICRPDA NICRA	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 (AICRPAM)
	KVK, Gonda	Gonda	Paraspur, (Colonelgan)	2. Bambampurwa (TDC - NICRA)
	AICRPDA-NICRA	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 (AICRPM) 2. Kochupathar (AICRPAM)
	KVK, Napam	Sonitpur	Balipara	3. Nagharia (NICRA-TDC)
	KVK, Bilasipara	Dhubri	Agomani	4. Udmari III (Additional TDC)
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, AICRPAM-NICRA 2. Hitanu, AICRPAM-NICRA 3. Dunda, TDC-NICRA 4. Asthal, TDC-NICRA
			Chinyalisaur	1. Bharkot, TDC-NICRA

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, Vijayapura	Vijayapura	Vijayapura	3. Kavalagi

Annexure - II

Staff position of AICRPAM-NICRA during 2019-20 (Upto 31st March 2020)

Centre	Agrometeorologist / Jr. Agronomist	RA/SRF/YP-I/YP-II
PC Unit	Project Coordinator (Ag. Met)	Dr. V.M. Sandeep Dr. V.P. Pramod Ms. N. Zaheda
Akola	Dr. Arvind R Tupe	Shri. Sachin V. More
Anand	Dr. Manoj M. Lunagaria Mr N.J. Chaudhari	
Anantapur	Dr. S.N. Malleswari Mr. K. Arun Kumar	Ms. B. Divya
Bengaluru	Dr. H.S. Shivaramu Dr. M.H. Manjunatha	Mr. Lingaraj Huggi
Bhubaneswar	Dr. Anupama Baliar Singh	Sri. Gourisankar Panigrahi
Chatha	Dr. Mahender Singh	Dr. Charu Sharma
Dapoli	Dr. V.G. More	Mr. Nitin Shantaram Khale
Faizabad	Dr. A.K. Singh	
Hisar	Dr. Chander Shekhar	Mr. Harendra Kumar
Jabalpur	Dr. Manish Bhan	Sri. Bhirendra Kumar
Jorhat	Mr. Kuldip Medhi	Sri. Pranjal Dutta
Kanpur	Dr. Naushad Khan	Sri. GendaLal
Kovilpatti	Dr. G. Sudhakar Dr. S. Subbulakshmi	Sri. K. Sappanimuthu
Ludhiana	Dr. Prabhjyot K. Sidhu Dr. SS Sandhu	
Mohanpur	Dr. Saon Banerjee Dr Asis Mukherjee	
Palampur	Dr. Rajendra Prasad	
Parbhani	Dr. K.K. Dakhore	Shri Amol Jodhale
Raipur	Dr. J.L. Chaudhary	Ms. Surbhi Jain
Ranchi	Dr. Pragyan Kumari	Dr. Bably
Ranichauri	Mr. Sumit Chaudhary	Sri. Ashutosh Negi
Samastipur	Dr. A. Sattar	Sri. Shanta Kumar Choudhary
Solapur	Dr. H.L. Ghadage Dr V.M. Londhe	Miss S.G.B. Birajdar
Thrissur	Dr. B. Ajithkumar	Ms Shanimol S.R.
Udaipur	Dr. N.S. Solanki	Sri. Gopal Nai
Vijayapura	Dr. P.S Pattar	

Annexure - III

Budget allocated for AICRPAM-NICRA 2019-20

(in Rupees)

S.No.	Centre	RE 2018-19			
		TA	RC	SCSP	Total
1	Akola	9000	380000	-	389000
2	Anand	9000	321000	-	330000
3	Anantapur	12000	432000	250000	694000
4	Bangalore	12000	560000	-	572000
5	Bhubaneswar	13000	450000	-	463000
6	Bijapur	10000	420000	-	430000
7	Chatha	14000	665000	250000	929000
8	Dapoli	12000	334000	-	346000
9	Faizabad	12000	400000	-	412000
10	Hisar	10000	400000	250000	660000
11	Jabalpur	15000	460000	-	475000
12	Jorhat	15000	440000	-	455000
13	Kanpur	12000	468000	250000	730000
14	Kovilpatti	10000	305000	250000	565000
15	Ludhiana	12000	450000	250000	712000
16	Mohanpur	12000	500000	250000	762000
17	Palampur	10000	325000	250000	585000
18	Parbhani	12000	350000	-	362000
19	Raipur	12000	400000	-	412000
20	Ranchi	13000	600000	250000	863000
21	Ranichauri	15000	400000	-	415000
22	Samastipur	15000	620000	-	635000
23	Solapur	12000	400000	-	412000
24	Thrissur	11000	420000	250000	681000
25	Udaipur	11000	500000	-	511000
	Total	**300000**	**11000000**	**250000**	**13800000**

Annexure - IV

AICRPAM-NICRA

Publications 2019-20

Bangalore

Abstracts presented in Conference/Seminar/Symposium

- Manjunatha, M.H., Shivaramu, H.S., Padmashri, H.S.L., Nagesha, Lingaraj Huggi and Soumya, D.V. (2020). Reliability and usability of forecast in relation with success of agromet advisory services,107th Indian Science Congress, 3-7 January, University of Agricultural Sciences, GKVK, Bengaluru.

Faizabad

Papers in Peer Reviewed Journal

- Arpita, S.N., Singh, A.K., Mishra, A.N., Shukla, S.K. and Kumar M. (2019). Studies on Extreme Weather Events of Eastern Plain Zone of Uttar Pradesh, *International Journal of Chemical Studies*, 7(1): 2014-2017.

Hisar

Book Chapter

- Chander Shekhar, Anil Kumar and Anurag (2019). Haryana towards climate resilient agriculture. In: "Climate Change and Agriculture: Causes, Impacts and Interventions". (Eds. Prasada Rao, G.S.L.H.V., Rao, V.U.M and Rao, D.V.S.). pp. 275-293. New India Publishing Agency, New Delhi (ISBN 9789387973626).

Abstracts presented in Conference/Seminar/Symposium

- Chander Shekhar, Anil Kumar, Divesh Choudhary and Anurag (2020). Economic impact assessment of agromet advisories on wheat crop: A case study. National Seminar on Agrometeorological Interventions for Enhancing Farmers' Income (AGMET-2020)" held at KAU, Thrissur, Kerala during January 20-22, 2020, pp 254.
- Divesh Choudhary, C.S., Dagar, Anil Kumar, Surender Singh and Raj Singh (2020). Micro level weather based agromet-advisories and economic impact assessment of Sirsa district, Haryana. National Seminar on Agrometeorological Interventions for Enhancing Farmers' Income (AGMET-2020)" held at KAU, Thrissur, Kerala during January 20-22, 2020, pp 257.

Kanpur

Papers in Peer Reviewed Journal

- Naushad Khan, Ajay Kumar, Singh, C.B., Karam Husain and Vijay Dubey (2019). Weather based agromet advisory for sustaining maize yield in Central Plain Zone of Uttar Pradesh. *International Journal of Chemical Studies,* 7(4): 263-268.

Technical Bulletin

- Success stories of farmers in climate Resilient Agriculture" under National Innovation on climate Resilient Agriculture. on 2019.

Mohanpur

Abstracts presented in Conference/Seminar/Symposium

- Banerjee. S., Mukherjee, A., Biswas, S. and Sattar, A. 2019. Change in Temperature and Rainfall Pattern at Coastal Region Adjoining Sundarbans, West Bengal. Proceedings of the International Conference on Livelihood Promotion, Bio-diversity Conservation and Social Security in Indian Sundarbans (ISBN: 978-93-88879-26-2): 322-327.

Raipur

Book Chapter

- J.L. Chaudhary (2019). Climate Resilient Agriculture in Chhattisgarh. In: "Climate Change and Agriculture, causes, impacts and interventions". New India Publishing House New Delhi. ISBN: 978-93-87973-62-6.

Solapur

Technical Bulletin

- Londhe.V.M., Ghadage. H, Amrutsagar, L., Jadhav V.M., Indi, J.D., Akashe, D.V., Gethe, V.B., Upadhye, R.M., Pawar, S.K. and Birajdar S.G. (2019). Krushi havamanavar adharit krushi salla Pustika (Jilha- Solapur Hangam- Kharip v rabi) MPKV/Res.Pub No. 283/2019.
- Londhe, V.M., Ghadage, H.L., Pawar, P.B., Amrutsagar, V.M., Jadhav, J.D. and Birajdar, S.G. (2019). Trend analysis of rainfall in Western Maharashtra. pp. 18-21.

Vijayapura

Technical Bulletin

- Venkatesh, H., Katageri, I.S., Hiremath, J.R., Shivaramu, H.S., Vijayakumar, P. and Subba Rao, A.V.M. (2019). "Impact of El Niño Southern Oscillation and Indian Ocean Dipole on Rainfall over Karnataka: A Preliminary Assessment".