National Innovations in Climate Resilient Agriculture

AICRPAM Component

AICRPAM - NICRA

Annual Report 2017-18

All India Coordinated Research Project on Agrometeorology
ICAR-Central Research Institute for Dryland Agriculture
Santoshnagar, Hyderabad-500 059

National Innovations in Climate Resilient Agriculture

AICRPAM Component

Annual Report
2017-18

All India Coordinated Research Project on Agrometeorology
ICAR-Central Research Institute for Dryland Agriculture
Santoshnagar, Hyderabad-500 059

Citation:
Vijaya Kumar P, Sarath Chandran MA, Bal SK, Subba Rao AVM and Dhakar R. 2018. National Innovations in Climate Resilient Agriculture - AICRPAM Component, Annual Report 2017-18. ICAR–Central Research Institute for Dryland Agriculture, Santoshnagar, Hyderabad-500 059, Telangana, India. 64p.

Copies: 200

Published by
Director
ICAR-Central Research Institute for Dryland Agriculture
Santoshnagar, Hyderabad - 500059
Ph: 91-040-24530177, 24530161 (O)
Fax: 91-040-24531802
Web: http://www.crida.in
E-mail: director.crida@icar.gov.in

Compiled & Edited
P Vijaya Kumar, Sarath Chandran MA, SK Bal, AVM Subba Rao and Rajkumar Dhakar

Technical Assistance
IR Khandgonda

Cover page design
A Mallesh Yadav

Printed at:
Balaji Scan Pvt. Limited,
Lakdikapul, Hyderabad, Tel : 23303424/25

List of Contributors

1. Dr. Anil Karunakar, Akola
2. Dr. S.N. Malleswari, Anantapur
3. Dr. Manoj M. Lunagaria, Anand
4. Dr. H.S. Shivaramu, Bangalore
5. Dr. Anupama Baliar Singh, Bhubaneswar
6. Dr. D.N. Jagtap, Dapoli (Dr. Vijay More since 08.02.2018)
7. Dr. Anil Kumar Singh, Faizabad (Dr. Rajesh Kumar since 28.07.2017)
8. Dr. Chandersekhar Dagar, Hisar
9. Dr. Manish Bhan, Jabalpur
10. Dr. Bondita Goswami, Jorhat
11. Dr. A.P. Dubey, Kanpur
12. Dr. G. Sudhakar, Kovilpatti
13. Dr. Prabhjyot Kaur Sidhu, Ludhiana
14. Dr. Asis Mukherjee, Mohanpur
15. Dr. Rajendra Prasad, Palampur
16. Dr. K.K.Dakhore, Parbhani
17. Dr. J.L. Chaudhary, Raipur
18. Dr. Mahender Singh, Jammu
19. Dr. Pragyan Kumari, Ranchi
20. Dr. R.G. Upadhyay, Ranichauri
21. Dr. Abdus Sattar, Samastipur
22. Dr. J.D. Jadhav, Solapur
23. Dr. B. Ajith Kumar Pillai, Thrissur
24. Dr. N.S. Solanki, Udaipur
25. Dr. H. Venkatesh, Vijayapura

Contents

1. Introduction

India's agricultural sector is facing a significant threat from climate change as extreme weather events are on the rise. A study conducted by 29 researchers around the world, published in the *Proceedings of the National Academy of Sciences*, has outlined how climate change is causing lower crop yields around the world. In particular, the study found that "each degree-Celsius increase in global mean temperature would, on average, reduce global yields of wheat by 6.0%, rice by 3.2%, maize by 7.4%, and soybean by 3.1%". The Indian economic survey of 2018 has noted that such impact is more adverse in un-irrigated lands compared with irrigated areas. "Extreme shocks have highly divergent effects between un-irrigated and irrigated areas (and consequently between crops that are dependent on rainfall), almost twice as high in the former compared to the latter," the survey said. 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 area 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 by 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 has 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 stake holders

It is a known fact that weather plays a dominant role in year to year fluctuation 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 shall 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 by 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. Weather Data Acquisition and Value Addition

AICRPAM was entrusted with the assessment of climatic variability in selected 100 most climate change vulnerable districts of India under the NICRA project. For meeting this requirement, 100 automatic weather stations (AWS) were installed in these districts. The 100 locations were identified representing various climatic vulnerabilities. The location map and details of AWS installed based on climatic vulnerability is given in Fig. 1 and Table 1.

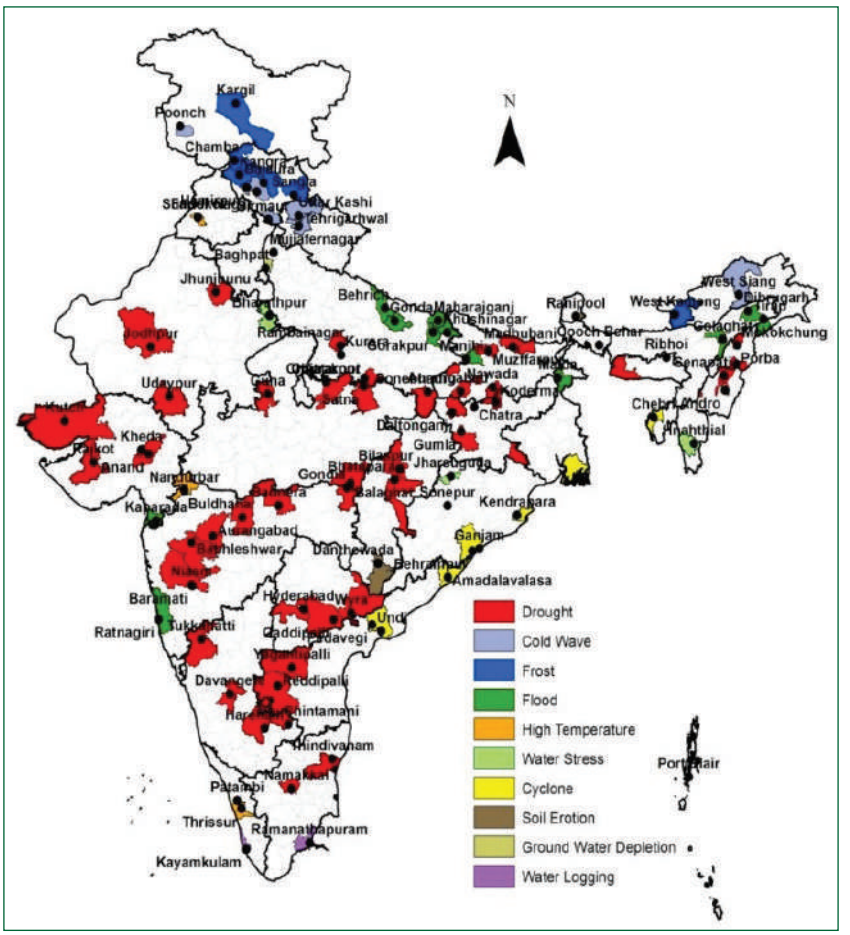

Fig. 1 Location map of 100 AWS installed under AICRPAM-NICRA project based on climatic vulnerability

Table 1. Details of AWS installed under the NICRA project in different states

ATARI Zone	State	Number of AWS
I	Himachal Pradesh	8
	Jammu & Kashmir	2
	Punjab	1
II	A&N Islands	1
	Bihar	7
	Jharkhand	4
	West Bengal	2
III	Arunachal Pradesh	3
	Assam	2
	Manipur	2
	Meghalaya	1
	Mizoram	1
	Nagaland	2
	Sikkim	1
	Tripura	1
IV	Uttar Pradesh	11
	Uttarakhand	2
V	Andhra Pradesh	5
	Telangana	3
	Maharashtra	9
VI	Gujarat	5
	Rajasthan	4
VII	Chhattisgarh	4
	Madhya Pradesh	4
	Orissa	5
VIII	Kerala	3
	Karnataka	4
	Tamil Nadu	3

2.1 AWS network maintenance, quality checking and database management

The NICRA AWS records seven meteorological parameters such as Temperature (maximum & minimum), Relative Humidity (maximum & minimum), Wind Speed, Wind Direction, Solar Radiation, Rainfall and Evapotranspiration. Out of these, Evapotranspiration is a derived parameter using FAO Penman Monteith method (Allen *et. al.*, 1998). The technical specifications of each sensor are given in Table 2.

Table 2. Technical specifications of meteorological sensors

Parameter	Sensor	Specifications
Temperature & Relative Humidity	Rotronic's AT/RH Sensor (HC2-S3)	Temperature Range: -50 °C to 100 °C
		Accuracy: ± 0.5% @ -10 °C to 70 °C
		Resolution: 0.02% Typical
		RH Range: 0 – 100%, Accuracy: ± 0.8%
Wind Speed & Direction	RM Young 85000 Ultrasonic Anemometer	Wind Speed Range: 0-70 ms^{-1}
		Resolution: 0.1 ms^{-1}, Accuracy: 0 to 30 ms^{-1}, ± 2%
		Wind Direction Range: 0-360°
		Resolution: 1 degree, Accuracy: ± 2 degrees
Solar Radiation	Apogee Solar Radiation SP-110	Range: 0 – 1750 Wm^{-2}
		Accuracy: ± 0.5% Operating Environment: - 25 °C to 55°C, 0 to 100% RH
Rainfall	Waterlog – H340 Rain Gauge	Resolution: 0.01 in. (@ 4 in. hr^{-1}.)
		Rate: 0 to 25 in. hr^{-1}.
		Operating Temperature: -0 to +60 ° C
Evapotranspiration	Derived	FAO Penman Monteith Method

The steps involved in quality checking of AWS data are depicted in Fig. 2.

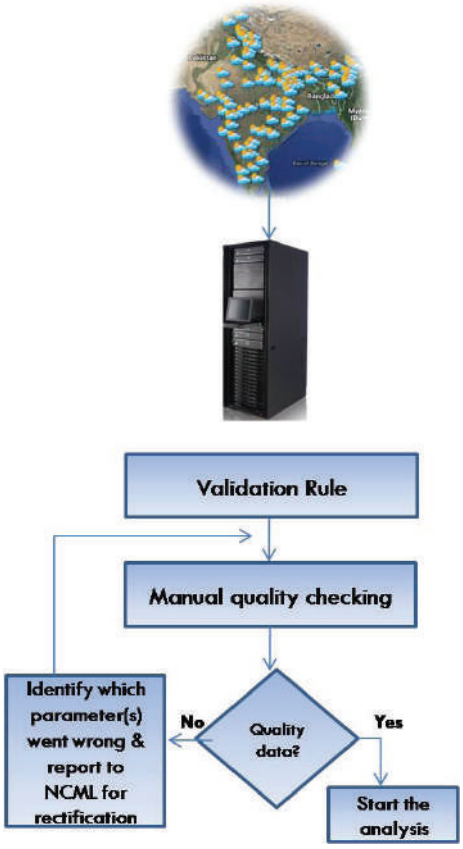

Fig. 2 Flow chart depicting quality checking of AWS data

2.2 AWS products

Hyetograph

A hyetograph is a graphical representation of rainfall intensity over time. It can be either incremental or cumulative. Using the hourly rainfall data of 2012 obtained using AICRPAM-NICRA AWS network, hyetograph was prepared for Amaravati of Maharashtra and the results are presented in Fig. 3 and 4.

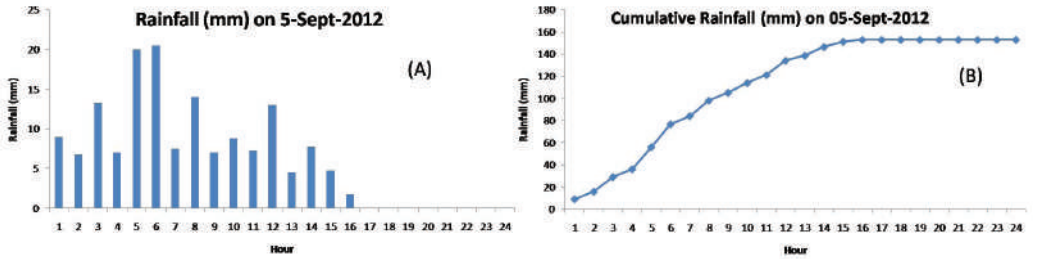

Fig. 3 Hyetograph (A) incremental basis and (B) cumulative basis of Amaravati, Maharashtra on 05-09-2012.

Amaravati recorded 152.7 mm rainfall on 05-09-2012, which was well distributed between zero and 1600 hours on that day. Similarly, Amaravati received 140.2 mm rainfall on 17-June-2012 and the hyetograph is given in Fig. 4.

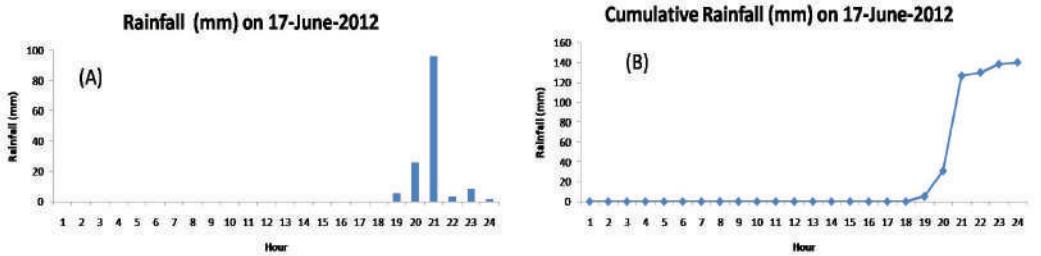

Fig. 4 Hyetograph of Amaravati, Maharashtra on 17-06-2012 (A) incremental basis and (B) cumulative basis.

Out of 140.2 mm received on 17 June 2012, 95 mm rainfall occurred during 2100-2200 hours. Such kind of information is useful for representing characteristics of heavy rainfall events, developing storm products to predict extreme flood etc.

3. Micro-level Agroclimatic Characterization

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. Anomalies in climatic variables need to be properly understood 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 centers using block level weather data is reported here under.

Bangalore

The centre has studied the seasonal rainfall received during 2017 at Nayanahalli NICRA village compared to the normal and the results obtained are presented in Fig. 5.

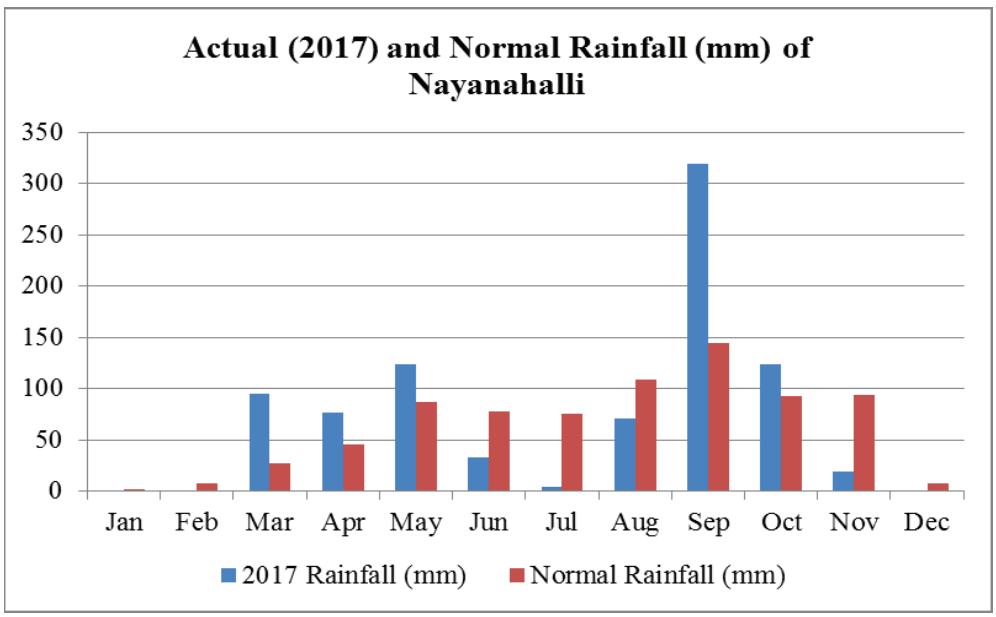

Fig. 5 Seasonal rainfall received at Nayanahalli NICRA village, Karnataka during 2017 compared to the normal

The following observations were emanated from the analysis

- NICRA village Nayanahalli, Kuthanagere and Durgada nagenahalli received 866 mm, 1230 mm and 928 mm of annual rainfall, respectively in 12, 16 and 13 rainy days , respectively.
- The highest rainfall was recorded at Nayanahalli (141 mm), Kuthanagere (124.2 mm) and Durgada Nagenahalli (84 mm) on 15th, 9th and 10th September, respectively.
- The rainfall distribution clearly shows bimodal rainfall in all three study villages.
- Though South West monsoon of all three villages express normal to excess rainfall situation, the excess rains of August and September has masked the deficit situation of June and July rains.
- Water balance diagram using rainfall and PET values revealed 190, 189 and 97 days of LGP in these villages.

Bhubaneswar

The centre has carried out the dry spell analysis during southwest monsoon 2017 at different blocks of Kendrapada district and the results are presented in Table 3.

The results indicated that Rajnagar block experienced longest dry spell of 23 days during 4-27 Aug 2017, which affected the kharif crops badly. Apart from this, Rajnagar also witnessed three more dry spells of more than 7 day duration. Other blocks like Garadapur, Pattamundai and Aul had witnessed 4 dry spells of more than 7 day duration.

Jammu

Dry and wet spell analysis of Kathua district

An analysis of dry and wet spells of Kathua district was carried out based on available daily rainfall data of the last seven years. Results of the analysis showed that (Table 4) amount of annual rainfall is more variable with CV of 20% than the number of rainy days with CV less than 10 per cent. The high variability was observed in dry spells of > 14 and >21 days in comparison to >7 days.

Table 3: Dry spells during southwest monsoon 2017 in different blocks of Kendrapada district, Odisha

Monsoon dry Spells in 2017					
Sl.No.	Blocks	> 7 days	Period	> 14 days	Period
1	Kendrapada	3	17.06 to 23.06, 03.09 to 12.09 & 17.09 to 27.09	NIL	
2	Derabis	2	17.06 to 25.06 & 04.09 to 12.09	NIL	
3	Marshaghai	3	17.06 to 23.06, 03.09 to 12.09 & 15.09 to 27.09	NIL	
4	Mohakalpara	3	01.06 to 10.06, 17.06 to 23.06 & 03.09 to 12.09	NIL	
5	Garadapur	4	01.06 to 09.06, 17.06 to 23.06, 03.09 to 12.09 & 22.09 to 30.09	NIL	
6	Pattamundai	4	17.06 to 23.06, 26.07 to 03.08, 11.08 to 17.08 & 20.09 to 27.09	NIL	
7	Aul	4	01.06 to 10.06, 17.06 to 23.06, 03.09 to 12.09 & 20.09 to 27.09	NIL	
8	Rajnagar	4	01.06 to 11.06, 16.06 to 23.06, 03.07 to 09.07 & 03.09 to 12.09	1	04.09 to 27.09
9	Rajkanika	3	17.06 to 23.06, 03.09 to 12.09 & 20.09 to 27.09	NIL	

Table 4: Analysis of rainfall pattern at Kathua district of J&K

Trend in Rainfall		Annual Average								
		2011	2012	2013	2014	2015	2016	2017	Mean	SD
Average Rainfall (mm)		1097	1512	1986	1217	1593	1350	1556	1473	291
No. of Rainy days		63	61	74	55	68	63	68	65	6
No. of Dry Spells	>7 days	9	8	13	7	21	6	3	11	6
	>14 days	2	1	3	6	8	1	1	4	3
	>21 days	4	5	1	2	2	3	7	3	2
No. of intensive rain spells	>60 mm per day	4	8	8	6	6	3	6	6	2

Vijayapura

Annual rainfall showed decreasing trend from 1986 (660 mm) to 2016 (560 mm). Variability patterns of annual rainfall in Gadag district over the past 30 years showed cyclic variation, with alternate high rainfall and low rainfall epochs of ten years duration (Fig. 6A). This is indicated by the curves of both moving average and polynomial methods. Taking into consideration both the linear trend and cyclic variations, the rainfall in the taluk could not only be lower, but also reach below normal epoch by 2020. Similar periodicity was noticed for annual rainy days (Fig. 6B) and October rainfall (Fig. 6C). On the contrary, the rainfall in the month of July increased only slightly (Fig. 6D), and phase lag is noticed between rainfall of July and October months.

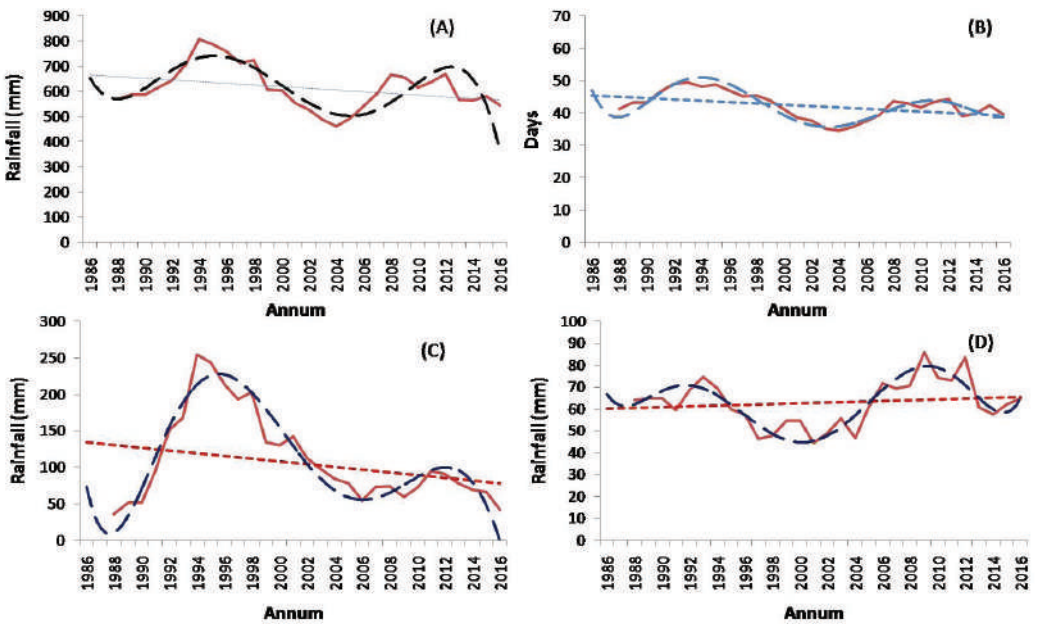

Fig. 6 Variability in (A) annual rainfall (B) annual rainy days (C) October rainfall and (D) July rainfall in Gadag Taluk, Gadag district, Karnataka.

4. Validation of Block-level Weather Forecasts

District level weather forecast is used for preparation of bi-weekly agromet advisory services (AAS) in India, since last two decades. But it did not account for the large spatial variation in weather parameters, especially rainfall, which may vary between a few kilometers. Hence, the validity of AAS prepared based on district level weather forecast is a problem to be resolved. India Meteorological Department has started issuing block-level weather forecast since 2014. AICRPAM has used block-level weather forecast for preparation of micro-level AAS under this project. AICRPAM centers have compared block and district level rainfall forecast with the observed rainfall at the AICRPAM-NICRA adopted villages and the results are presented in this chapter.

Jorhat

The centre has compared block level rainfall forecast provided by Indian Meteorological Department (IMD), Pune and the actual data obtained from rain gauge installed at both the NICRA villages viz Thengalgaon and Kochupathar located at Khumtai Golaghat and the results are presented in Fig. 7.

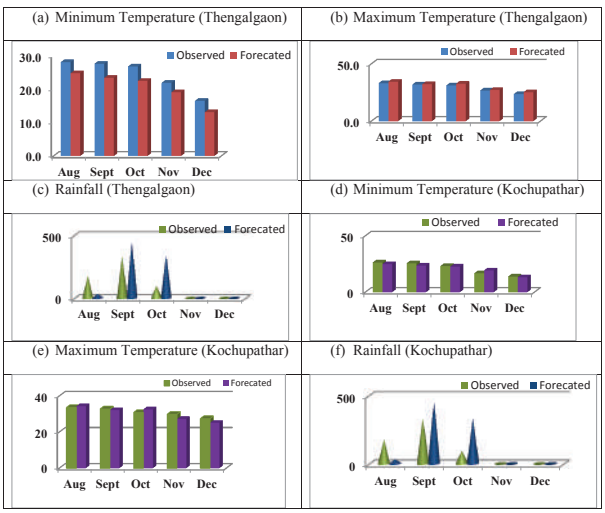

Fig. 7: Comparison between forecasted weather (from IMD) and actual weather (reported by FIF) at Thengalgaon and Kochupathar village.

Perusal of the Fig. 7a indicates that the actual minimum temperature was substantially higher than the forecasted minimum temperature in all of the 5 months at Thengalgaon. From the Fig. 7b, it was observed that the actual

maximum temperature was comparatively lower than the forecasted maximum temperature during the period August to December. However, the actual total rainfall received during months i.e. September and October was somewhat lower than the forecasted total rainfall (Fig. 7c).

In Kochupathar, a perusal of the Fig.7f indicates that total actual rainfall was substantially higher than the forecasted rainfall received in the months of September and October while it was lower during the month of August. From the Fig. 7e, it was observed that the actual maximum temperature was higher than the forecasted maximum temperature during most of the months. Again the actual minimum temperature was higher than the forecasted minimum temperature in all the months, except November (Fig. 7d).

Hisar

The daily agrometeorological data recorded at agromet observatory of ICAR-CICR, Sirsa was used for forecast verification and analysis. The season-wise quantitative verification analysis of the forecast for rainfall were carried out using various error structures and the values have been depicted in Table 5. The highest (98.9 per cent) correct rainfall forecast was observed during pre-monsoon followed by winter (98.2 per cent) and post monsoon (97.7 per cent). The least correct forecasted events were noticed during monsoon season (80.8 per cent). In case of annual rainfall, 94.1 per cent of forecast events were correct and the unusable events were 1.3 percent. The observed rainfall is found to be correct, if the absolute difference is less than or equal to 25% of the observed, it is usable but not correct if the absolute difference lies between 25% of the observed and 50% of the observed and is unusable otherwise.

The quantitative analysis of predicted maximum temperature using different error structures are shown in Table 5. The highest numbers of correct Maximum temperature forecast events were observed in post-monsoon season, followed by winter and pre monsoon season. However, monsoon recorded the lowest number of correct forecasted events i.e. 37.7 per cent. The usable events during winter were 20.3 per cent while, 32.2 per cent were unusable. In case of forecast events on annual basis, 46.9 percent were correct with 21.9 percent usable and 31.2 per cent unusable. The highest unusable events were recorded during monsoon season.

Table 5: Quantitative analysis (%) of predicted weather events using error structures

Error structure	Pre Monsoon	Monsoon	Post Monsoon	Winter	Annual
	Rainfall				
Correct	98.9	80.8	97.7	98.2	94.1
Usable	0.0	4.1	1.1	0.0	1.3
Unusable	1.2	15.1	1.1	1.8	4.6
	Maximum Temperature				
Correct	44.6	37.7	60.9	47.5	46.9
Usable	28.3	18.9	20.7	20.3	21.9
Unusable	27.2	43.4	18.5	32.2	31.2
	Minimum Temperature				
Correct	46.7	47.5	51.1	50.9	48.8
Usable	26.1	19.7	22.8	25.4	23.0
Unusable	27.2	32.8	26.1	23.7	28.2
	Maximum Relative Humidity				
Correct	44.6	68.0	45.7	74.6	57.5
Usable	29.4	21.3	28.3	17.0	24.4
Unusable	26.1	10.7	26.1	8.5	18.1
	Minimum Relative Humidity				
Correct	66.3	57.4	35.9	52.5	53.4
Usable	27.2	38.5	23.9	33.9	31.2
Unusable	6.5	4.1	40.2	13.6	15.3

If difference between observed and forecasted is < 1 °C, it is correct; if difference is >1 °C and <2 °C, then it is usable and if difference is >2 °C, it is unusable.

Table 5 shows the season-wise quantitative verification analysis for minimum temperature using various error structures. The highest (51.1 per cent) correct forecasted events were observed during post monsoon season followed by winter (50.9 per cent) and monsoon season (47.5 per cent). The least correct events were during pre-monsoon (46.7 per cent). Forecast verification of minimum temperature events on annual scale showed that 48.8 per cent of events were correct and 23 per cent were usable while 28.2 percent were unusable. The unusable percentage was relatively high during monsoon season (32.8 per cent).

The season-wise quantitative verification analysis for maximum relative humidity using various error structures are given in Table 5. The highest percent (74.6 per cent) of correct forecast event was observed during winter season followed by monsoon (68 per cent) and post-monsoon (45.7 per cent). The least number of correct forecast events were observed during pre monsoon (44.6 per cent). In case of annual maximum relative humidity forecast events, 57.5 per cent events were correct and usable events were 24.4 per cent while 18.1 per cent were unusable. The unusable events were highest during pre-monsoon and post monsoon seasons (each 26.1 per cent). If difference between observed and forecasted event is < 10% it is correct, if difference is >10 and <20% then it is usable and if difference is >20% it is unusable.

Table 5 shows the season-wise quantitative verification analysis for minimum relative humidity. The highest (66.3 per cent) percentage of correct forecast events were observed during pre-monsoon season followed by monsoon (57.4 per cent) and winter (52.5 per cent) seasons. The least correct events were observed during post monsoon (35.9 per cent) season. In case of minimum relative humidity forecast events over a year, 53.4 per cent were correct, 31.2 percent events were usable and 15.3 percent were unusable. The usable percentage was relatively high during post monsoon season (40.2 per cent).

The forecasted events were compared with the observed events on daily basis for rainfall, maximum and minimum temperatures and relative humidity. The comparison is shown in Fig 8. The comparison indicated that the forecast failed to predict events of more than 30 mm rainfall. The forecast of maximum and minimum temperature was satisfactory and same was the in the case of morning relative humidity also.

Mohanpur

The block-level medium range weather forecast issued by IMD was compared with the rainfall data from Gopalganj and Bongheri villages of Kultoli block, South 24 Parganas district and the results are presented in Fig. 9.

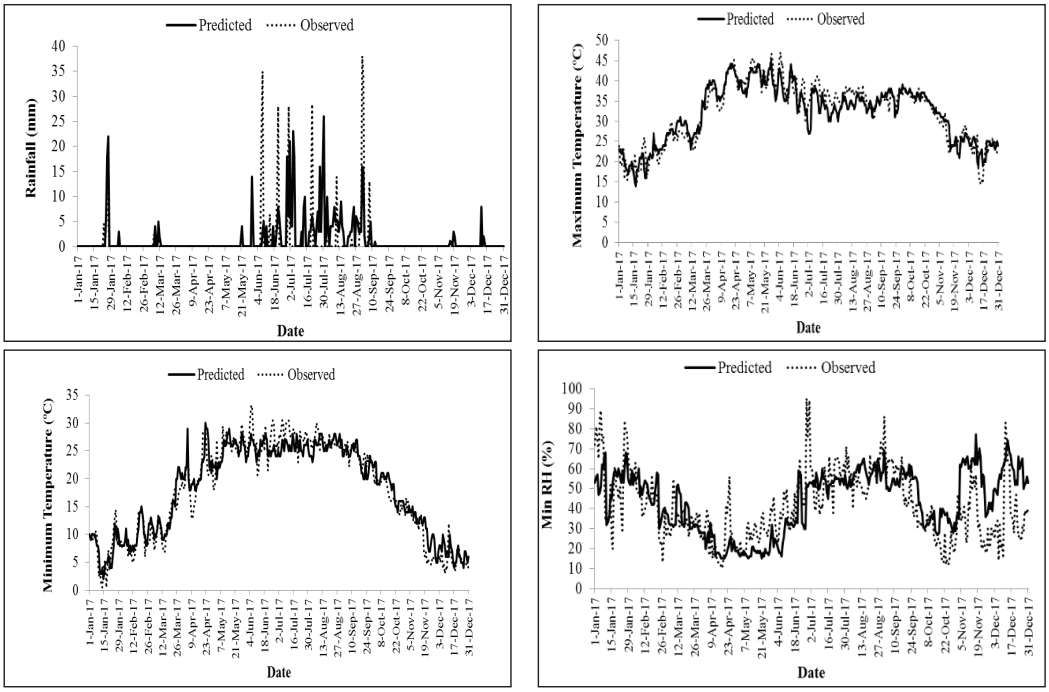

Fig. 8 Comparison of predicted and observed daily weather events at Sirsa, Haryana

It is observed that during the months of southwest monsoon season (June, July and August), there is lot of difference between actual and predicted data, except on few dates was observed. The September and October rainfall forecast is slightly better, although the daily rainfall is under-predicted.

Kanpur

The comparison of block-level weather forecast with observed rainfall at Daleepnagar, Uttar Pradesh revealed that the rainfall forecast was over estimated throughout the southwest monsoon season, except on few weeks (Fig. 10).

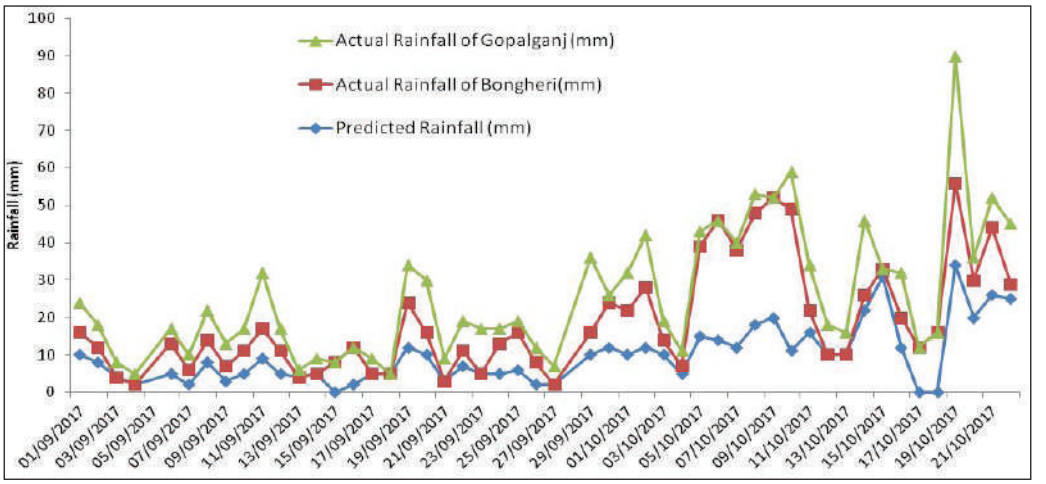

Fig. 9 Variation of daily rainfall (for rainy days only) in Bongheri and Gopalganj village, South 24 Parganas showing the relation of forecasted and actual rainfall data (from September, 2017 to October, 2017):

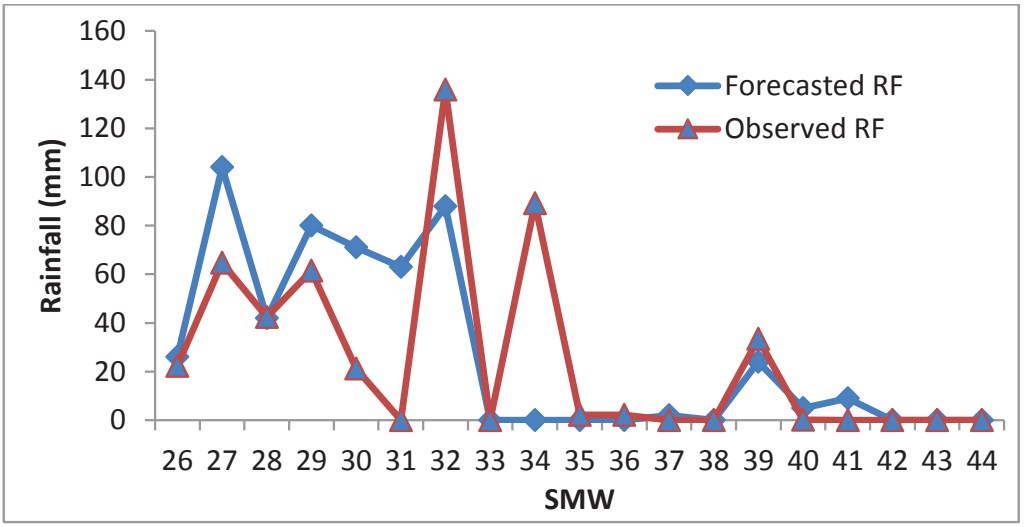

Fig. 10 Comparison of forecasted and observed rainfall at Dalipnagar, Uttar Pradesh

5. Economic Impact of Block-level Agromet Advisory Services

The ultimate aim of weather based AAS is to help the farmers in increasing the economic benefit by suggesting management practices suitable to 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 different AICRPAM centers. Economic impact of individual advisories is discussed here and the cumulative impact of block level AAS issued throughout the 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 are discussed in Table 6.

Table 6: Economic impact of micro-level AAS at various AICRPAM-NICRA centres

Name of the Farmer	Date of Issue	Crop	Rainfall Forecast	Advisory Given	Observed Rainfall	Action taken by the Farmer	Profit/ Loss
Bhubneshwar							
Hina Rout, Ekalpur	20-07-2017	Rice	Low to Medium rainfall	Withhold application of fertilizers & pesticides	Medium rainfall	Waited for the dry weather to apply pesticides for Rice BLB	Saved ₹ 300
Manoranjan Nayak, Ekalpur	20-07-2017	Pulses	Low to Medium rainfall	Withhold sowing of pulses	Medium rainfall	Didn't sow the *kharif* greengram in one acre land	Saved seed worth ₹ 320
Muralidhara Pradhan, Ekalpur	21-10-2017	Rice	Medium to heavy	Go for harvesting of the early duration paddy and shift produce to safer place	Heavy rainfall	Did not go for harvesting and lost their entire produce	₹9100 lost
Gyana Rout, Ekalpur	02-11-2017	Rice	Cloudy Weather	Drain out water from the field, spray Carbaryl 50 WP @ 1500 g per ha	Cloudy for 5 days	Drained out the water & sprayed Carbaryl 50 WP in afternoon	Prevent from serious BPH attack
Nabin Badatya, Padmapur	14-12-2017	Rice	Medium rainfall due to cyclonic activity in Ganjam	Spray 1.5 g Streptocycline with 25 g Cupper Oxychloride per 10 litre water to prevent grain discoloration in rice due to rainfall. Go for harvesting of crop even at Physiological maturity	Medium Rainfall	Drained out excess water from filed, harvested late duration rice at physiological maturity stage to protect from rain and sprayed Streptocycline in rice field	Saved rice from lodging and germination in the field itself and protected from the grain discoloration
Jammu							
Kewal Krishan	12-07-2017	Normal Transplanted Rice (Transplanting stage)	120 mm	Go for transplanting of rice after the receipt of rain	54.0 mm	Transplanted the rice and saved the irrigation	Farmer saved fuel and labour charges of Rs 1200-1400/ha

Name of the Farmer	Date of Issue	Crop	Rainfall Forecast	Advisory Given	Observed Rainfall	Action taken by the Farmer	Profit/ Loss
Ratan Chand	25-07-2017	Normal Transplanted Rice (Seedling est. stage)	125 mm	Drain out the excess water and do not apply weedicide till the water level maintained	162.7 mm	Followed the advisory	Saved the crop from submergence and also saved weedicide & labour charges
Dev Raj	08-08-2017	Normal Transplanted Rice (Tillering stage)	43 mm	Do not irrigate and postpone the plant protection, weedicide and fertilizer application	71.4 mm	Postponed all the operations and saved the irrigation	Saved the chemicals, fertilizer and labour charges
Sagar Chand	16-08-2017	Early Transplanted Rice (Vegetative stage)	0 mm	Go for the chemical spray to crop suffering from plant hopper	39.7 mm	Followed the advisory	Wastage of the chemicals and labour charges
Devraj Kumar	22-08-2017	Normal Transplanted Rice (Vegetative stage)	5 mm	Do not irrigate and postpone the plant protection, weedicide and fertilizer application	29.0 mm	Postponed all the operations and saved the irrigation	Saved the chemicals fertilizer and labour charges
Sunil Sharma	08/09/17	Early Transplanted Rice (Milk stage)	7 mm	Postpone the chemical spray for blast and stemborer	55.4 mm	Postponed the chemical spray	Saved the chemicals and labour charges of ₹800-900/ha
Rajinder Kumar	07-12-2017	Wheat	15 mm	Postpone the sowing of the wheat	47.4 mm	Postponed the sowing	Saved the seed and labour charges
Som Dutt	09-02-2018	Wheat (Ear head)	35 mm	Postpone the irrigation and chemical spray for yellow rust	41.5 mm	Suspend the operations	Saved the fuel, chemical and labour charges of ₹1200-1400 /ha

Name of the Farmer	Date of Issue	Crop	Rainfall Forecast	Advisory Given	Observed Rainfall	Action taken by the Farmer	Profit/ Loss
Akola: Kanshivani NICRA village							
Dinesh Bahakar	01-08-2017	Soybean: Late vegetative stage	Forecast of cloudy weather and 1 to 3 mm rainfall expected next5 days.	Crop in late vegetative stage, undertake hoeing/ weeding operation before interlocking of canopy growth between rows to make crop weed free and facilitate better surface tilth, aeration and improve infiltration .	2 mm rainfall received on 03 August	Followed the advisory and weeding/ hoeing undertaken.	Weed free condition enhanced crop vigour and subsequent growth and improved surface soil tilth after hoeing operation ensured better soil aeration and rain water conservation.
	08-08-2017	Peak Vegetative stage, Infestation of leaf eating caterpiller	Light rains (9 mm) rainfall expected on next 5 days	With incidence of leaf eating caterpillar observed, undertake spraying of Chlorantraniliprol- e along with stickers and adjuvant	No rainfall occurred	Spraying of Chlorantranili- prole) along with stickers undertaken	Significantly reduced the infestation of leaf eating caterpillar
	11-08-2017	Moisture stress symptom due to dry weather (2 mm rains) last 16 days	Forecast of dry weather to light showers	Real time advisory To apply protective irrigation in view of continued subdued rainfall activity period (only2 mm during	Dry period prevailed next 7 days. 27 July-11Aug.) causing moisture deficit like situation.	With insufficient rainfall and with dry weather expected further, protective irrigation was given	Timely protective irrigation improving the readily available moisture benefitted subsequent crop growth and development

Name of the Farmer	Date of Issue	Crop	Rainfall Forecast	Advisory Given	Observed Rainfall	Action taken by the Farmer	Profit/ Loss
	16-08-2017 and 18-08-2017	Peak flowering to pod initiation stage.	Forecast of cloudy weather with light to moderate rains next 5 days.	Do not undertake Any plant protection/foliar spray. Real time advisory to drain out excess water due to water logging	70.5 mm rainfall received between 18-21 August	Drained out waterlogged areas immediately	Adequate drainage of waterlogged areas improved field/ crop condition.
	22-08-2017	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	24.4 mm rainfall received between 23-28 August	No other operations undertaken. Drained out scattered waterlogged patches.	Better field condition prevailed for further crop growth and development
	29-08-2017	Peak pod formation stage	Cloudy weather and light rainfall (7 mm) expected next 5 days.	Recommended foliar spray of 2% urea (200 g/10 litres of water)	No rains occurred next 7 days.	Foliar spray of urea was done on 2 September.	Foliar spray would benefiting terms of ready crop nutrition during pod formation stage.
	12-09-2017	Seed development stage	Forecast of scattered light to moderate rainfall (45 mm) in next 5 days.	Real time advisory given to drain out excess water from waterlogged areas of crop field.	62.4 mm rainfall received between 13-15 September	Excess water from waterlogged areas across the crop field drained out.	With drainage of excess water better field condition prevailed for crop growth and development
	19-09-2017	Seed development stage	Forecast of light to moderate rainfall (42 mm) next 5 days.	Advisory given to drain out water logged areas of crop field.	42.0 mm rainfall received between 19-23 September	Drained out waterlogged areas immediately	Better field Condition for subsequent crop development

Name of the Farmer	Date of Issue	Crop	Rainfall Forecast	Advisory Given	Observed Rainfall	Action taken by the Farmer	Profit/ Loss
	03-10-2017	Crop at maturity stage	Forecast of light Rains in next 5 days	Undertake harvest on a clear day avoiding rainy weather and keep the harvest produce safely to protect against rains	No rains occurred next 5 days	Soybean was harvested on 5th October	Obtained yield of 19.5 q/ha, net profit of ₹18400/ ha
Kovilpatti							
S. Kumaravel, Malangudi	29-10-2017	Rainfed Chilli	30 mm	Rainfall is expected in the coming days, farmers were advised to thin and fill gaps in dry seeding crops by using rainfall.	10.7 mm	Thinning and gap filling in dry seeding crops was done by using rainfall	Timely gap filling recorded 5 % higher yield.
M. Jayaprakash, Buchampatti	08-01-2018	Okra	0 mm	Dry weather is expected in the coming days, farmers were advised to spray Dimethoate @ 2 ml / litre of water to control the insect vector, whitefly to manage yellow vein mosaic virus.	0 mm	Farmers sprayed chemicals and controlled the pest.	Farmers earned higher net income of ₹1500/ha than the non adopted farmers.
M. Tamilselvi, Malangudi	19-01-2018	Rainfed chilli	0 mm	Prevailing weather condition favourable for Thrips incidence. Spray imidachloprid 17.8 % SL @ 3 ml/ 10 litre of water or Dimethoate 30 % EC @1.0 ml/lit.	0 mm	Thrips were controlled by spraying and farmers done dust mulching	Loss due to pest was avoided

Name of the Farmer	Date of Issue	Crop	Rainfall Forecast	Advisory Given	Observed Rainfall	Action taken by the Farmer	Profit/ Loss
Kanpur							
Shushil Shukla Paras Nath Dinesh Kumar (Baghpur) Chandra Prakash Brijesh Rajaram (Ludhaura)	04-7-2017	Paddy, Maize	Light to moderate rainfall	Stop irrigation, spraying and conserve moisture. Use rotted cow dung in paddy field	37.3 mm rainfall received	Stopped irrigation, thereby saving ₹ 1500/- on account of labour and electricity charges for irrigation in paddy fields. Saving ₹ 1500/- from irrigation at critical stage (ear-head formation) of maize	
Sanjay Singh, Bhagwan, Deen Harish Singh, Ramnaresh, (Baghpur) Shiv Kumar, Lala Ram, Chhotelal, Tej Ram, Devnarayan, Rajesh Tank (Ludhaura)		Paddy, Maize Bajra, Urd & Moong	Moderate to heavy rainfall	Stop irrigation & Stop Sowing of bajra, urd, moong, drain out excess water. Stop harvesting of baby corn Stop irrigation & Stop Sowing of bajra, urd, moong	135.9 mm rainfall received	Saved ₹ 1500 on irrigation of paddy at tillering/booting stage. Saved ₹ 2000 on labour and seed cost of Bajra, Moong & Urd Saved ₹ 1500 on irrigation of paddy at tillering/booting stage & Saved ₹ 2000 on seed cost, labour & bullock charges	
Anand							

Name of the Farmer	Date of Issue	Crop	Rainfall Forecast	Advisory Given	Observed Rainfall	Action taken by the Farmer	Profit/ Loss
60 farmers			continuous cloud cover	farmers were advised to take measures for pod borer in Pigeon pea		Thirty six farmers had followed the AAS. Only one spray in advance saved the crops.	Saved ₹3000/ha of two spraying..
Ludhiana							
60 farmers		vegetable, orchard and wheat	Weather will remain clear	Irrigate the vegetables, orchard and wheat crop to save from frost	Frost occurred	22 farmers followed the advisory	Saved the crop from damage of frost
60 farmers	08-02-2017		Weather will remain cloudy and there is prediction of rainfall	Do not irrigate the crops as rain may occur	40.4 mm rainfall	29 farmers followed the advisory	Saved the cost of labour/diesel for irrigation, and also saved weedicide and labour cost
Kovilpatti: Ramana-thapuram district, Tamil-nadu							
Mr. C. Kumar-avel, S/o. Mr. Chemban	29-10-2017	Chilli (Nursery stage)	Max. T: 32°C, Min. T: 25°C, RH: 90%, Rainfall: 30 mm	Rainfall is forecasted for the coming days. Farmers were advised to drain out excess water in the chilli nursery.	5.9 mm	Farmers made drain-age facility	Additional labour cost of ₹200 was incurred for making drainage facility.
	08-11-2017	Chilli Transplanting	Max. T: 31°C, Min. T: 24°C, RH: 90%, Rainfall: 30 mm	As rainfall was expected in coming days, farmers were advocated to undertake transplanting of chilli	8.3 mm	Transplanting was done	Timely operation ensured good seedling vigour.

Name of the Farmer	Date of Issue	Crop	Rainfall Forecast	Advisory Given	Observed Rainfall	Action taken by the Farmer	Profit/ Loss
	17-11-2017	Chilli Vegetative stage	Max. T: 34°C, Min. T: 24°C, RH: 83%, Rainfall: 0 mm	High humidity with dry weather is expected in the coming days, farmers were advised to apply pendimethalin 1.0 kg a.i./ha or Fluchloralin 1.0 kg a.i./ha as pre-emergence herbicide, after giving irrigation.	0 mm	Pendimethalin was applied	Herbicide controlled weeds effectively. By this labour charge of ₹3000/ha was saved.
	29-11-2017	Chilli Vegetative stage	Max. T: 33°C, Min. T: 25°C, RH: 95%, Rainfall: 35 mm	As rainfall was expected in coming days, farmers were advised to withhold application of irrigation and spraying of pesticide.	9.6 mm	Irrigation and spraying of pesticide was withheld.	Saved ₹1600 on account of pesticide cost and labour charge
	19-01-2018	Chilli (Flower initiation to flowering)	Max. T: 30°C, Min. T: 21°C, RH: 85%, Rainfall: 0 mm	Prevailing weather condition is congenial for incidence of Thrips. Spray Imidachloprid 17.8 % SL @ 3 ml/10 litre of water	0 mm	Pesticide was sprayed	Thrips, aphids and mites were controlled effectively
	23-02-2018	Chilli (Fruiting stage)	Max. T: 33°C, Min. T: 22°C, RH: 75 %, Rainfall: 0 mm WS : 8 kmph	Dry weather was expected, farmers were advised to spray PPFM 1 % or KCl 1% avoid drought. Inter-cultivation operation may be done to conserve soil moisture in cotton.	0 mm	Spraying of PPFM was done.	Yield increase of 50 kg/ha was registered.
	02-03-2018	Chilli (Fruiting stage)	Max. T: 33°C, Min. T: 23°C, RH: 70 %, Rainfall: 0 mm	Prevailing weather condition is favourable for Fruit borer. To control the pest spray Neem oil @ 2 %.	0 mm	Spraying of Neem oil was done.	Yield increase of 100 kg/ha was registered.

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

Kovilpatti

Mr. C. Kumaravel, S/o Mr. Chemban, has 5 acres of land in Malangudi village, Tiruppullani block, Ramanathapuram district. The region is dependent on northeast monsoon rainfall and he had cultivated chilli (cv. Ramnad Mundu) in 3.5 acres during *rabi* 2017-18 (Fig. 11). Protective irrigation was provided during in-season drought using a common well. A series of agromet advisories were issued to him during the cultivation, which was followed as such.

A comparison of benfit:cost ratio of Mr Kumaravel, a farmer who followed micro-level AAS in chilli with another chilli growing farmer, who did not follow AAS was undertaken and the details are presented in Table 7.

Table 7: Comparison of cost of cultivation and benfit:cost ratio of AAS adopted and non-adopted chilli farmers at Ramanathapuram district, Tamilandu

Name of the operation	AAS farmer	Non AAS farmer
Field preparation (₹/ha)	6200	7000
Seed cost (₹/ha)	6500	7200
Fertilizer and manure cost (₹/ha)	7200	8000
Labour cost (irrigation, weeding and fertilizer) (₹/ha)	5200	6500
Plant protection cost (₹/ha)	7000	9500
Harvesting charges (₹/ha)	4500	6250
Total cost of cultivation (₹/ha)	37600	44450
Yield (kg/ha)	1150	1080
Price (₹/kg)	65.00	60.00
Gross income (₹/ha)	74750	64800
Net income (₹/ha)	37150	20350
B:C ratio	**1.99**	**1.46**

The AAS farmer obtained higher B:C ratio (1.99) over non AAS farmer (1.46) due to adoption of agro advisories viz., timely implementation of pest and disease management through herbal insecticide spray and micro nutrient & water soluble fertilizers applications.


Fig. 11 Mr. Kumaravel's chilli field, Ramanathapuram district, Tamilnadu

Kanpur

The centre had issued micro-level AAS to farmers of Baghpur village, Maitha block, Kanpur Dehat district of Uttar Pradesh during *kharif* 2017 and undertook a comparison study of cost of cultivation of rice, pearl millet and maize between farmers who followed and not followed AAS. The cost and benefit of five rice growing farmers who followed (Fig. 12) and not followed was collected and averaged, which is presented in Table 8.


Fig. 12 Rice farmers who adopted micro-level AAS at Baghpur village, Maitha block, Kanpur Dehat district of Uttar Pradesh during kharif 2017

Table 8: Comparison of average cost of cultivation of rice between AAS and non-AAS farmers at Baghpur village, Kanpur Dehat district, Uttar Pradesh during kharif 2017

	AAS-Farmer		Non AAS-Farmer	
Field Preparation				
(i) Ploughing /Harrowing	1 hr @ ₹400/hr	400	1 hr @ ₹ 400/hr	400
(ii) Cultivator with planking	2 hr @ ₹400/hr	800	2 hr @ ₹ 400/hr	800
Compost FYM	10 tonnes /ha@ ₹ 500/tonne	5000	5 tonnes /ha @ ₹ 500/tonne	2500
Fertilizer (150:75:75) NPK				
(i) DAP	165 kg/ha@ ₹ 23.0/kg	3795	165 kg/ha@ ₹ 23.0/kg	3795
(ii) N	265 kg/ha @ ₹ 6.80/kg	1802	264 kg/ha @ ₹ 6.80/kg	1802
(iii) MOP	127 kg/ha @ ₹ 18.0/kg	2286	127 kg/ha @ ₹ 18.0/kg	2286
(iv) Zn	25 kg/ha @ ₹ 50.0/kg	1250		
Seed Rate (Variety)	15 kg/ha @ ₹ 270/kg PHB-71, Pro-agro- 6444 (hybrid)	4050	20 kg/ha @ ₹ 270/kg Pro-agro-6444,PHB-71,	5400
Nursery / Planting/Fertilizer/ weeding(1)	50 Labour/ha @ ₹ 174/ Labour	8700	60 Labour /ha @ ₹ 174/ Labour	10440
Plant Protection				
(i) Weedicide (Butachlor)	3.0 lt./ha @ ₹ 203.5/lt	610	25 kg/ha@ ₹ 8.50/kg	212.5
(ii) Quinalphos 25%EC	500 ml @ ₹ 303.5/lt	152		
(iii) Insecticide (Malathion) 50%	500 ml @ ₹ 229.5/lt	115		
2 Irrigation 10 hr/ha./ irrigation	One Irrigation @ ₹ 150/hr	3000	One Irrigation @ ₹ 150/hr	6000
Harvesting/lifting	20 Labour @ 174/Labour	3480	20 Labour @ ₹ 174/Labour	3480
Threshing/winnowing	15 Labour @ ₹ 174 Labour	2610	15 Labour @ ₹ 174/Labour	2610
Land Rent	₹ 6000/ year/ha	3000	₹ 6000/year/ha	3000
Cost		**41050**		**42725**
Seed yield	43.23q/ha@ 1300/q	56199	38.80 q/ha @ 1300/q	50440
Straw yield	72 q/ha @ 200/q	14400	70 q/ha@ 200/q	14000
Income		**70599**		**64440**
Net Profit (Rs)		**31445**		**23012**

The AAS farmers have obtained higher cost: benefit ratio (1:1.72) as compared to Non-AAS farmers (1:1.51) by conserving moisture in upper layer of the soil; savings made in cost of seed, labour charges, irrigation and insecticide / pesticides.

Pearl millet

The cost and benefit of five pearl millet farmers (each) who followed and not followed AAS was collected and averaged, which is presented in Table 9.

Fig. 13 Pearl millet farmers who adopted micro-level AAS at Baghpur village, Maitha block, Kanpur Dehat district of Uttar Pradesh during kharif 2017

The higher profit obtained by AAS farmers can be attributed to reduction in input costs towards labour, irrigation, fertilizer and plant protection chemicals.

Bangalore

Benefit: Cost Ratio of AAS and non-AAS farmers

The Agromet Advisory Services were disseminated once in five days and alerts were given to the farmers under the situation of sudden changes in weather and extreme weather. The crops were being monitored on day to day basis and crop related problems expressed by farmers were resolved with suitable technical advices.

Table 9: Comparison of average cost (Rs) of cultivation of pearl millet between AAS and non-AAS farmers at Baghpur village, Kanpur Dehat district, Uttar Pradesh during *kharif* 2017

Particulars	AAS-Farmer		Non AAS-Farmer	
Field Preparation				
Ploughing /Harrowing	1 hr @ ₹ 400/hr	₹ 400	1 hr @ ₹ 400/hr	₹ 400
Cultivator with planking	2 hr @ ₹ 400/hr	₹ 800	3 hr @ ₹ 400/hr	₹ 1200
Compost FYM	8 tonnes /ha @ ₹ 500/ tonne	₹ 4000	5 tonnes /ha @ ₹ 500/tonne	₹ 2500
Fertilizer (100:40:40) NPK				
DAP	88 kg/ha @ ₹ 23.0/kg	₹ 2024	55 kg/ha @ ₹ 23.0/kg	₹ 1265
N	185 kg/ha @ ₹ 6.80/kg	₹ 1258	88 kg/ha @ ₹ 6.80/kg	₹ 600
MOP	68 kg/ha @ ₹ 18.0/kg	₹ 1224	42 kg/ha @ ₹ 18.0/kg	₹ 765
Seed Rate(Variety)	5 kg/ha@ 80/kg (Hybrid)	₹ 400	5 kg/ha @ 55/kg (desi)	₹ 275
Sowing/Fertilizer/weeding/ Thinning /irrigation	15 lb/ha@174/lb	₹ 2610	20 lb/ha@174/lb	₹ 3480
Plant Protection Traichodarma virdy (Wp)	5.0 kg/ha @ ₹ 65.50/ kg	₹ 327	5.0 kg/ha @ ₹ 65.50/ kg	₹ 327
Pendimethilin 30% Ec	3.0 lt/ha @ ₹ 365/lt	₹ 1095	3.0 lt/ha @ ₹ 365/lt	₹ 1095
Carbofuran 3 g Insecticide	20 kg/ha. @ ₹ 37.50/ kg	₹ 750	20 kg/ha. @ ₹ 37.50/ kg	₹ 750
1 Irrigation 8 hr/ha / irrigation	Irrigation @ ₹ 150/hr	₹ 1200	Irrigation @ ₹ 150/hr	₹ 3600
Harvesting/lifting	10 Lb @ 174/Lb	₹ 1740	10 Lb @174/Lb	₹ 1740
Threshing / warning	8 Lb @ 174/Lb	₹ 1392	5 Lb @174/Lb	₹ 870
Land Rent	₹ 6000/ year/ha.	₹ 3000	₹ 6000/ year/ha.	₹ 3000
Cost		**₹ 22221**		**₹ 21867**
Seed yield	20.68 q/ha @ 950/q	₹ 19646	18.57 q/ha @ 950/q	₹ 17641
Straw yield	75 q/ha @ 100/q	₹ 7500	70 q/ha @ 100/q	₹ 7000
Income		**₹ 27146**		**₹ 24641**
Net Profit		**₹ 4924**		**₹ 2774**

Lb = Labour

Comparison of B: C ratio between AAS farmers and Non-AAS farmers showed that, farmers who have followed Agromet Advisories (AAS) had obtained

considerable gain in production and income when compared to those who have not followed. Among the different crops of NICRA adapted villages, fruit crops recorded higher gain in terms of B: C ratio (2.57) followed by vegetable crops (1.92), flower crops (1.86) and field crops (1.75) against Non-AAS farmers (fruit crops: 1.75, flower crops: 1.64, vegetable crops :1.57, and field crops:1.45).

Case study-1: Millet based farming: Coping with weather extremes in 2017

Weather based contingent crop plan was suggested for early season drought. Medium duration finger millet variety GPU-28 (110 days) was suggested for sowing in August 1st week. Our timely advice of short duration variety in NICRA villages could reduce climate change vulnerability besides addressing the problems of malnutrition in the villages. In Kuthanagere, nearly 30 farmers adopted double cropping/intercropping systems with finger millet as base crop and followed timely advice of sowing short duration variety besides soil conservation measures and rain water harvesting, which brought extra income (₹ 15000 to 30000/ha).

Case Study-2: Tamarind- A resistant crop to hail storm

An economic analysis of five farmers having mango and tamarind orchard at Durgada nagenahalli village, Koratgere taluk of Tumkur district was made. On an average, mango farmers got ₹ 52,500 per ha per annum as compared to ₹ 65,250 per ha per annum in tamarind. As tamarind is less susceptible to hail storm and relatively more suitable to the locality based on soil site parameters, farmers prefer tamarind than any other dry land orchard crops. Therefore, the crop is recommended under NICRA project due to its sustainable yield and income under rainfall abnormalities associated with hail storm. A summary of comparison on benefit: cost ratio of 30 farmers who followed and not followed micro-level AAS is presented in Fig. 14.

Akola

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 during kharif 2017. During the crop growing period, a

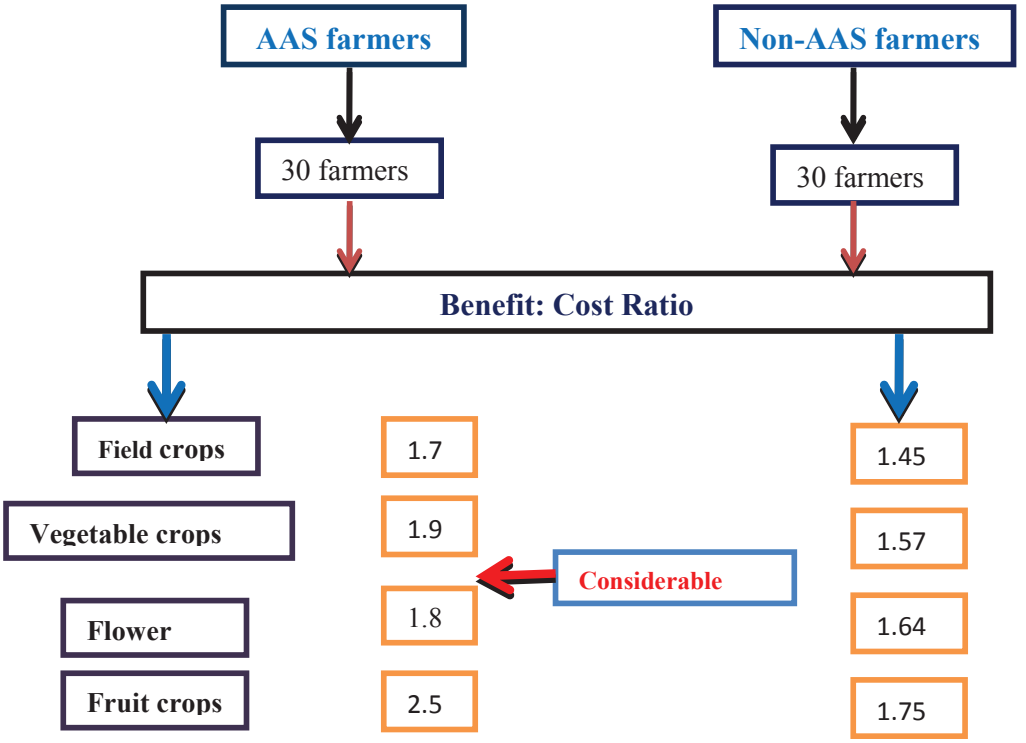

Fig. 14 Economic Impact of Agromet Advisory Services in terms of Benefit: Cost ratio of 30 farmers at AICRPAM-NICRA adopted villages

series of AAS bulletins/real time advisories were issued which was followed as such by the farmer.

Table 10 describes B:C ratio obtained in case of the soybean farmer Shri. Dinesh Bahakar, in response to the AAS issued and accordingly timely action taken by the farmer. The expenditure on different operations and returns received on sale of produce and other details were collected from farmer's feedback. It also includes the B:C ratio obtained in case other four AAS farmers also who have followed more or less similar agromet advisories as aforementioned. Table 11 contains the cost of cultivation and benefit: cost ratio of AAS non-adopted farmers.

Table 10: Analysis of B:C ratio of soybean farmers (AAS adopters) in Kanshivani NICRA village

Input Details	Ramhari Kale	Sharad Waghamare	Sanjay Metkar	Dinesh Bahakar	Bhashkar Sable
Land preparation (₹ ha^{-1})	2650	2950	2650	2150	2150
Fertilizer cost (₹ ha^{-1})	4550	4550	4420	4700	4160
Seed cost (₹ ha^{-1})	5220	4920	5040	5220	4920
Planting cost (₹ ha^{-1})	3020	3020	2800	2800	2580
Weeding (₹ ha^{-1})	1800	1600	1800	2000	1600
Hoeing (₹ ha^{-1})	800	800	800	800	800
Plant protection(Rs ha^{-1})	2300	2500	2500	2800	2300
Irrigation (₹ ha^{-1})	800	1000	1000	900	800
Foliar spray of 2% urea	450	450	450	450	450
Miscellaneous (₹ ha^{-1})	1600	1800	1500	1600	1500
Harvesting cost (₹ ha^{-1})	5000	5000	5000	5000	5000
Threshing cost (₹ ha^{-1})	3560	3900	3600	3900	3400
Cost of cultivation (₹ ha^{-1})	31750	32490	31560	32320	29660
Seed yield (q ha^{-1})	17.8	19.5	18.0	19.5	17.0
Priceofsoybean (₹ q^{-1})	48060	52650	48600	52650	45900
Net Profit(₹ ha^{-1})	16310	20160	17040	20330	16240
Benefit cost ratio	**1.51**	**1.62**	**1.54**	**1.63**	**1.55**

Higher profit obtained by Sh. Dinesh Bahakar is mainly due to

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

30 farmers

Table 11: Analysis of BC ratio of soybean farmers (Non-AAS adopters) in Kanshivani NICRA village

InputDetails	Kailash Dhore	Gajanan Ganeshpure	Dyaneshwar Kale	Punjaji Waghmare	Raju Waghmare
Land preparation (₹ ha^{-1})	2400	3300	3000	3400	2800
Fertilizer cost (₹ ha^{-1})	5200	5600	5200	5400	4900
Seed cost (₹ ha^{-1})	5100	5400	5100	5400	5280
Planting cost (₹ ha^{-1})	3020	2800	2800	2800	3020
Weeding (₹ ha^{-1})	1800	1800	2200	2000	1800
Hoeing (₹ ha^{-1})	0	800	0	800	800
Plant protection (₹ ha^{-1})	2500	4600	2800	2600	2600
Irrigation (₹ ha^{-1})	800	1000	2000	2000	1000
Foliar spray of 2% urea	0	0	0	0	0
Miscellaneous (₹ ha^{-1})	1400	1600	1500	1700	1600
Harvesting cost (₹ ha^{-1})	4500	4500	4500	4500	4500
Threshing cost (₹ ha^{-1})	2520	3060	2970	3168	2880
Cost of cultivation (₹ ha^{-1})	29240	34460	32070	33768	31180
Seed yield (₹ ha^{-1})	14.0	17.0	16.5	17.6	16.0
Price of soybean (₹ q^{-1})	37800	45900	44550	47520	43200
Net Profit (₹ ha^{-1})	4300	10050	8400	11766	7730
Benefit cost ratio	**1.29**	**1.33**	**1.39**	**1.41**	**1.39**

Hisar

The economic impact of micro level agromet advisories issued to the farmers' was undertaken at AICRPAM-NICRA domain village Farwain Kalan (Sirsa) during *kharif* 2017. Mr. Sandeep Godara, a farmer from the domain village has 2 hectare of irrigated land under cotton cultivation during *kharif* 2017. During the crop growing period, a series of weather based agromet advisories in the form of AAS bulletins were issued, which were followed as such by the farmer. A comparison was made between AAS and Non-AAS farmers and Benefit:Cost (B:C) ratio was calculated (Table 12) and it was found that the B:C ratio was higher (1.71) in case of AAS farmers than non-AAS farmer (1.33). The total expenditure of AAS farmers is ₹ 58570 ha^{-1}, which is ₹ 4480 lower than the Non-AAS farmers. The net profit of AAS farmers is ₹ 41350 ha^{-1}, which is ₹ 20283 more than the Non-AAS farmers, who have not utilized the weather based management practices.

- The AAS farmers followed agromet advisories and carried out all farm operations in time as suggested in AAS bulletins and through SMS.
- They maintained proper drainage of water in the fields as per AAS bulletins whereas non-AAS farmer failed to do so some times.
- The non-AAS farmers faced losses due to occurrence of 22, 35 and 28 mm rainfall on 7, 8 and 27th June during vegetative phase of cotton, which was better managed by AAS farmers.

Table 12: Economic impact assessment of AAS for cotton during *kharif* 2017 at Farwain Kalan, Sirsa district, Haryana

Sr. No.	Input details (per hectare)	Farmers Adopting AAS	Farmers not Adopting AAS
1.	Land preparation (₹ ha^{-1})	2005	2755
2.	Fertilizer cost (₹ ha^{-1})	4945	4945
3.	Sowing (₹ ha^{-1})	1035	1035
4.	Seed cost (₹ ha^{-1})	4300	4300
5.	Seed treatment (₹ ha^{-1})	1100	0
6.	Hoeing/ weeding (₹ ha^{-1})	5550	7050
7.	Plant protection (₹ ha^{-1})	4560	5420
8.	Irrigation (₹ ha^{-1})	3945	4675
9.	Picking (3-4) (₹ ha^{-1})	1250	1500
10.	Miscellaneous (₹ ha^{-1})	90	150
11.	Harvesting cost (₹ ha^{-1})	4790	6220
12.	Rental velue of Land	25000	25000
13.	**Total Expenditure**	**58570**	**63050**
14.	Seed yield (q ha^{-1})	19.6	16.5
15.	Cotton Price (₹ ha^{-1})	99921	84117
16.	**Net profit (₹ ha^{-1})**	**41350**	**21067**
17	**Benefit cost ratio (B:C)**	**1.71**	**1.33**

Total saving of adopted farmers is ₹ *20283 ha^{-1}.*

7. Farmers' Awareness Programs on Climate Change

The details of awareness program on climate change conducted to farmers of different states under the project are presented in Table 13.

Center	Name of Village/Location	Date on which	Total No. of farmers	Men	Women
Akola	Dr. PDKV, Akola	29-Mar-18	65	59	6
Anand	Amalpur, Manjrol village	29-Jan-18	107	55	52
Anantapur	ARS, Ananthapuramu	31-Mar-18	100	92	8
Bengaluru	Belavatta, Adalagere and Ammanaghatta villages, Gubbi taluk, Tumkur district	29-Aug-17	45	30	15
	Somapura, Chinnahalli and Kodigehalli village, Koratagere taluk, Tumkur	31-Aug-17	42	28	14
	Chowdanakuppe, Kunigal taluk, Tumkur	05-Sep-17	45	30	15
	Kempasagara and Ammanaghatta, Magadi taluk, Ramanagara	05-Sep-17	40	30	10
	Durgada nagenahalli , Tumkur district	15-Feb-18	42	28	14
Chatha	SKUAST-J, Chatha	06-Oct-17	54	50	4
	Sherpur	21-Mar-18	183	175	8
Hisar	KVK, Sirsa	08-Feb-18	55	40	50
	Balawas, Hisar	09-Feb-18	59	45	14
Jabalpur	Katra Khamriya (Gosalpur)	30-Sep-17	100	97	03
	Dongaria (Panagar)	08-Nov-17	62	61	01
	Kisrod (Shahpura)	17-Nov-17	64	55	09
	Kudhamaily (Mandla)	10-Nov-17	67	48	19
Jorhat	Thengalgaon, Golaghat	12-Jan-18	100	78	22

Center	Name of Village/Location	Date on which	Total No. of farmers	Men	Women
Kovilpatti	Malangudi village, Tiruppullani block, Ramnad district.	22-Mar-18	120	48	72
	Allikundam village, Usilampatti block, Madurai district	26-Mar-18	112	51	61
	Buchampatti village, Chellampatti block, Madurai district	26-Mar-18	104	31	73
	Agricultural Research Station, Kovilpatti block, Tuticorin district.	27-Mar-18	72	29	43
Mohanpur	Alaipur, and	24-Mar-18	34	34	0
	Kulberia	25-Mar-18	57	44	13
	Chandamari	26-Mar-18	55	55	0
Parbhani	Ujalamba, Parbhani	30-Mar-17	150	121	29
Raipur	Kapsi, Sureli (Kanker)	05-Mar-18	52	42	1
	Jhalkhamaria(Mahasamund)	24-Mar-18	46	32	14
	Lafinkhurd (Mahasamund)	14-Mar-18	56	44	12
	Baikunthpur (Koriya)	20-Mar-18	51	40	11
Ranchi	Belagarha (Gumla)	21-Dec-17	54	38	16
	Rajderwa (Palamu)	24-Jan-18	48	40	8
	Jorkat (Palamu)	15-Mar-18	63	10	53
Ranichauri	Hitanu, Dunda blocvk	02-Feb-18	43	08	35
Samastipur	KVK, Birauli	21-Mar-18	125	101	24
Solapur	Mulegaon Farm, ZARS, Solapur in collaboration with Lokmangal Agril. College, Wadala	05-Aug-17	78	56	22
	At Ghanegaon, Tal- Barshi, Dist- Solapur in collaboration with KVK, Solapur	28-Sep-17	214	175	39
Thrissur	Niramaruthur (Malappuram district)	07-Mar-18	60	32	28
	Valavannur	13-Mar-18	80	38	42
Udaipur	Bamanheda (Rajsamand)	27-Jan-18	113	82	31
	Vagatpura (Rajsamand)	11-Jan-18	65	31	34
Vijayapura	Hegadihal, Vijayapura	23-Mar-18	130	105	25

Jorhat

Farmers' Awareness Programme was organized at Thengaon on 12 January, 2018**.** Director of Research, AAU Jorhat, Dr. G.N. Hazarika; village man of Thengalgaon Mr. Mahendra Bora, Village man of Soukonagaon, Mr. Sikon Thengal, Chairman of Thengal Kachari Autonomous Council, Mr. Bipin Bora, Retired Air Force official, Mr. Jiten Bora addressed the villagers and shared their precious views on various aspects. Director of Research, AAU Jorhat, Dr. G.N Hazarika also gave an elaborate description of different technologies and assured the farmers for providing help from AAU. Around 100 farmers participated in the programme (Fig. 15).

Fig. 15 Farmers Awareness Program on climate change at Thengalgaon village, Assam

Bijapur

Farmers' Awareness Programme was conducted at Hegadihal village of Vijayapur Taluka in association with AICRP on Dryland Agriculture by celebrating the "World Meteorological Day" on 23rd March 2018. Dr. H.Venkatesh, Agrometeorologist of AICRPAM, Dr. M.S. Shirahatti, Chief Scientist, AICRPDA, Dr. V.S. Surakod and Dr. (Mrs) Khyadagi made presentations during the programme. Dr. H. Venkatesh, in his address opined that farmers created awareness about the change in climate, explained about the importance of weather in agriculture and also use of weather forecast in increasing the agriculture production or reducing the losses caused by sudden variations in weather. He also gave informa-

tion about the services provided to farmers like Mobile SMSs, direct contact over telephone, Whatsapp group, Mobile App "Havaamaana Krishi" etc by the Unit. regarding weather forecast and weather based Agromet Advisories.About 130 farmers and farm women participated in this programme (Fig. 16).

Fig. 16 Farmers awareness program on climate change conducted at Hegadihal village of Vijayapur Taluka, Karnataka

Jammu

A one day farmers' awareness programme on the "Management of Scary Effect of Dry Spell" was organized at village Sherpur, Hiranagar of district Kathua under NICRA-AICRPAM project by Agrometeorology Section, SKUAST-Jammu on 21 March, 2018. More than 180 farmers participated in the awareness programme (Fig. 17). The awareness programme was inaugurated by Dr. J. P. Sharma, Director Research, SKUAST-J, Chatha, Jammu. The main objective of the programme was to make the farmers aware about the importance of agromet advisory services and mechanized/customized farming systems, etc. to manage dry spell during *kharif & rabi* seasons.


Fig. 17 Farmers awareness program on climate change conducted at Sherpur village, Kathua district, Jammu & Kashmir

Agrometeorology Section organized field day programme on "Weather Management in Farm Operations" under the project on NICRA-AICRPAM on 6 Oct. 2017. About 54 farmers from NICRA adopted Villages viz., Sherpur and Chappaki participated in this program. Dr. Mahender Singh, Principal investigator of the project briefed about the importance of the field day and weather observations and forecasting in relation to various farm operations during the visit to



Fig. 18 Glimpses of Field day at SKUAST-J on 6th of Oct., 2017

agrometeorology observatory. There was a sensitization discussion with farmers about the variable weather in the area and the changing rainfall pattern during the current season and their effect on the crop production. The farmers narrated about the weather related field problems and need based advices were given to the queries of the farmers. During Field day programme, farmers also visited Integrated Farming System Model, Mushroom Centre, Mega Seed Processing Plant and Technology Park of SKUAST-J (Fig. 18).

Fig. 19: Farmers awareness program on climate change conducted at different talukas of Tumkur district, Karntaka

Bangalore

Farmers' awareness programmes were conducted at Belavatta, Adalagere and Ammanaghatta villages of Gubbi taluk; Somapura, Chinnahalli and Kodigehalli villages of Koratagere taluk; Chowdanakuppe village of Kunigal taluk of Tumkur district. It was also conducted at Kempasagara and Ammanaghatta villages of Magadi, Ramanagara district on 29.08.2017, 31.08.2017, 05.09.2017 and 15.2.2018 respectively (Fig. 19).

Samastipur

A Farmers's Awareness Programme on Climate Change under NICRA project was conducted at KVK, Birauli on 21 March, 2018. A total of 125 farmers participated in the day long training programme (Fig. 20). The programme was inaugurated by Associate Director Research of Dr. Rajendra Prasad Central Agricultural University, Pusa, Bihar. Seven lectures were delivered on different aspects of agriculture and animal husbandry in light of climate change. All farmers were given *Kisan Diary* published by the university consisting of capsulated information related to package and practices of cultivation and varieties of all crops. It also contains detailed information on animal husbandry and fisheries.

Fig. 20 Famers' awareness programme on climate change held at KVK, Birauli on 21 March, 2018

Kovilpatti

Awareness programme on climate change was organized at Malangudi village of Tiruppullani (Block), Ramanathapuram (Dt) for farmers by the All India Coordinated Research Project on Agrometeorology unit, ARS, Kovilpatti on 22.3.2018 (Fig. 21). Dr. G. Sudhakar, Assistant Professor (Agronomy) explained the farmers and farm women about impact of climate change on agriculture. An exhibition was also arranged in regional language depicting various aspects of climate change and its impact on agriculture and allied enterprises. Dr. S. Subbulakshmi, Assistant Professor (Agronomy) explained elaborately about the preparation of agromet advisory services based on weather forecasting to the participants. A questionnaire comprising of 17 questions were distributed to the farmers to get their feedback on climate change, importance of weather parameters in agriculture.

Fig. 21 Farmers' awareness program on climate change conducted by Kovilpatti centre at Ramanathapuram district, Tamilnadu

Anand

Climate change awareness program for farmers were organized on 29th January 2018 at Manjrol (of Chhota Udepur district) in collaboration with KVK Mangalbharati.Total of 107 farmers attended and participated in the program (55 male and 52 female farmers) (Fig. 22). During the program, lectures and discussion were held about climate change, role of agriculture in changing scenario and importance of NICRA services for them.

Fig. 22 Farmers' awareness program on climate change conducted at Manjrol, Chhota Udepur district, Gujarat.

Ranichauri

An awareness program on impact of climate change on agriculture was conducted by the centre at Hitanu village, Dunda block, Uttarkashi district, Uttarakhand on 2nd Feb 2018. The program was attended by 8 male and 35 female farmers (Fig.23).

Fig. 23 Farmers' awareness program on climate change conducted at Hitanu village, Dunda block, Uttarkashi district, Uttarakhand

Hisar

The AICRP on Agrometeorology unit of the Dept. of Agricultural Meteorology, CCS Haryana Agricultural University, Hisar organized two "Farmers' Awareness Programs (FAP) on Climate Change" under the National Innovations in Climate Resilient Agriculture (NICRA) project funded by ICAR. The FAP were organized at KVK, Sirsa on 8th Feb 2018 and at village Balawas, Hisar on 9th Feb

2018. A total number of 55 farmers participated in the program and majority of the farmers were from AICRPAM-NICRA adopted village Farwain Kalan (Fig. 24). A documentary on climate change issue "The Inconvinient Truth" was also showed to the farmers. Books on package and practices of *kharif* and *rabi* crops prepared by CCS HAU, Hisar, were also distributed among the farmers to promote adoption of new agro-technologies that were developed by university.

Another FAP was organized on 9th Feb 2018 at village Balawas, Hisar in association with AICRP on Dryland (NICRA-Dryland). The books on package and practices of *kharif* and *rabi* crops given by CCS HAU, Hisar, were also distributed among the farmers to adopt the new agro-technologies of the University. A total 59 farmers participated in the program and majority of them were from AICRP on Dryland (NICRA-Dryland) adopted village Balawas, Hisar (Fig. 25).

The CCSHAU, Hisar organized Kisan Melas for *kharif* and *rabi* seasons and AICRPAM-NICRA unit actively participated in the programs and made farmers aware about the climate change and educated them to cope up with these situations. The farmers' are informed about various technologies and Agrometeorological services rendered.

Fig. 24 Farmers awareness program conducted at KVK, Sirsa on 8 Feb 2018


Fig. 25 Farmers awareness program conducted at village Balawas, Hisar on 9 Feb 2018

Raipur

A farmers' awareness programme was conducted on 5 March, 2018 in village Kapsi of District Kanker (Fig. 26). Cluster demonstration of chickpea was held in the *rabi* season of 2017-18 in this village and seed certification process is also going on. This is an important village, where second cropping of chickpea, vegetables and wheat is practiced.

Fig. 26 Farmers awareness program on climate change conducted at Kapsi village, Kanker district of Chattisgarh

Annexure-I

Location of NICRA adopted villages

AICRPAM Center	Name of NICRA - KVK	District	Block/ Thasil/ Mandal	Name of NICRA Village(s)
Akola	AICRPAM village Akola	Akola	Akola	Kanshivani)
	AICRPDA village Akola	Akola	Akola	Warkhe
	KVK, (Dr. PDKV), Buldhana	Buldhana	Buldhana	Choutha (Except survey, other activity at Choutha not initiated due to delayed implementation)
Anand	KVK, Mangalbharti	Chhota Udepur	Sankheda	Manjrol
Anantapur	KVK, Yagantipalle	Kurnool	Banaganapalle	Yagantipalle
	KVK, Reddipalli	Ananthapuramu	Singanamala	Peravali
	AICRPDA NICRA	Ananthapuramu	Gooty	Vannedoddi
Bengaluru	KVK, Chintamani KVK, Magadi KVK, Herehalli	Chikkaballapur Ramanagara Tumkur	Chikkaballapur Magadi Koratagere	Nayanahalli Kuthanagere Durgada nagenahalli
Bhubaneswar	Ganjam	Ganjam	Ganjam	Ekalpur Padampur
	Kandhamal	Kandhamal	Kandhamal	Budhadani, Phulbani
	Kendrapada	Kendrapada	Kendrapada	Krushnadaspur
Chatha	KVK, Kathua	Kathua	Kathua	Chhapaki Khurd Sherpur Bala Dhalli
Dapoli	Dept. of Agronomy, College of Agriculture, Dapoli	Ratnagiri	Dapoli Khed	Bandhtivare Natunagar
Faizabad	KVK, Bahraich TDC - Nicra,KVK Gonda	Bahraich Gonda	Huzurpur, Kaiserganj Paraspur, Colonelganj	Banpurwa Bambampurwa

AICRPAM Center	Name of NICRA - KVK	District	Block/ Thasil/ Mandal	Name of NICRA Village(s)
Hisar	KVK, Sirsa	Sirsa	Sirsa	Farwain Khurd
			Rania	Kharian Pani-hari
			Nathusari Chopta	Rupana Khurd
	AICRPDA, Hisar	Hisar	Hisar	Balawas
Jabalpur	KVK, Rewa	Rewa	Raipur Karchuliyan	Raura Patauna
Jorhat	KVK, Khumtai	Golaghat	Kothalguri block	Thengal Gaon (AI-CRPAM-NICRA village) Kachupathar (AI-CRPAM-NICRA village)
	KVK, Sonitpur	Sonitpur	Balipara block	Nagharia (TDC)
Kanpur	KVK, Dalleepnagar	Kanpur Dehat	Maitha	Bagpur Ludhaura
Kovilpatti	KVK, Madurai	Madurai	Usilampatti Chellampatti	Allikundam Buchampatti
	KVK, Ramanthapuram	Ramanathapu-ram	Tirupullani	Malangudi
Ludhiana	KVK, Fatehgarh Sahib	Fatehgarh Sahib	Fatehgarh Sahib	Badhoshe Kalan Bauranga Zer
Mohanpur	KVK, Ram Krishna Ashram	South 24 Paraganas	Kultoli	Bongheri Gopalganj Kulberia
Palampur	KVK, Bara	Hamirpur	Sujanpur	Bageda Palahi Karot
			Bhoranj	Dhamrol

AICRPAM Center	Name of NICRA - KVK	District	Block/ Thasil/ Mandal	Name of NICRA Village(s)
Parbhani	VNMKV, Parbhani	Parbhani	Parbhani	Babulgaon Ujalamba Mandakali
Raipur	KVK, Mahasamund KVK, Kanker KVK, Baikunthpur	Mahasamund Kanker Koriya	Mahasamund Kanker Baikunthpur	Jhalkhamaria, Lafinkhurd Kapsi, Sureli Salka
Ranchi	ZRS, Palamu KVK,Bishunpur Gumla	Palamu Palamu Gumla	Daltonganj Satbarwa Ghaghra	Jorkat under Dry land Rajderwa Belagarha under TDC
Ranichauri	KVK, Chinyalisaur	Uttarkashi	Dunda	Badethi Hitanu
Samastipur	KVK, Saraiya	Muzaffarpur	Saraiya	Ballisaraiya Bhagwatpur
Solapur	KVK, Baramati	Pune	Baramati	Jalgaon KP Loni Bhapkar
Thrissur	KVK, Malappuram	Malappuram	Malappuram	Thavanur Valavannur
Udaipur	KVK, Rajsamand	Rajasamand	Rajasamand	Vagatpura Jorawar Singh ji Ka Kheda Kundeli
	KVK, Kota	Kota	Kota	Chomakot
Vijayapura	ICAR- KVK, Hulkoti	Gadag	Gadag	Kurthkoti
	AICRPDA, Vijayapura	Vijayapura	Vijayapura	Kavalagi

Annexure-II

Staff position of NICRA during 2017-18 (up to 31st March 2018)

Centre	Agrometeorologist / Jr. Agronomist	Senior Research Fellow
Akola	Dr. Anil Karunakar	Sh. Vijay M Bodade
Anand	Dr. M. Lunagaria Dr. N. J. Chaudhary	Sh. M. I. Saxena
Anantapur	Dr. S.N. Malleswari / Dr. G.N. Swamy	Sh. B.Swami Chaitanya
Bengaluru	Dr. H.S. Shivaramu	Ms. C. M. Munirathnamma
Bhubaneswar	Dr. Anupama Baliar Singh	Sh. Gourisankar Panigrahi
Chatha	Dr. Mahender Singh	Dr. Charu Sharma
Dapoli	Dr. D.N. Jagtap (7/6/2015-7/2/2018) Dr. V.G.More (08/02/2018 to till date)	Sh. Mayur Manohar Naik
Faizabad	Dr. A. K. Singh	-
Hisar	Dr. Chander Shekhar	Dr. Divesh Chaudhary
Jabalpur	Dr. Manish Bhan	-
Jorhat	Dr. Bondita Goswami	Sh. Sri Pranjal Dutta
Kanpur	Dr. A. P Dubey/Dr. Naushad Khan (Incharge /Co-PI, NICRA)	Sh. Ajay Kumar Mishra
Kovilpatti	Dr. G. Sudhakar Dr. S. Subbulakshmi	Sh. K. Sappanimuthu
Ludhiana	Dr. Prabhjyot K. Sidhu	Sh. Rajanbeer Singh
Mohanpur	Dr. Saon Banerjee	Sh. Mrinal Kanti Das
Palampur	Dr. Rajendra Prasad	Sh. Manoj Kumar Negi,
Parbhani	Dr. K.K. Dakhore	Sh. A. D. Nirwal
Raipur	Dr. J. L. Chaudhary	Ku. Surbhi Jain
Ranchi	Dr. Pragyan Kumari	Dr. Bably
Ranichauri	Dr. R. G. Upadhyay	-
Samastipur	Dr. A. Sattar	-
Solapur	Dr. J. D. Jadhav	Sh. B. T. Jadhav up to 31.03.2018
Thrissur	Dr. B. Ajith Kumar	Ms. Likhitha K. B. (Data Entry Opeartor)
Udaipur	Dr. N.S Solanki	Dr. Santosh Devi Samota,
Vijayapura	Dr. H. Venkatesh	Mr. Jagdeesh R. Hiremath

Annexure-III

Budget allocated for AICRPAM-NICRA

(*in Rupees*)

S.No.	Centre	Revised Estimate 2017-18		
		Contingency	TA	Total
1	Akola	500000	12000	512000
2	Anand	500000	12000	512000
3	Anantapur	550000	12000	562000
4	Bangalore	550000	12000	562000
5	Bhubaneswar	500000	12000	512000
6	Chatha	550000	22000	572000
7	Dapoli	520000	12000	532000
8	Faizabad	390000	12000	402000
9	Hisar	534915	4000	538915
10	Jabalpur	500000	12000	512000
11	Jorhat	650000	15000	665000
12	Kanpur	490000	10000	500000
13	Kovilpatti	400000	10000	410000
14	Ludhiana	490000	10000	500000
15	Mohanpur	500000	12000	512000
16	Palampur	501800	10000	511800
17	Parbhani	450000	12000	462000
18	Raipur	500000	10000	510000
19	Ranchi	550000	21000	571000
20	Ranichauri	480000	10000	490000
21	Samastipur	500000	10000	510000
22	Solapur	510000	12000	522000
23	Thrissur	483285	12000	495285
24	Udaipur	500000	15000	515000
25	Vijayapura	900000	9000	909000
	Total	**13000000**	**300000**	**13300000**

Annexure-IV

Publications

Coordinating unit

Research Papers

Bal, S.K., Minhas, P.S., Singh, Y., Kumar, M., Patel, D.P., Rane, J., Sureshkumar, P., Ratnakumar, P., Choudhary, B.U. and Singh, N.P. 2017. Coping with hailstorm in vulnerable Deccan Plateau region of India: Technological interventions for crop recovery. Current Science 113(10): 2021-2027.

Book chapters

Vijaya Kumar, P., Subba Rao, A.V.M., Sarath Chandran, M.A., Dubey, A.P., Srinivasa Rao, Ch. 2017. Krishi mausam paramars seva se prakshethre udpaadkatha evam labh par mausam vichalan ka prabhav (Hindi). In: (Eds) Srinivasa Rao Ch, Indoria AK, Sharma KL, Yadav SK, Sammi Reddy K, Yadav SR and Prabhakar G. 2017. Varsh aadhaarith Krishi kshethrom ki samasyaayem evam samaadhan. ICAR-CRIDA. p 209-226.

Bal, S.K., Sureshkumar, P., Singh, Y., Nangare, D.D., Fand, B.B., Saha, S. and Minhas, P.S. 2017. Hailstorm occurrence and its management strategies with the changing climate. pp 39-54. In: Climate Change and Sustainable Agriculture (eds. P Sureshkumar, M. Kanwat, P.D. Meena, Vinod Kumar and R.A. Alone). New India Publishing Academy, New Delhi.

Subba Rao, A.V.M. 2018. Agromet Advisories and their Role in the Risk Management. *In:* Strategies for Enhancement of Farmers Income in Dryland Agriculture, Feed The Future prepared under India Triangular Training (FTF-ITT) (eds. Manoranjan Kumar, Rejani, R., Krishna Rao, B., Nagasree, K., Sammi Reddy, K., Usha Rani,V. and Chandra Sekhar P.,) published by ICAR- Central Research Institute for Dryland Agriculture, Hyderabad, India. ISBN no is 978-93-80883-46-5

Annual Report

Vijaya Kumar, P., Sarath Chandran, M. A., Subba Rao, A.V.M. 2017. National Innovations on Climate Resilient Agriculture-AICRPAM component, Annual Report 2016-17. ICAR–Central Research Institute for Dryland Agriculture, Santoshnagar, Hyderabad-500 059, Telangana, India. 59 p.

Cooperating Centres

Bangalore

International Publication

- Arun Kumar, J.S., Shivaramu, H.S. and Anilkumar, S.N. (2017). Impact of watershed development on Soil characteristics in Kuthanagere micro-watershed in Ramanagar district of Karnataka, India, *Int. J. Curr. Microbial App. Sci*., 6(10):pp 2914-2922.

Book

- Shivaramu, H.S., Rajegowda, Padmashri, M.B., Govindaraju, H.S., Soumya, C., Narendra Babu, D.V., Vijayakumar, P. and Singh, K.K. (2017), "Agroclimatic characterization of Southern dry zone of Karnataka (NARP Agroclimatic Zone-VI)", Published by Director of Research, UAS Bengaluru, p.179.

Popular Articles

- "Krithika rajyabharadalli krishi tayari heegarali" was published in *Krishi Kanaja* – special edition of *Prajavani*, on 16.05.2017.
- "Dry patch in bits of monsoon season rises worries" was published in *Indian Express* on 31.07.2017.
- Article on "Mangoes rain on Bengaluru two months earlier, thanks to Vardah" in *Bangalore Mirror* on 24.01.17.
- An article on "Impact of North east monsoon deficiency on Yield" was published in *Krishi Kayaka* issue-1, vol-7 of (2017).

Faizabad

Publications

- Singh, Ashish., Singh, A.K. and Mishra, A.N. (2017). Impact Assessment of climatic change on rice yield using simulation model. *Journal of Pharmacognosy and phytochemistry* 2017;6(3):841-844.
- Singh, A.K. (2017). Livestock production and management in relation to climatic variability in Eastern India. *Progressive Research- An International Journal*. Vol.12 (special-I): pp. 1256-1259.

Hisar

Publications

Peer Reviewed Research papers

- Anurag, Kumar, A., Singh, R., Singh, D. and Kumar, M. (2017). Long term trends in weather parameters at Hisar (Haryana): A location in semi arid region of North West India. *Inter. J. Rec. Sci. Res.,* 8(7): 16876-16881.
- Anurag, Kumar, A., Singh, D., Singh, R., Singh, S. and Shekhar, C. (2017). Evaluating rainfall trends at Hisar (Haryana) in the semi arid zone of North India. *Ann. Arid Zone,* 56(3&4): 83-87
- Praveen, Anurag, Singh, R., Niwas, R. Kumar, A., Khichar, M. L. and Kumar, M. (2017). Climatic suitability of the distribution of the rice cultivation zone in Haryana (India). *Envi. & Eco.*, 35(3D): 3040-3045.
- Singh, R., Singh, R., Karwasra, S.S., Kumar A. and Choudhary, D. (2018). Climate suitability for karnal bunt (Tilletia indica) disease of wheat crop in Haryana. *J. Agrometeorol*. 20 (Spacial Issue I): 184-187.

Popular article

- Nayak, M.K., Kumar, A. and Singh, M. (2017). Contingency Crop Planning Under Aberrant Weather Conditions. AGROBIOS News letter, Vol. XVI (03): 27-28.

- Nayak, M.K., Kumar, A. and Singh, M. (2017). Agricultural Drought and its Management. AGROBIOS News letter, Vol. XVI (03):29-30.

Kovilpatti

Publications

- Booklet on "Impact on Climate Change on Crop Production" (in Tamil) was prepared and distributed to the farmers of NICRA Villages.

Ludhiana

Publications

- Sandhu S S, Prabhjyot-Kaur and K K Gill (2017) Impact of climate change on the wheat duration in Central Punjab of India. *J Agromet.19 (Special Issue - AGMET 2016): 226-230 (October 2017).*
- Kaur R, Simerjeet Kaur and Sandeep Singh Sandhu (2017) Effect of terminal heat stress in wheat and its management with chemicals in north-west India. *Agric. Res. J.* 54 (1): 114-116.
- Harleen Kaur and Prabhjyot Kaur. 2017. Decadal shifts of the frequency of extreme temperature events in Punjab. *Agric. Res. J.* 54 (2) : 267-69.
- Harpreet Singh and Prabhjyot-Kaur. 2017. Adaptive strategies to reduce the impact of terminal heat stress in wheat (*Triticum aestivum*) crop. In National Seminar AGMET-2017 on "Agrometeorology for Sustainable Development with special emphasis on Agrometeorological Practices for Climate Resilient Farming and Food Security" held at CCS HAU, Hisar during 12-14 October, 2017.

Raipur

Publications

- Gandhi, Gurupreet Singh, Chaudhary, J.L., Puranik, H.V., Das, G.K. and Chandrakar, M.R. (2017). Adoption of Agromet-advisory services (AAS)

under AICRPAM-NICRA at Mahasdamund of Chhattisgarh for improving livelihood of rural farmers. Presented at First Asian Conference on Water and Land Management for Food and Livelihood security (WLMFLS-2017), IGKV Raipur 20-22 January, 2017.

- Chaudhary J.L., Das G.K., Rajesh Khavse and Deepika Unjan, (2017). Economic Impact of NICRA-AICRPAM project through Micro-level agroadvisories services in Mahasamund district of Chhattisgarh state-a case study. Presented at International Seminar on Global climate change: Implications for agriculture and water sectors). CCAW 2017 held at WALMI, Aurangabad in joint co-ordination of VNM Krishi Vidyapeeth, Parbhani, MPKV, Rahuri, PDKV, Akola, Dr. BSS KKV, Dapoli, WALMI, Aurngabad and JART, Pune.

- Chaudhary J.L., Rajesh Khavse, Deepika Unjan, Das G.K., Subba Rao A.V.M., Pramod V.P. and Vijaya Kumar P. 2017. Block-level agro-climatic characterization of Mahasamund district in Chhattisgarh state. Technical Bulletin No. DeAM/NICRA-AICRPAM/2017-18/01 released in WGM meeting of AICRPAM on 27 Nov., 2017 at SKUAST, Jammu.

Recognitions

- Mr. Ningappa Basappa Singoti from Dharward district of Karnataka secured 'Best Farmer Award' on the occasion of ICAR-CRIDA foundation day on 12.04.2017 for adopting micro-level agromet advisories issued by AICRPAM Vijayapura centre for crop production, which fetched him high crop yield.

AICRPAM-NICRA Annual Review Meeting

22-23 May 2017 at Dr. BSKKV, Dapoli, Maharashtra