National Initiative on Climate Resilient Agriculture
AICRPAM Component

Annual Report 2013-14

AICRPAM - NICRA

Central Research Institute for Dryland Agriculture

Santoshnagar, Hyderabad - 500 059


University of Agricultural Sciences, Dharwad
Annual Review Meet: 2012-13


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1.0 NICRA - Background information

India is becoming more vulnerable to climate change as major proportion of population depends on agriculture and allied sectors. Depending on the magnitude and distribution of warming, climate change projections for the mid-term (2012-2039) period for India indicated a 4.5 to 9% yield reductions which may roughly amounts to 1.5% of GDP per year. Realizing the impact of climate change, the Government of India has prioritized the climate change research and a major project "National Initiative on Climate Resilient Agriculture (NICRA)" has been initiated in 2010-2011 with the following objectives:

- To enhance the resilience of Indian agriculture covering 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 on 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.

- 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

In evolving strategic research in climate change, the foremost task would be identification of climatic risk prone areas. This in turn has to be followed by determination of location specific climatic risks and then strategies to overcome them. Also, utility of agromet advisories to minimize the losses due to aberrant weather on short-term and climate change on long-term basis has to be assessed. In this backdrop, AICRPAM-NICRA project has been initiated with the following objectives:

- Carry out benchmark survey of adopted villages
- Conducting climate change awareness programmes and to know the perception of farmers about climate change

- Strengthen the micro level agromet advisories and assess economic impact of agromet advisories issued
- Installation of 100 AWS
- Monitoring of crop and weather conditions on real time basis at micro level in the nearby KVK district of each of the 25 centres of AICRPAM for developing operational weather-based AAS
- Development of methodologies for dissemination of agromet advisories to individual farmers using ICT tools / SIM technologies / FM radio services / local TV network
- Improvement in the technical and scientific skills of personnel / Institutes involved in preparation of AAS
- Development of ways and methods to expand AAS system to block / village level

2.0 Weather data acquisition and value addition

2.1 Determination of accuracy of AWS data

The accuracy in data recorded by AWS at different locations was determined by comparing the AWS data against the data recorded in the manual meteorological observatories. A close agreement between AWS recorded temperature and rainfall was noticed at all the stations evaluated. The coefficient of determination (R^2) values ranged from 0.90 to 0.99 across locations (Fig.1 & Fig . 2).

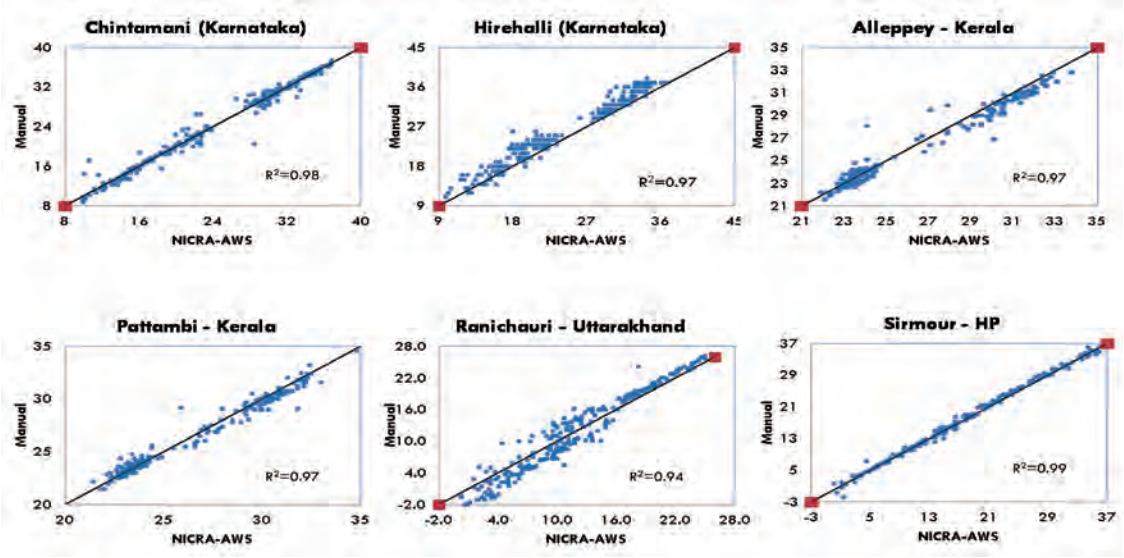

Fig. 1: A comparison of temperature data recorded from AWS and manual observatory

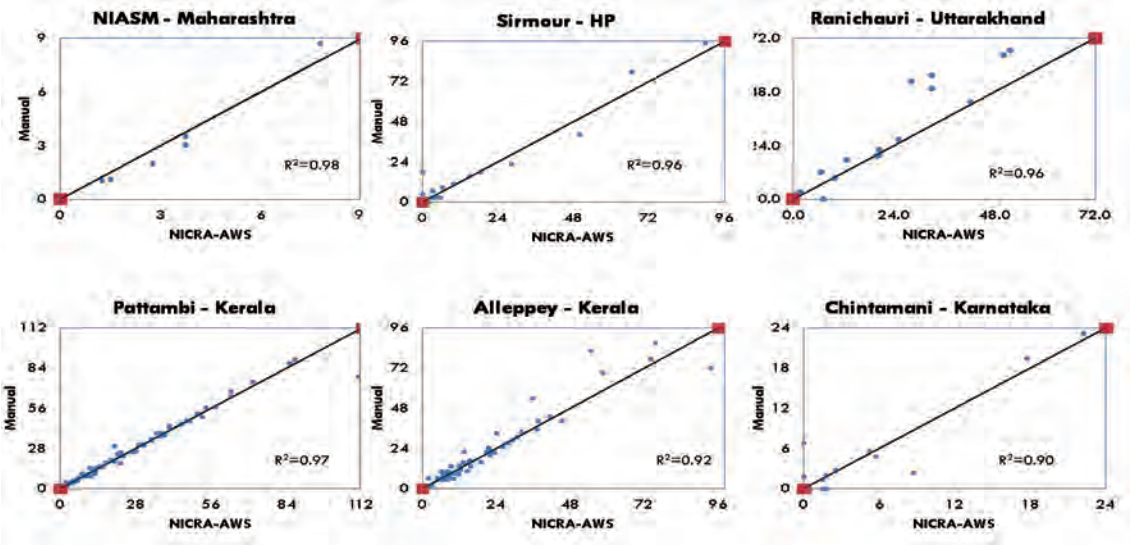

Fig. 2: A comparison of rainfall data recorded from AWS and manual observatory

2.2 AWS data based map products

Real-time weather data from 100 AWS stations were used to generate spatially interpolated daily weather maps using ArcGIS. These maps provide a gist on the current weather status across the country. For an instance, changes in temperatures and rainfall over a time period as shown in Fig. 3 could be used in fine tuning the agromet advisories.

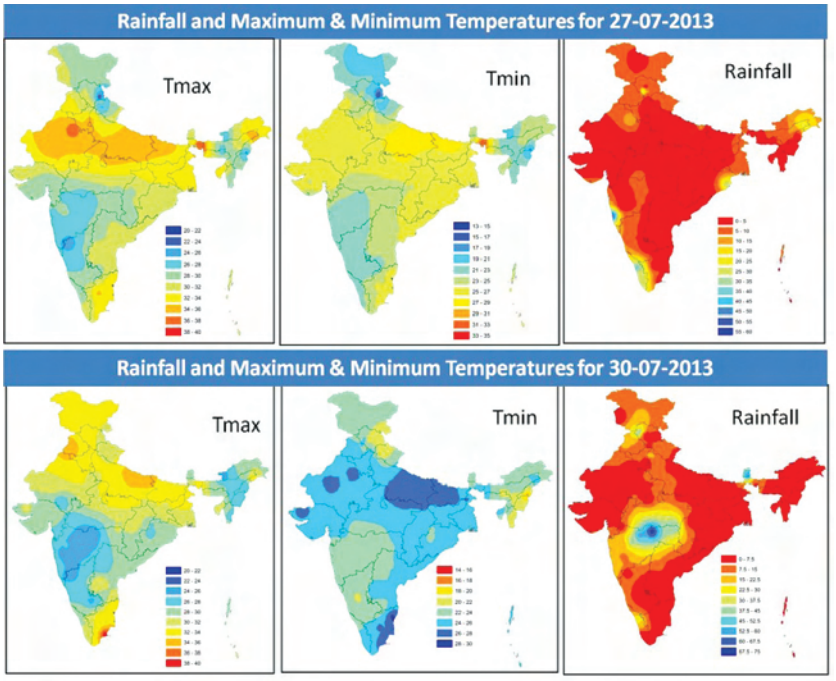

Fig. 3: Spatial changes in temperature and rainfall during 27th to 30th July 2013 period

Indian food grain production is largely dependent on the intra-seasonal performance of south west monsoon. Generation of map products on the onset of monsoon, its progression and spatial distribution of monthly rainfall as demonstrated in Fig.4&5 assist in the identification of rainfall deficit/excess areas which may go as an input in designing the alternate coping mechanism / contingency measures for a situation like drought/ heavy rainfall /flood in different regions of the country.

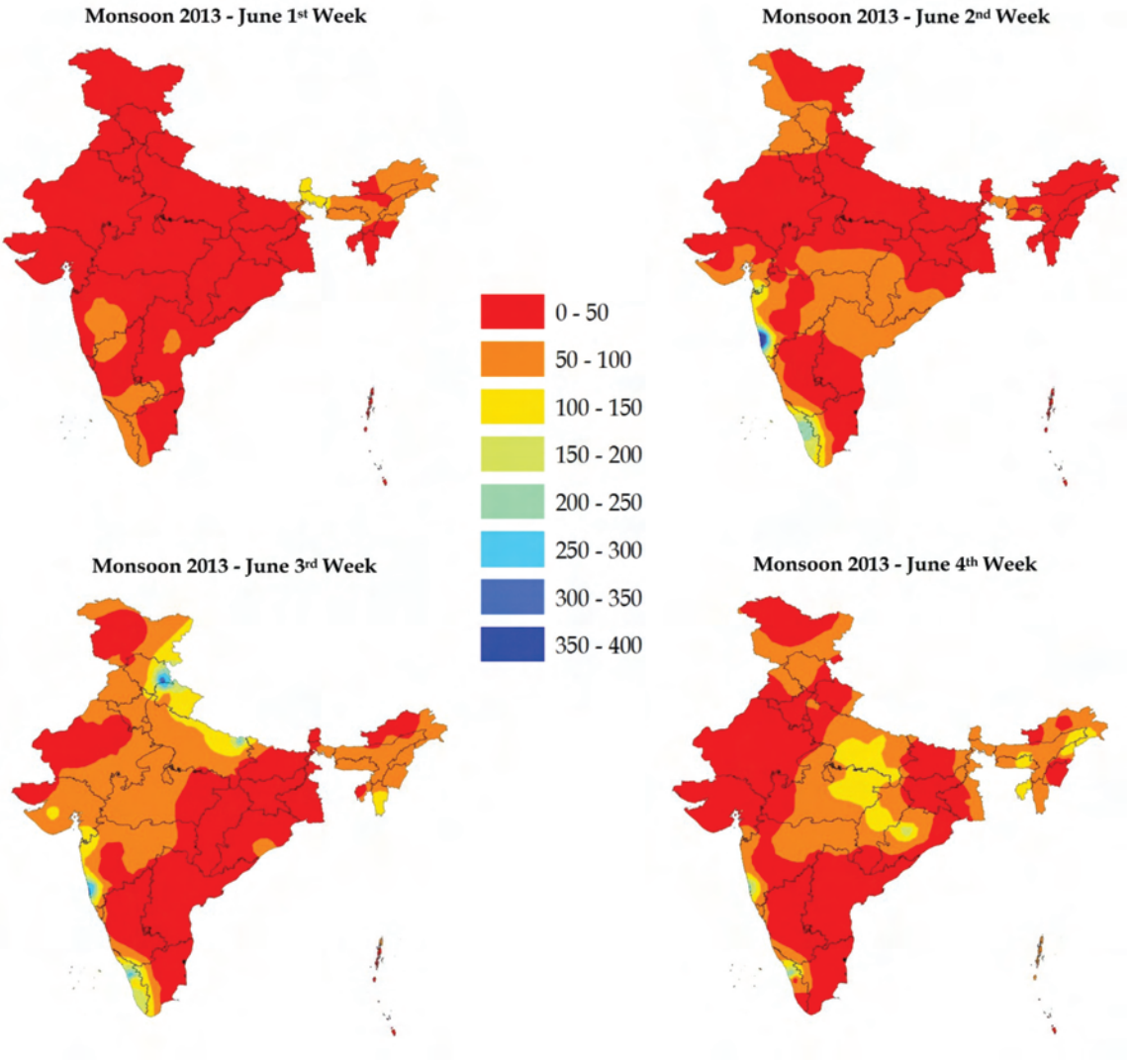

Fig. 4. Monitoring onset of monsoon using AWS data

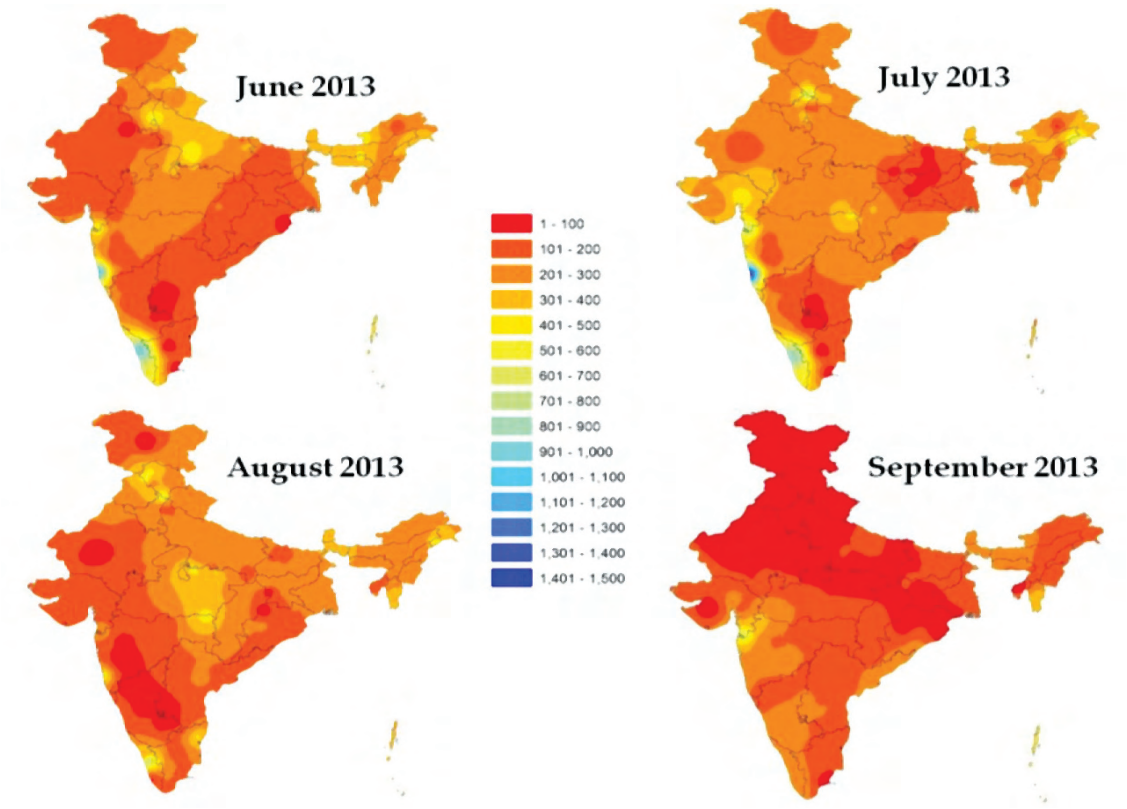

Fig. 5. Spatial variability in monthly rainfall distribution during 2013 SWM season

Extreme weather conditions like heatwave and coldwave can be monitored regularly using these map products. Temperature maps generated using the T_{max} during the month of May to identify heat wave conditions across the country are depicted in Fig 6. Thus, AWS station network helps in monitoring the extreme weather events on real-time basis and in the issue of forewarnings.

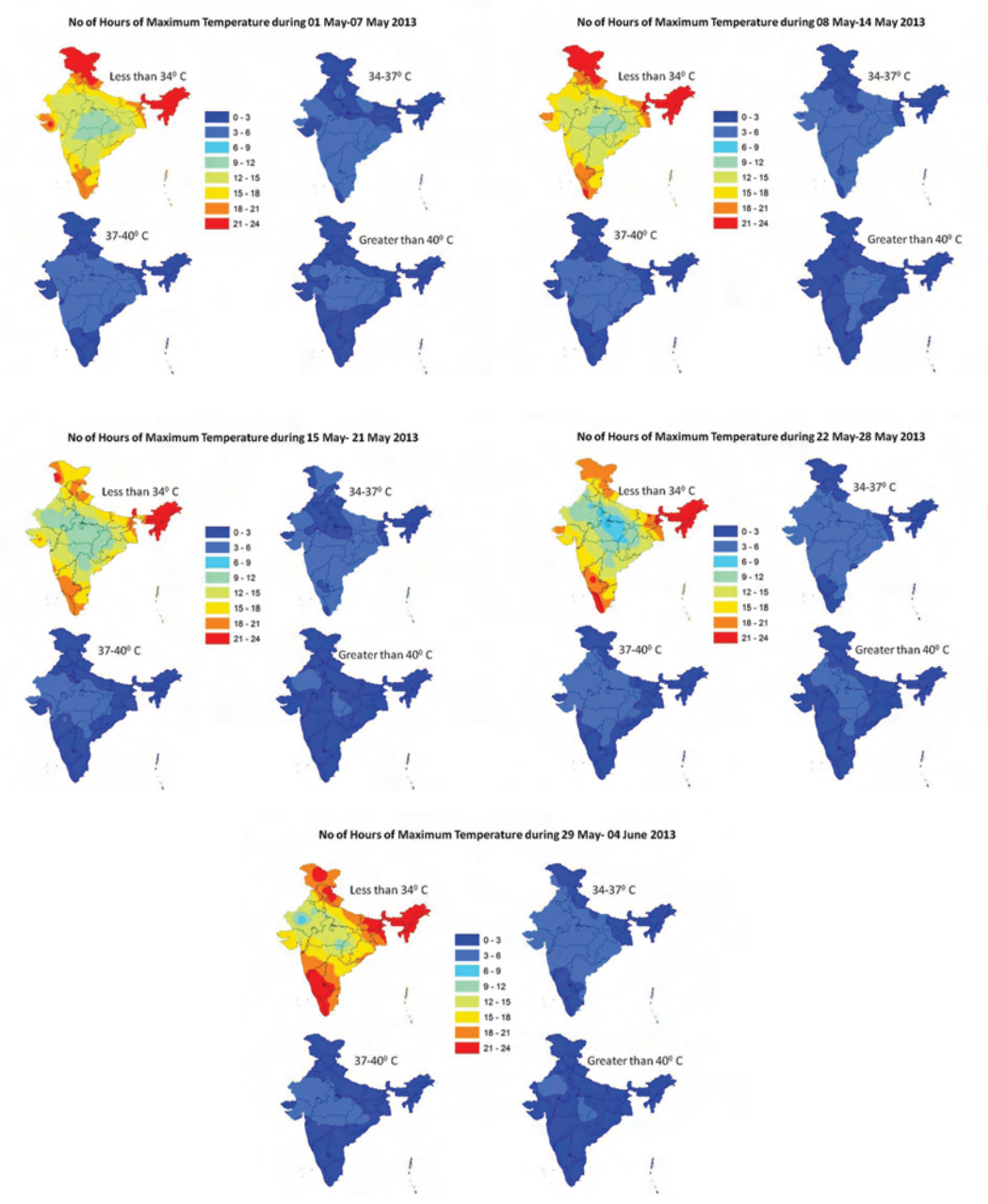

Fig. 6: Monitoring the persistence of heat wave conditions using AWS products

Issue of Agromet advisories at micro level on real-time basis requires weather data at a very fine resolution. Spatial coverage of 100 AWS network is not sufficient in the issue of micro level agromet advisories. Hence, efforts are on to integrate AICRPAM AWS data with AWS data of IMD sourced from IMD web portal.

3.0 Research accomplishments

3.1 Trends in *Kharif* paddy yields and minimum temperatures

Monthly minimum temperature data of Climate Research Unit (CRU), for the period 1971-2009, were used to detect trends at the district level for a total of 599 districts. The magnitude of rise in minimum temperature during *kharif* season was found to be 0.19°C per 10 year for the country as whole. Anomalies were negative prior to 1999 in majority of the years and turned positive beyond 1999. Changes are not uniform over the entire country. Minimum temperatures during the *kharif* season showed strong warming trend in southern states, Indo-Gangetic Plains (IGP), north-eastern parts, majority of the Jammu & Kashmir, Gujarat and entire Himachal Pradesh. A strong warming trend was noticed over 52.7% of geographical area and the degree of warming is about 0.24°C per 10 year.

On a monthly basis, minimum temperatures for the *kharif* season were examined to detect the month(s) during which the temperatures are rising at a much faster rate. The monthly trends for the months June to October indicated that rising trends were noticed in more number of districts (492) during September. However, it was August during which more number of districts (357) that showed strong warming (p=0.01) compared to September (335). During the month of June, the number of districts showing rising trends was the least (235) followed by October (332).

Rising trends in minimum temperature during kharif were found to have a negative impact on paddy yields in majority of the paddy growing districts. Spatial distribution of correlations between kharif paddy yields and minimum temperatures are presented in Fig. 7. About 268 districts exhibited a negative impact of rising temperatures and 49 of them were statistically significant (P = 0.05). These 268 districts accounted for 57.2% of cultivated area under kharif paddy out of which districts showing strong negative influence accounted for 18.7% area. Negative impacts were noticed mostly in the eastern parts of the country and in Indo-Gangetic Plains. In the southern India, some districts adjoining West coast also exhibited sensitivity of paddy yields to temperature. In the rest of the districts, the association was either not significant or positive.

Correlations worked out between monthly minimum temperatures and kharif paddy yields indicated that minimum temperatures during August and September were exerting a negative impact in more number of districts (197) compared to June, July (<174) or October (105) months. This may be due to the crop entering the reproductive phase during the August–September period and becoming more sensitive to temperature than the vegetative stages during June and July months. In the statistically significant districts, kharif paddy yields declined on an average @ 859 kg ha^{-1} and in the negative but non-significant districts the yields declined @ 411 kg ha^{-1} per 1 °C rise in temperature.

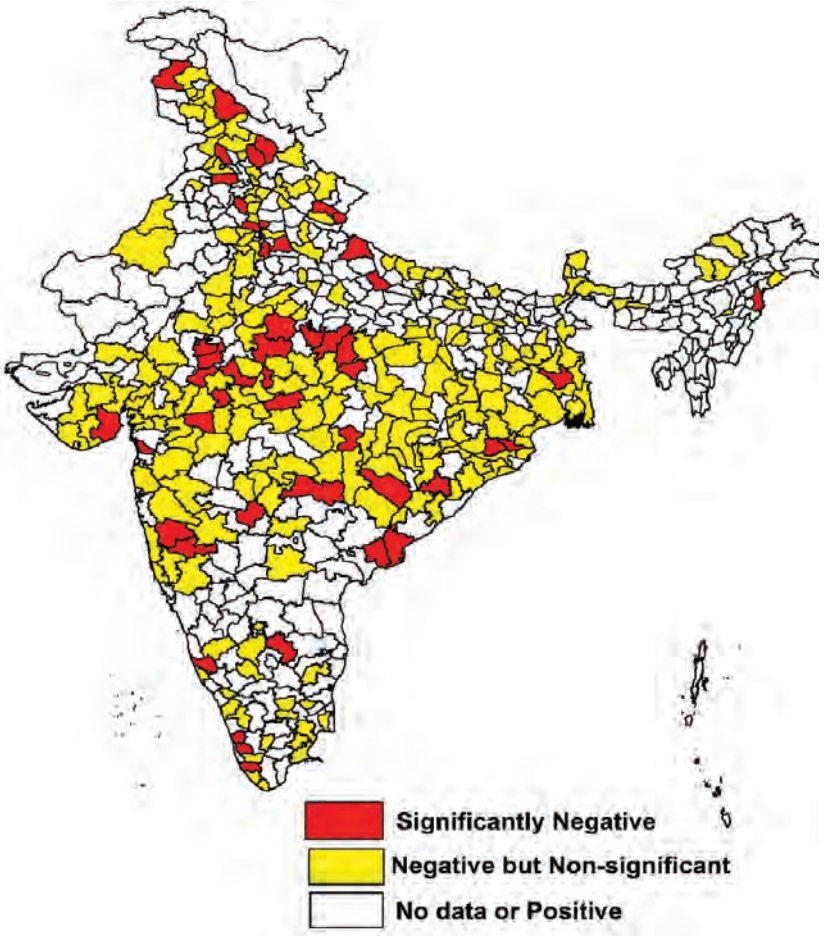

Fig. 7. Correlation between district-level *kharif* paddy yields and seasonal minimum temperatures

3.2 Weather indices for groundnut

Weather indices for groundnut were designed by analyzing long-term yield and weather data of three locations *viz.,* Bangalore, Anand and Ludhiana. These indices are helpful for weather based insurance of groundnut.

Higher rainfall during pod initiation to pod filling favored higher pod yields and rainfall less than 119, 109, 156, 138 and 122 mm during pod initiation to pod filling stage resulted in lesser yield in DH 3-30, Robut 33-1, TMV-2, JL-24 and K-134, respectively at Bangalore (Table 1). However, at Anand rainfall during first seed to harvest was found to be critical for obtaining higher yield and in varieties Robut 33-1, GG-2 and Gaug-10 rainfall lesser than 319, 469 and 174 mm respectively, during first seed to harvest stages resulted in lower than optimum yields. At Ludhiana, in variety M-13, rainfall of 334 mm during complete emergence to 50% flowering was found critical for higher pod yield and any decrease during this stage resulted in below optimum pod yields.

Table 1: Rainfall limits at different phenophases of groundnut for different yield categories at Bangalore, Anand and Ludhiana

Centre	Variety	Category	Stage	Rainfall (mm)	Yield (kg ha^{-1})
Bangalore	DH 3-30	Above average	Pod initiation to pod filling	118.7	1438
		Average		82.4	899
		Below average		65.8	468
	Robut 33-1	Above average	Pod initiation to pod filling	108.7	1235
		Average		71.0	801
		Below average		10.7	256
	TMV-2	Above average	Pod initiation to pod filling	155.7	2015
		Average		85.0	1384
		Below average		40.3	902
	JL-24	Above average	Pod initiation to pod filling	138.4	1879
		Average		111.6	1424
		Below average		36.3	947
	K-134	Above average	Pod initiation to pod filling	122.3	2211
		Average		102.4	1456
		Below average		50.8	872
Anand	Robut 33-1	Above average	First seed to harvest	318.8	2790
		Average		254.9	1766
		Below average		43.7	869
	GG-2	Above average	First seed to harvest	469.0	2356
		Average		341.8	1761
		Below average		28.9	1043
	Gaug-10	Above average	First seed to harvest	174.3	2033
		Average		86.9	1361
		Below average		6.9	476
Ludhiana	M-13	Above average	Complete emergence to 50% flowering	333.6	3370
		Average		165.4	1813
		Below average		58.1	361

The relationship between pod yield and rainfall during pod initiation to pod filling was established as a mean of five cultivars by regressing reduction in pod yields (%) on reduction in rainfall expressed in per cent (Fig. 8). It could be noticed that rainfall at this phenophase alone accounted for 62 % variation in pod yields. At Bangalore, with a one per cent decline in rainfall, the pod yields would decline by 0.6 per cent.

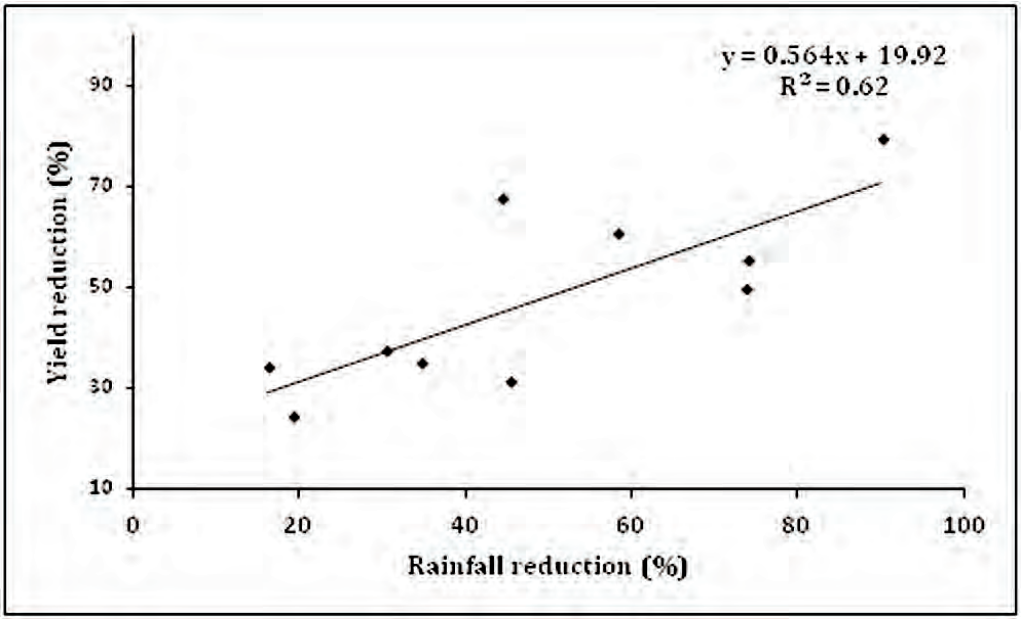

Fig. 8. Sensitivity of groundnut pod yields at Bangalore to rainfall during pod initiation to pod filling stage (mean of five varieties)

Response of groundnut varieties to water availability and duration of moisture stress was assessed by relating pod yields with indices like water requirement satisfaction index (WRSI) and number of consecutive dry days at the three centres (Table 2). The WRSI required for optimum pod yield ranged from 64.7 to 93.3 per cent across different varieties and centres. At Bangalore (cv. DH 3-30) and Anand (cv. Robut 33-1) two dry spells of more than 15 and 20 days, respectively caused nearly 70 percent reduction in pod yield compared to no dry spell. At Ludhiana, M-13 variety was found tolerant to one spell of 15 dry days but yield reduced by 90% with four such dry spells.

Table 2: Thresholds of Water Requirement Satisfaction Index (WRSI) for optimum yields of groundnut varieties

Centre	Variety	Category	WRSI (%)	Yield (kg ha^{-1})
Bangalore	TMV-2	Above average	81.5	2015
		Average	80.7	1384
		Below average	72.1	902
Anand	Robut 33-1	Above average	87.3	2790
		Average	70.5	1766
		Below average	45.6	869
	GG - 2	Above average	93.3	2356
		Average	77.6	1761
		Below average	38.0	1043
	Gaug-10	Above average	64.7	2033
		Average	49.8	1274
		Below average	29.9	476
Ludhiana	M-13	Above average	92.6	3370
		Average	56.8	1813
		Below average	31.5	361

3.3 Assessment of high temperature risk in wheat

High temperature risk in six wheat varieties grown under different sowing environments at six centers was assessed by working out the probability of exceedence of the upper limits of temperature (both maximum and minimum) during identified critical stages. The results (Table 3) showed that probability of occurrence of high temperature during the critical stage of any wheat variety increased with delay in sowing at all the six centres and the probability was found to be variable in different cultivars. Further, the risk due to both higher maximum and minimum temperatures was found to be lowest at Ranichauri (hill station) with lowest temperature during the growing period, among the six centres studied. Among all the varieties and centres, risk was highest in K-9107 at Ranchi.

Table 3. High temperature risks at six locations in terms of probabilities of maximum and minimum temperatures exceeding upper limits during critical stage of wheat varieties

Centre	Variety	Week of sowing (SMW)	Stage/Limits of Maximum Temp and Minimum Temp	Probability of Max T (%)	Probability of Min T (%)
Kanpur	HD-2285	47	Milk (≥ 32, ≥ 16.7 °C)	1	0
		50		45	26
		52		89	76
	K-8804	47	Milk (≥ 32.6, ≥ 17.1 °C)	0	0
		50		34	18
		52		79	68
	K-9107	47	Milk (≥ 33.3, ≥ 17.7 °C)	0	0
		50		21	9
		52		71	58
Ranichauri	UP-1109	44	Anthesis (≥ 24.2, ≥ 12.2 °C)	15	11
		47		17	13
		50		34	30
	RR-21	44	Anthesis (≥ 23.7, ≥ 11.6 °C)	17	15
		47		20	17
		50		38	40
Ludhiana	PBW-343	45	Maturity (≥ 35.2, ≥ 17.2 °C)	21	25
		48		46	51
		49		70	80
	WH-542	45	Maturity (≥ 35.1, ≥ 17.2 °C)	8	5
		48		46	51
		50		71	80
Raipur	GW-273	48	Milk (≥ 33.7, ≥ 15.9 °C)	26	35
		49		26	35
		51		63	78
		52		73	85
	Kanchan	48	Milk (≥ 34.4, ≥ 16.6 °C)	3	15
		49		11	24
		51		51	66
		52		63	75
Udaipur	Raj-4037	45	Dough (≥ 34.6, ≥ 14.3 °C)	5	5
		47		13	47
		49		32	65
		51		53	79
Ranchi	K-9107	47	Milk (≥ 32.5, ≥ 14.9 °C)	3	9
		49		34	57
		51		55	80
		52		89	100
	HUW-468	47	Milk (≥ 32.2, ≥ 13.9 °C)	0	8
		49		19	50
		50		42	76
		51		59	86
	BG-3	47	Milk (≥ 31.7, ≥ 12.9 °C)	1	30
		49		23	70
		50		23	70
		51		65	97

4.0 Outreach activities

4.1 Micro-level Agromet advisories

One of the objectives of AICRPAM-NICRA project is to strengthen Agromet advisory services at micro-level and to make the advisories reach more number of farmers. Agromet advisory service aims to generate agrometeorological information and develop suitable dissemination system to improve farming system productivity. It also helps farmers to minimize the detrimental effects of weather on crops and livestock. Each centre provides the agromet advisories on every Tuesday and Friday, and also alert on the weather extremes as and when required. Advisories are being disseminated through personal contact, display on public offices, SMS etc. Micro-level Agromet advisories have been successfully issued under AICRPAM-NICRA project by several centers.

At Bhubaneswar, micro-level Agromet advisories setup has been operationalized and the advisories are issued to selected villages of two blocks. These have integrated TSP with Panchayatraj department and services of Block Weather Women (BWW) were availed for the first time whose responsibility is to receive the Agromet advisory and disseminate them by technical means or in person to the farmers (Fig. 9).

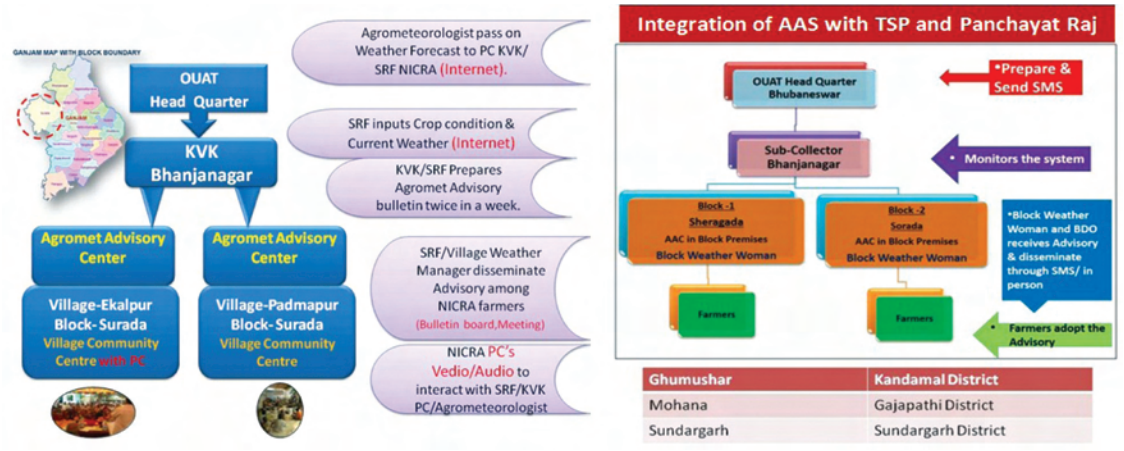

Fig. 9. Flow charts depicting dessimination of AAS and integration with TSP and Panchayat Raj department

Agromet advisory bulletins provided the information on sowing, management operations and pest control in vegetables and other crops. At the end of *kharif* season a survey on the economic benefit accrued in both villages indicated that on an average the benefit is around Rs.3250/- per hectare.

Agromet advisories also contained information on several agricultural activities like soil and water conservation measures, effective pest control measures, reduced irrigation applications and adapting new varieties in the two adopted villages of Bhubaneswar center (Fig. 10). Targeted farmers of the adapted villages were got convinced on the beneficial effects of these advisories and the impact study also indicated that, the agromet advisories are very beneficial.

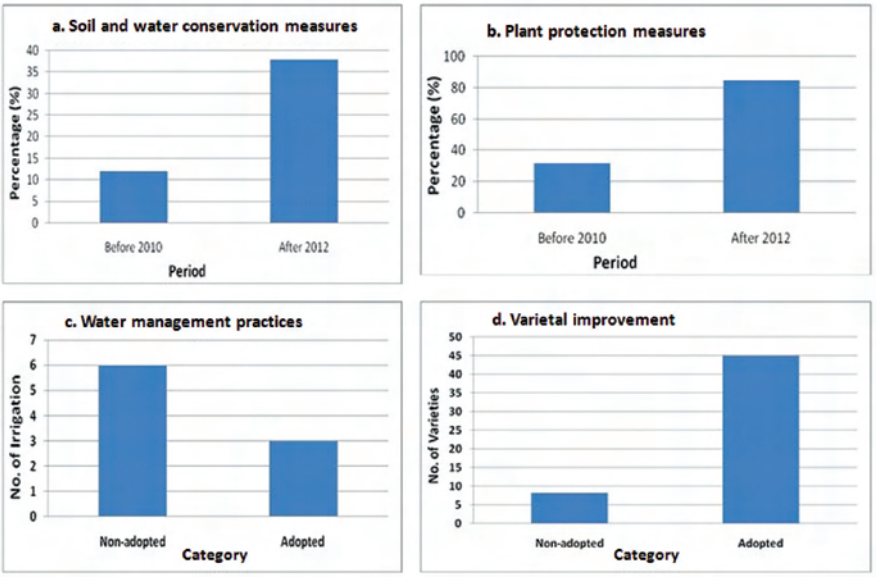

Fig. 10. Impact of AAS on the adoption of various agricultural practices

The mechanism of disseminating AAS adapted by Udaipur center is different from the one explained earlier and their mode dissemination of AAS to the microlevel is depicted in Fig. 11. Agromet advisories issued by the Udaipur center during the month of July containing the information on rainfall situation and sowing schedule of maize resulted in benefit in the range of Rs.18000 - 24000 per hectare.

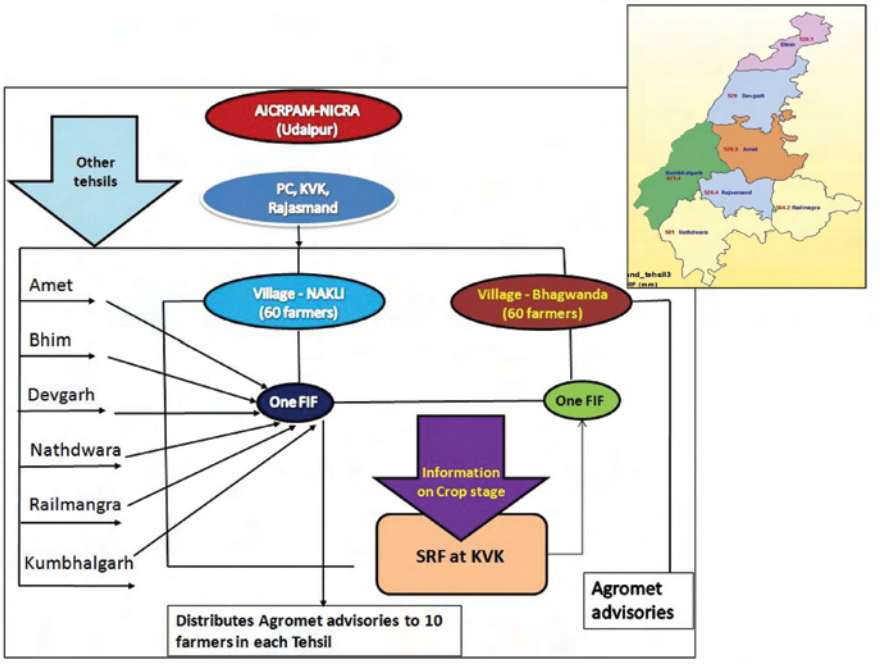

Fig. 11. Flowchart of AAS dissemination mechanism adopted at Udaipur

The various approaches adopted by different centers in disseminating are listed below with examples.

Anantapur

Date	No. of farmers			Advisory issued
	M	F	T	
04-06-2013	300	70	370	Yagantipalle village: Chances of light rains (6-12 mm) for the next 3 days in Kurnool district, Maximum Temp 36-38 °C, Minimum Temp 23-24 °C and Wind Speed 18-21 (Kmph)

Bangalore

Date	Villages	Forecasting	Advisory issued	Rainfall received (mm)
4-8 May 2013	Patrenhalli Nayanhalli Mylappanahalli	Light rainfall is expected	Farmers are advised to prepare lands for *Kharif* sowing	3.0 (4th May)
26-30 June 2013	Patrenhalli	Cloudy conditions and likely chances of drizzling rains	Take up sowing of red gram and finger millet. Control downy mildew in gourds by spraying Ridomil+Mancozeb	4.4
	Nayanhalli			3.0
	Mylappanahalli			3.6

Bijapur

At Bijapur, agromet advisories were found useful in sub-humid talukas of Belgaum district. For semi-arid talukas, advisories on pest and disease management were found useful.

Forecast date	F/C	Bailhongal	Hukkeri	Chikkodi	Belgaum	Khanapur
RF in previous week		8.78	5.34			
19.06.2013	8	13.0	3.3	2.2	8.9	3.6
20.06.2013	8	4.7	0.8	0.7	8.8	1.1
21.06.2013	9	4.8	2.4	3.7	10.7	2.0
22.06. 2013	9	7.2	1.7	0.3	0.1	0.7
23.06.2013	10	12.0	1.8	0.0	9.8	0.5
Cumulative	44	42.0	10.2	7.1	38.4	8.0
Advisory issued	• Farmers are advised to take up spraying after next five days as there is forecast of rainfall on all the five days. • As the taluk has received the rain during last week and there is forecast of moderate rainfall during the next five days, taking advantage of these rains farmers are advised to take up sowing of Green gram, Maize, Bt cotton, Redgram and Groundnut • Take up sowing of crops across the slope; it helps to conserve the soil moisture					

Dapoli

At Dapoli, advisories for rice crop at different growth stages in NICRA adopted villages *viz.,* Lanja and Rajapur were given as detailed below :

Stage	Month	Rainfall received (mm)		Effect on Crop	Advisory given
		Lanja	Rajapur		
Sowing (4th -12th Jun)	June	430.2	367.4	• Affected germination of seeds of rice and finger millet in low lying areas • Affected the growth of nursery in the water stagnated fields	• Postpone sowing of rice seeds during heavy rains • Provide drainage facility for rice nursery • Sow nursery in upland well drained fields
Seedling (13th Jun-1st Jul), Tillering (02th Jul-10th Aug)	June-July	2595.	2518.5	• Water logging immediately after transplanting increased mortality of seedlings • Tillering was affected • Incidence of blue beetle was observed in low lying areas	• Provide proper drainage • If the incidence of blue beetle is noticed, spray carbaryl 50 wp @ 1 kg in 500 lit. of water per hector or Quinalphos 25% EC or Chloropyriphos 20% EC or Triazophos 40% EC in 500 lit. of water per hectare
Vegetative stage	August	552.9	307.0	• Incidence of blue beetle was observed in low lying areas	• Provide proper drainage • Spray carbaryl 50 Wp @ 1kg in 500 lit. of water per ha. Or quinolphos 25% EC or Chloropyriphos 20%EC or Triazophos 40% EC in 500 lit. of water per hectare
Flowering stage (22nd Aug-14th Sep)	August-Septem-ber	208.4	199.0	• Incidence of blue beetle was observed	• Spray carbaryl 50 Wp @ 1kg in 500 lit. of water per ha. Or quinolphos 25% EC or Chloropyriphos 20%EC or Triazophos 40% EC in 500 lit. of water per hectare
Harvesting (01-18th Oct)	October	197.8	145.8	• Harvesting of early and mid late rice varieties delayed due to continuous rains	• Drain out excess water from rice fields

Jammu & Kashmir

Date of issue	Name of the village	Weather event /forecast	Agromet advisory	Remarks / amount of rainfall received(mm)
18th & 19th Jan 2013	Sherpur and Chhapaki	Moderate rain is likely to occur	Skip the irrigation to wheat. Postpone the weedicide spray	Save up to 2200/ acre due to 56.6 mm rainfall
5th 6th Feb 2013	Sherpur and Chhapaki	Moderate rain is likely to occur	Skip the irrigation to wheat. Postpone the chemical spray to mustard crop suffering from white rust and alternaria blight.	Save up to 2200/ acre due to 11.4 mm rainfall
13th 14th 15th & 16th June 2013	Sherpur and Chhapaki	Light to moderate rain is likely to occur	Go for the transplanting of rice. Sow the upland rice. Postpone the sowing of maize	Save up to 3200/ acre due to 57.0 mm rainfall
29th 30th July 2013	Sherpur and Chhapaki	Light to moderate rain is likely to occur	Go for the transplanting of Basmati rice. Postpone intercultural operations in maize crop	Save up to 2800/acre due to 95 mm rainfall
14th 15th Aug 2013	Sherpur, Chhapaki and Dhali	Light tomoderate rain is likely to occur	Skip irrigation to rice field. Postpone insecticide spray. Drain out excess water from maize and pulses	Save above 2200/ acre due to 150.8 mm rainfall
8th 9th Nov 2013	Sherpur, Chhapaki and Dhali	Light to moderate rain is likely to occur	Delay the sowing of wheat and mustard	Save above 3600/ acre due to 25.6 mm rainfall
22nd Dec 2013	Sherpur, Chhapaki and Dhali	Light to rain is likely to occur	Postpone the weedicide and fungicide spray in the wheat field	Save above 2400/ acre due to 22.2 mm rainfall

Solapur

At Solapur agromet advisories were issued in the events of dry spell, unseasonal rainfall and hailstorms.

Month	Rainfall (mm)	Climatic extremes	Measures suggested through Agromet Advisory
August Dry spell 3rd - 30th Aug (28 days)	39.4	Dry spell of 28 days affected growth period of Kharif crops	• Provide protective irrigation to Bajra and sunflower wherever possible • Maintain optimum plant population by following thinning operations in Bajra and sunflower to minimize competition for moisture. Keep the crop weed free & follow hoeing operation to conserve moisture • Opening of alternate dead furrow for water / moisture conservation. • Vaccination of cattel for Peste Des Pettis Ruminants (PPR) and Hemorrhagic septicemia (HS) with 15 days interval
October & Nov	34.3	Dry spell of 17 days	• Irrigation scheduling at critical growth stages of Rabi crops • De-worming of livestock & vaccination against Foot & Mouth disease (FMD)
Dec 2013-Feb 2014	-	1) Moisture stress 2) cloudy weather 3) Fluctuations in minimum temperature	• Control of Aphids & Rust on Wheat by spraying of Dimethoate 30 EC 500 ml & 1.5 kg Mencozeb respectively per hectare in 500 litres of water should be done • Control of pod borer in gram spraying of Cloropyriphos 25 ml in 10 litres of water should be undertaken
Feb- March 2014	58	Unseasonal rains and hailstorm	• Spraying of copper oxychloride 30 gm per 10 litres of water to avoid fungal attack on fodder & grains wetted in rains • Proper grading & drying of Jowar & wheat grains affected by unseasonal rains

Anand centre has initiated voice message tool viz., **'Awaz De'** on their mobile phone to disseminate advisories.

4.2 Agromet Advisory Services - Economic impacts

Weather forecast and weather based agromet advisories help in increasing the economic benefit to the farmers by suggesting them with management practices suitable to anticipated weather conditions. In order to check the viability of any advisory service, economic impact assessment of that service is inevitable. Impact study of agromet advisory issued to the farmers of NICRA adopted villages were carried out by various centres. The impact of agromet advisories at different locations in monetary terms are reported here.

At Anand, agromet advisories issued for NICRA adopted villages resulted in savings ranging from Rs 2000 - 2500 per ha in paddy and mustard crops.

Date	Forecasted weather	Advisory given	No. of farmers who adopted advisory	Economic benefit
30/08/2013 03/09/2013 11/09/2013 07/09/2013	Light rainfall and continuous cloudy weather	Prophylactic measures of bacterial leaf blight of paddy	Ten farmers	Adopted farmers saved Rs. 2500 ha^{-1} with one prophylactic spray compared to three sprays carried by non adoptee farmers in the control of BLB of paddy.
07/01/2014 17/01/2014 04/02/2014	Cloudy weather	Prophylactic measures of mustard aphid and white rust	Seven farmers	Adopted farmers saved Rs. 2000 ha^{-1} with one prophylactic spray compared to three sprays carried by non adoptee farmers in the control of mustard aphid and white rust.

At Bangalore, in case of vegetable crops savings by adoption of agromet advisories varied from Rs.500-5000 by individual farmers apart from non quantifiable savings. In case of major horticulture crops, individual farmer could save from Rs. 6000-15000 and in ragi Rs.300-2000. Some case studies on the economic benefit of AAS, Bangalore are reported here under.

Name of the farmer	Crop/ Stage/ Date	Farm activity initially planned by the farmer	Forecast/ Advisory given	Action taken by farmer in response to AAS	Savings	Benefit/ amount
Krishnappa	Grape 04/07/13	Spray of Ridomil, Neem	Not to plan for pesticide application because of likely chances of rainfall	Withhold pesticide application	Saved wastage of fungicide and labour	Rs.1200
M.V Suresh	Beans 1/12/13	Repeated spraying of acephate against whitefils	Advised to provide shade nets around the crop, yellow sticky traps and spray triazophos	Provide shade nets around the crop and spray triazophos	Movement of whitefiles and other pests through wind reduced significantly	Rs.1000
M.V Manjunatha	Grapes	To spray Bavistin, Beam	Since downy mildew disease was not at threshold level, Advised to just take up protective spray of Bordeaux mixture	Withhold pesticide application	Saved wastage of fungicide	Rs.3000
M.V Shomashekar	Grapes	Intended to spray confidor + ridomil	Advised not to spray because of likely chances of moderate rain	Postponed the spraying schedule	Saved labour charges + pesticides	Saved labour charges Rs.600+ pesticide Rs. 1000

At Bijapur, farmers of different talukas of Belgaum district were provided with agromet advisory for pest and disease management as well as on harvesting due to which they saved money ranging from Rs 2000 to 62500/ha.

Farmer's name	Crop	Advisory used for	Advisory followed and benefit/loss
Maruthi Ganachari (Gokak taluk)	Soybean	Management of leaf eating caterpillar and pod borer	• Followed spray schedule as per NICRA advisory. • Compared to neighbouring farmer, who is not using the advisory, increase in yield by 450 kg/ha and got good rate (Rs.3000/q) Total-27.5 q ha^{-1}. Benefit:Rs.13500/ha
	Sugarcane	Early shoot borer and whitening of leaves	Increase in yield by 1 tonne/acre. Benefit of Rs.1500/acre (after subtracting chemical & labour cost) (Rs. 3750/ha).
Laxman Udappa Bandari (Gokak taluk)	Sugarcane	Management of sugarcane wooly aphid	Increase in yield by half tonne/acre. Benefit of Rs. 800/acre (Rs. 2000/ha).
	Kapli wheat	Advisory used for harvesting purpose	A farmer has harvested the produce. As there was forecast of rain for next day, he covered the harvested produce with plastic. This saved his produce costing around Rs. 10,000/acre.
Praveen Hiremath (Bailhongal)	Cotton	Use of advisories for control of leaf reddening and dropping of flowers	Taken up spraying as per advisories, increase in yield by 50 kg/acre. Benefit: Rs. 2000/acre.
Bhimappa Hullur (Gokak)	Maize	-	Farmer planned to harvest the crop - forecast made was there will be no rain in next five days. He delayed the harvesting due to unforeseen reason. However, there was moderate amount of rainfall. Fortunately his decision of postponing he did not incur any loss. Otherwise, if he had harvested, he would have faced quality loss in produce.
Govind Dudaguni (Gokak)	Maize	Management of stem borer	Followed the spray schedule.Benefit:50-60 kgs/ acre:Rs.1500/acre (Rs 3750/ha)
	Wheat	Management of blight in wheat	Forecast of Blight disease in wheat. Disease was seen and disease was controlled in initial stage itself. Saved 2 sprays and labour charges around Rs. 700/acre/spray): Benefit:Rs.1400/acre (Rs. 3500/ha)
Mutteppa Kadkol (Gokak)	Cabbage	Management of snails	Recommended the use of Snail kill tablets. Insect was completely controlled (150 Rs)-Improvement in quality resulted in additional benefit of 500Rs/ tonne. Benefit:1500Rs/acre (Rs 3750/ha)
	Maize	Management of blight	Got good quality grains. Increase in rate by Rs.100/q compared to other farmers. Total -8q/ acre. Benefit: Rs. 800/acre (Rs. 2000/ha)
Annagouda Patil (Hukkeri)	Tobacco	Harvesting of tobacco	Forecast made was there will be no rain in next five days. So, had taken up harvesting. There was heavy rainfall. Harvested tobacco was destroyed. Loss of Rs. 25,000/acre (Rs. 62500/ha)

At Faizabad, farmers belonging to two villages *viz.,* Banpurwa and Rajapur of Bharaich district were provided with agromet advisory on land preparation, sowing and irrigation management in paddy, wheat and mustard crops.

Name of the farmer	Crop/Date	Farm activity initially planned by the farmer	Forecast/ Advisory given	Action taken by farmer in response to AAS	Savings	Benefit/ Amount
Banpurwa						
Vindeshwari Singh s/o Ram Naresh Singh	Paddy, 26-09-2013	Irrigation of paddy	Not to plan for irrigation because of likely chance of rainfall	Postponed the irrigation	Saved wastage of oil and labour	Saved oil and labour Rs. 1000
Chunmun Singh s/o Jagatpal Singh	Mustard, 04-10-2013	Land preparation for mustard	Postpone the farm operations because of possibility of occurrence of rain	Postponed the Harrowing and Weeding	Saved labour charges	Rs. 1000
Sundar Singh s/o Ramshankar Singh	Mustard, 31-10-2013	No plans on the irrigation	No chances of occurrence of rains and farmers are advised irrigation apply	Apply irrigation	Avoided the yield loss	Rs. 2000
Rajesh Singh s/o Munna Singh	Wheat, 19-11-2013	No plan of sowing	Temperature 25-27°C and advised the farmers sowing of wheat	Sowing of wheat	Avoided the yield loss	Rs. 3000
Rajapur						
Indrasen Singh s/o Dayanand Singh	Paddy, 26-09-2013	Irrigation of paddy	Not to plan for irrigation because of likely chance of rainfall	Postponed the irrigation	Savings on the oil and labour	Rs. 1500
Satya vart Singh s/o Indraj Singh	Mustard, 05-10-2013	Land preparations of mustard	Postpone the farm operations because of possibility of occurrence of rain	Postponed the land preparation	Saved labour charges	Rs. 1500
Babban Singh s/o Ram Narayan Singh	Mustard, 31-10-2013	Irrigation not planned	No chances of rainfall and advised irrigation	Apply irrigation	Avoided the yield loss	Rs.1800

Harihar Singh s/o Amar Bahadur Singh	Wheat, 08-11-2013	No plan of land preparation	No chance of rainfall and advised the farmers land preparation of wheat	Land preparation	Avoided the yield loss	Rs.2000
Shyam Singh s/o Harihar Singh	Wheat, 19-11-2013	No plans on the sowing	Temperation 25-27oC and advised the farmers sowing of wheat	Sowing of wheat	Avoided the yield loss	Rs.2500
Indrasen Singh S/o Dayanand Singh	Wheat 15.1.14	Irrigation of wheat	Not to plan for irrigation because of likely chance of Rainfall	Postponed the irrigation	Saved wastage of oil and labour	Rs. 1200

At Udaipur, agromet advisories issued for two villages *viz.,* Nakli and Bhagwanda of Rajsamand district resulted in yield advantages of eight per cent in gram to 46 per cent in maize.

Crop	Total no. of farmers	Total area (ha)	Average yield (q/ha)		Per cent increase in the yield over farmers' practice
			With AAS	Without AAS	
Maize	13	8.3	22	15	46.7
Wheat	23	15.6	48	40	20.0
Mustard	7	1.5	12	10	20.0
Gram	6	0.5	27	25	8.0

At Jabalpur, economic impact of agromet advisories was assessed in Chakoda village during *kharif* and *rabi* seasons. Per cent gain in income by AAS farmers over non AAS farmers were in the range of 2 to 9% in wheat, 15 to 20% in sesame, 12 to 20% in black gram, 6 to 19% in groundnut and 10 to 30% gain in soybean.

At Jammu, assessment of economic impact of agromet advisories provided to NICRA adopted villages showed that farmers who adopted the advisories could save money ranging from Rs. 2000-5000 in different growing seasons.

At Kanpur, cost of cultivation of paddy crop was calculated for AAS adopted farmers in comparison to non AAS farmers and found that adopted farmers were able to reduce input cost by irrigation scheduling, plant protection measures and man power as compared to non adopted farmers.

Inputs	Cost (Rs)		Savings (Rs) by AAS farmers
	AAS farmer	Non AAS farmers	
Land preparation with green manure	2400	3500	1100
Fertilizer (N:P:K @ 120:60:60)	6359	7377	1018
FYM 10t/ha	5000	-	0
Seed rate (30 kg @ Rs 48/kg)	1440	1440	0
Planting (30 persons)	3600	3600	0
Weeding (15 persons)	1800	5400	3600
Plant protection	1650	2515	865
Irrigation,10 persons @ Rs 120/hrs	1200	3600	2400
Harvesting, 30 persons @ Rs 120/person	3600	3900	300
Threshing and winnowing, 40 persons	4800	5400	600
Land rent	6000	6000	0
Miscellaneous	1000	1000	0
Interest of working capital	1751	1958	207
Total	**40590**	**45690**	**10090**

At Mohapur, a detailed comparison between cost of cultivation of *kharif* rice, *rabi* Lathyrus and Boro rice in NICRA adopted and non adopted villages was carried out and results are as follows:

Sl. No.	Particulars	Kharif season rice		Rabi season Lathyrus		Boro season rice	
		NICRA Village	Non-NICRA Village	NICRA Village	Non- NICRA Village	NICRA Village	Non-NICRA Village
A.	Components of Cost A1						
i.	Seed (Rs. ha^{-1})	1303	1305			3,086	3,882
ii.	Manure (Rs. ha^{-1})	630	77	1,925	2,290	1,174	694
iii.	Fertilizer (Rs. ha^{-1})	2384	1908	0	0	7,243	5,526
iv.	PPCL (Rs. ha^{-1})	633	1192	0	0	2,309	5,480
v.	Irrigation charges (Rs. ha^{-1})	0	0	0	0	9,449	12,655
vi.	Bullock Labour (Rs. ha^{-1})	352	766	0	0	970	1,145
vii	Tractor Labour (Rs. ha^{-1})	2683	2775	0	0	4,035	3,715
viii.	Hired human Labour (Rs. ha^{-1})	14067	14559	0	0	10,980	11,034

ix.	Miscellaneous Cost (Rs. ha^{-1})	0	0	1,887	1,636	0	0
x.	Interest on working capital @10%p.a. (Rs. ha^{-1})	735	753	0	0	1,308	1417
B.	Total Cost A1 (Rs. ha^{-1})	227887	23335	127	131	40,554	45,603
xi.	Imputed rental value of owned land (Rs. ha^{-1})	13916	12532	3,938	4,056	26,602	24,591
C.	Cost B (Rs. ha^{-1})	36703	35868	7,048	5,804	67,157	70,195
xii.	Imputed value of family labour (Rs. ha^{-1})	9482	11143	10,985	9,860	12,604	14162
D.	Cost C (Rs. ha^{-1})	46185	47011	4,717	6,308	79,761	84,357
				15,702	16,168		
E.	Return structure						
i.	a. Physical Main Product (kg h^{-1})	3396	3119			5,733	5,296
	b. Physical By Product (Kahon h^{-1})	13	9	783	644	15.84	14
ii.	Total return (a+b)	46387	41775			88,674	81,972
	a. Main Product	42451	38991	23,490	19,345	83129	76,800
	b. By product	3936	2784			5,545	5172
iii.	Net return over Cost A1 (Rs. ha^{-1})	23600	18439	19,552	15,289	48,119	36,358
iv.	Net return over Cost B (Rs. ha^{-1})	9684	5907	12,505	9,485	21,517	11,776
v.	Net return over Cost C (Rs. ha^{-1})	202	-5236	7,788	3,177	8913	-2385
vi.	Farm invest-ment income	14,118	7,296	14,835	8,981	35,515	22,195
vii.	Return cost ratio over Cost A1	2.03	1.79	5.96	4.77	2.19	1.80
viii.	Return cost ratio over Cost B	1.26	1.16	2.14	1.55	1.32	1.17
ix.	Return cost ratio over Cost C	1.00	0.89	1.50	1.20	1.11	0.97

At Raipur, farmers who follow NICRA-AAS in paddy crop have average saving of 12.4 percent in manures and fertilizers, about 30 per cent in weeding, about 19.4 per cent in plant protection, 16.71 per cent in irrigation and the overall saving during crop growing season is 11.13 per cent. Manures and fertilizers saving could be done by AAS farmers as by following advice, saving in top dressing of urea was there. In plant protection also, a saving of Rs. 410 per hectare was made mainly focusing on the cost saving in spraying of herbicides / insecticides. However harvesting, thrashing, winnowing and transportation costs are coming out to be almost same under both the systems.

S. No.	Particulars	Average cost with AAS	Average cost without AAS	Average savings with AAS	percentage savings with AAS *
A.	Variable cost				
1	Field preparation	1368	1368	0	0
2	Manure & fertilizer	3030	3530	500	12.4
3	Sowing	1826	1826	0	0
4	Transplanting	2180	2180	0	0
5	Weeding	1266	1766	500	29.9
6	Plant protection	1786	2286	500	19.4
7	Irrigation	1645	2055	410	16.8
8	Harvesting	1770	1770	0	0
9	Threshing, winnowing and transportation	1363	1363	0	0
	Sub-total	16238	18148	1910	11.1
B	Fixed cost				
1	Land rent	6980	6980	0	0
2	Interest on working capital	175	190	0	0
	Total fixed cost	7155	7170	0	0
C	**Total cost(A+B)**	**23393**	**25318**	**1925**	**8.2**

4.3 Impact assessment of extreme weather events

Hailstorm damage was assessed and reported by majority of the AICRPAM - NICRA centers. Following are some of the details on the hailstorm events occurred in various parts of the country during February and March 2014 and the nature and extent of damage reported in various crops.

Centre	Date of hail occurrence	Nature and extent of damage
Faizabad	17th-18th Jan 2014	Flower drops in pulse crop, lodging in mustard crops, Rotting in potato
Udaipur	26th and 28th Feb 2014	50- 80 % crop loss in 12 districts
Anantapur	15th April 2014	Paddy, mango
Solapur	9th Mar 2014	Citrus, banana, sweet orange, custard apple, pomegranate, guava, field crops like maize, *rabi* jowar, mustard, wheat, onion, ratoon sugarcane, summer soybean, flower crops-marigold got damaged
Parbhani	22nd Feb-13th Mar 2014	Wheat, maize, sugarcane, onion and horticultural crops

4.4 Farmers' awareness programs

This is one of the most critical, but sometimes neglected aspects of adaptation for climate change. It is also important for fostering a sense of participation in and support for climate change adaptation and mitigation. It also engenders a "bottom-up" approach to planning and implementation of policy to complement the more traditional "top-down" approach adopted by governments. The communication strategies should aim to make stakeholders aware of the nature and potential consequences of impact of climate change. Ideally, personal visits and discussions with farming communities are preferable, but newspapers, radio and television can reach a large target audience quickly. Keeping this view, it is felt necessary that climate change awareness has to be inculcated in the farming community through climate change awareness programs of AICRPAM-NICRA. The present awareness of Indian farming community on the climate change impacts was assessed at different centers through a pre-designed questionnaire. The details of the climate change awareness program conducted by different centers are presented in the ensuring table.

Details of farmers awareness programs conducted at different locations

Center	Name of village / location	District	Date	Male	Fe-male	No. of farmers
Akola	Akola	Akola	29-Mar-13	45	0	45
Anand	KVK, Dethali	Kheda	23-Jan-14	199	0	199
	Tribal Research Station	Panchmahals	03-Mar-14	74	0	74
Anantapur	Krosurivaripalem	Krishna	01-Feb-14	100	0	100
	RARS, Anakapalli	Vishakhapat-nam	03-Feb-14	100	0	100
Bangalore	Doddanaravangala	Tumkur	27-Aug-13	115	25	140
Bijapur	Bachinagudda	Badami	30-Dec-13	88	14	102
	Honnalli	Bijapur	07-Feb-14	148	0	148
	Dummavad	Dharwad	19-Feb-14	120	0	120
	Kaladagi	Bagalkot	24-Feb-14	145	0	145
Chatha / Jammu	Sherpur Bala	Kathua	15-Feb-14	183	0	183
	Dhalli	Kathua	04-Mar-14	165	0	165
	Sherpur	Kathua	06-Mar-14	25	0	25
	Chappaki	Kathua	19-Mar-14	168	0	168
Faizabad	KVK Gonda	Faizabad	24-Sep-13	101	10	111
	KVK Basti, Bhilwal	Faizabad	06-Feb-14	118	7	125
Jabalpur	Seoni	Seoni	26-Sep-13	60	0	60
	Chhindwada	Chhindwada	06-Jun-13	107	0	107
	Dindori	Dindori	19-Sep-13	90	0	90
	Panna	Panna	02-Sep-13	99	0	99
	Banda	Katni	11-Feb-14	167	0	167
	Mahgawan	Jabalpur	26-Feb-14	152	0	152

Jorhat	Khumtai	Khumtai	02- Ap-14	100	62	162
	Thengal Gaon	Golaghat	04-Apr-14	55	45	100
Mohanpur	Bongheri	South 24 Pargana	16-Jul-13	20	2	22
	Goligram	Burdwan	23-Aug-13	67	0	67
	KVK, Howrah	Howrah	26-Sep-13	18	7	25
Ranichauri	Dargi	Tehri Garhwal	12-Dec-13	70	0	70
	Maun	Tehri Garhwal	10-Feb-14	75	0	75
Raipur	KVK, Malidih	Mahasamund	30-Sep-13	77	0	77
	IGKVV Raipur	Raipur	31-Oct-13	100	0	100
Samastipur	IRS, Bikaramganj	Rohtas	09-Apr-13	150	0	150
	Ballisaraia	Muzaffarpur	09-Feb-14	61	0	61
	Bhagvatpur	Muzaffarpur	26-Feb-14	40	8	48
Solapur	Dhule	Dhule	10-Jul-13	82	21	103
	Nandurbar	Nandurbar	11-Jul-13	165	37	202
	Baramati	Pune	24-Jul-13	88	18	106
	KVK, Mohol	Solapur	08-Jan-14	205	68	273
	KVK, Mohol	Solapur	07-Feb-14	210	31	241
	KVK, Mohol	Solapur	08-Feb-14	113	06	119
Thrissur	KVK, Thavanur	Malappuram	06-Jan-14	103	0	103
	Aripra	Malappuram	10-Feb-14	58	0	58
Udaipur	Nakli	Rajsamand	26-Apr-13	35	50	85
	Nala Fala	Udaipur	29-Jan-14	110	30	140

4.4.1 Farmers' suggestions on strengthening the AAS

At Dapoli, the opinion of the farmers on strengthen the agromet advisory services were collected on different aspects of AAS and their opinions are listed below:

Sr. No.	Particulars	Suggestions by the farmers
1.	Mode of dissemination	Personal Visit
2.	Time of dissemination in a day	Morning
3.	Lead time	Morning
4.	Frequency of Advisory	Once in a week
5.	Content of Advisory	Block level weather forecast and crop management practices
6.	Language of Advisory	Marathi (Local language)
7.	Commodity of Advisory	All crops, animal husbandry, fisheries and allied activities like poultry, goatry.
8.	Management practices	All crops latest management practices

4.4.2 Perception of farmers' on climate change

A total of 44 farmers awareness programs were conducted during 2013-14 at different locations under AICRPAM-NICRA in which 5,012 farmers have participated (Fig. 12).

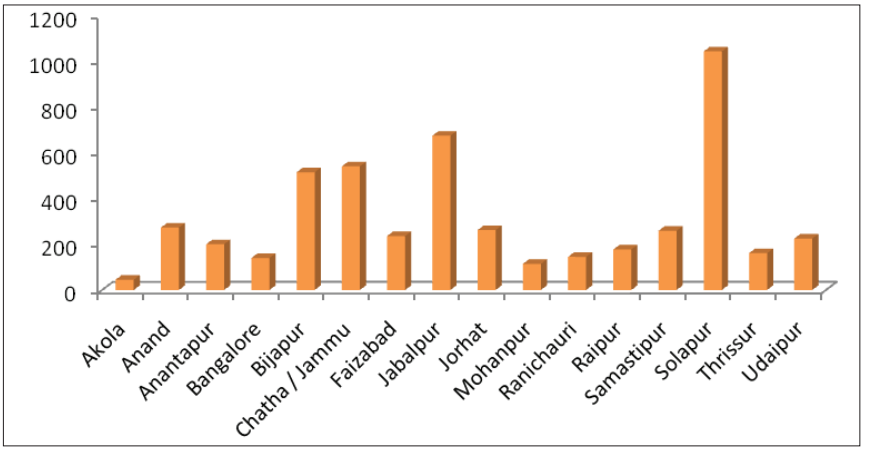

Fig. 12: Participation of farmers (no.) in CC awarness programs at different locations

The perception of farmers of different regions on climate change and related aspects as on date was assessed through a pre-designed questionnaire. The farmers response on different aspects was assessed and there results are reported here:

At Anand, nearly 60 to 98 % of the farmers agreed that monsoon rainfall amount is showing increasing trend. Very few farmers agreed on changes in quantum of monsoon rainfall. Nearly 60 to 80% of the respondent farmers told that heavy rainfall events are showing increasing trend. Two to fifteen per cent of the farmers told that there is no change in heavy rainfall events, whereas less than 5% of the farmers opined that heavy rainfall events are showing decreasing trend. Nearly 40 to 60% of the farmers said that dry spell/drought are showing decreasing

trend. Similarly <5 % of the farmers said that dry spell/drought is showing increasing trend, whereas 10 to 40% of the farmers told that there is no change in dry spell/drought. Nearly 60 to 70% of the respondent farmers told that hail storm events are showing decreasing trend, whereas 10 to 25% farmers told that hailstorm events are showing no change.

At Anantapur, 28.9% of the farmers expressed that October is the month of highest rainfall. 25% of the farmers expressed that June and January months are hottest and coldest months respectively. 35.5% of the farmers opined that summer temperature increased over years. 28.9% farmers said that summer temperature decreased. 63.3% of the farmers did not have any exposure to rainfall and temperature measuring instruments. Only 2% of farmers are aware of raingauge and thermometer.

At Dapoli, about 77% farmers opined that May is the hottest month and 51% farmers opined that there is a late withdrawal of monsoon in recent years. The opinion regarding the usefulness of agromet advisory bulletin in farm operations like plant protection, fertilizer application, sowing/transplanting/seed rate manipulation, water management and harvesting of crops at proper stage was 66.66, 86.66, 80.00, 41.66, 78.33 and 58.33, respectively in the Aasage village.

At Hisar, more than 85 % of selected farmers irrespective of their category perceived that the numbers of rainy days are becoming fewer. More than 90 per cent farmers of the two villages under reference believed that there is an increase of temperature during last couple of years. Around 57 per cent farmers believed in moderate scorching sun making uncomfortable to work in their fields. However, about 68 per cent farmers do not experienced any variations in summer temperature in their region. This number has come down to 60% regarding changes in winter season temperatures.

At Jabalpur, most of the farmers opined that there is a delay in the onset of monsoon. At Jammu, 50% of the farmers agreed that there is a delay in onset of monsoon and it is withdrawing early in recent years. On weather based agromet advisories, 95% of the farmers were aware of the agromet advisories and only 5 percent have heard about them for the first time.

At Mohapur, about 40% farmers opined that there is an increase in frequency of storms and floods (Fig.13).

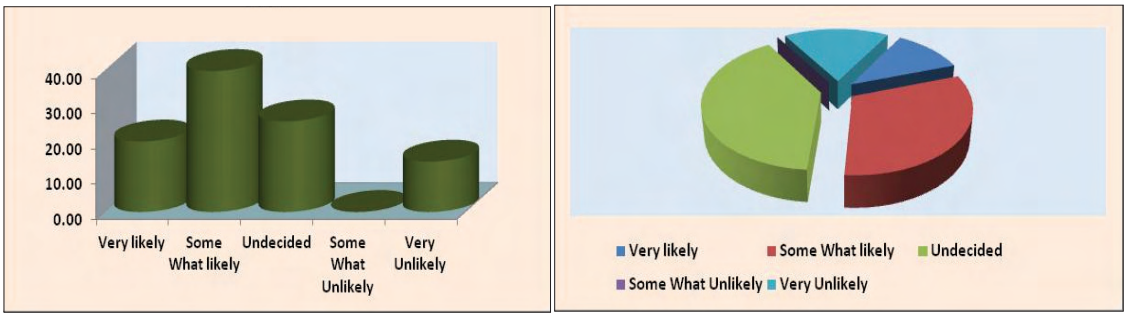

Fig. 13: Division in the opinion of farmers on increase in flood and storm frequency

4.4.3 Success stories of agromet advisories

In Jammu&Kashmir, a progressive vegetable farmer from Sherpur Bala village, Hiranagar Distt., Kathua namely Sri Vishal Sharma S/O GurVillas, (Mobile: 9697544655) got interested in AAS. During Rabi 2013 through Agromet advisory bulletin no.80, it was advised to delay sowing of vegetable pea as rainfall was forecasted in the ensuing week. Mr. Chaman Lal, S/O Milkhi Ram, (Phone no. 09122-239364) from same village is another vegetable grower who didn't follow the advisory and sowed vegetable pea in the adjoining field during first week of October. There was heavy rainfall (144.0 mm) during the first week of October. Mr. Vishal Sharma being a regular follower of the advisory postponed sowing as per the recommendations of the agromet advisory for the next few days. This resulted in comparatively better crop growth and yield in the fields of Mr. Vishal Sharma over the fields of Mr. Chaman Lal.

5.0 Associated activities

5.1 Reclamation of marshy land

At Jorhat, technical assistance was provided to Nirmal Self Help Group (SHG) of Thengal Chowkana fishery (Registration number-208/2010) in the reclamation of a marsh land for fishery cultivation. The marshy land was brought under fish cultivation during the year 2012 with an financial assistance of Rs.15,00,000 from ITDP (Integrated Tribal Development Programme) and technical as well as knowhow and do how support from the agro-met advisory issued to 60 targeted farmers twice a week on Tuesday and Friday, respectively.

5.2 District Level Contingency Plans

In Himachal Pradesh, district level contingency plans for eight districts *viz.,* Hamirpur, Bilaspur, Una, Kangra, Kullu, Sirmaur, Mandi and Lahaul & Spiti DLCPs were prepared by Palampur center and published. A special issue of Parvatiye Khetibari (Quarterly Hindi Magazine by CSK HPKV, Palampur), ISSN 0970-0587, Year 33, July-September, 2013 and Vol. 3, on Climate Change was also published under AICRPAM - NICRA.

6.0 Appendices

6.1 Locations of NICRA-KVKs

AICRPAM Center	Name of NICRA - KVK	District	Block/Thasil/ Mandal	Name of NICRA village
Akola	KVK, Buldhana	Buldhana	Buldhana	1. Yelgaon 2. Devpur
Anand	KVK, Dethali	Kheda	Matar Chakalasi	1. Raghavanaj 2. Nadiad
Anantapur	KVK, Yagantipalle	Kurnool	Banaganapalle	1. Yagantipalle 2. Yarragudi
Bangalore	KVK, Chintamani	Chikkaballapur	Chikkaballapur	1. Patrenahalli 2. Nayanahalli 3. Mylappanahalli
Bhubaneswar	KVK, Bhanjanagar	Ganjam	Ganjam	1. Ekalpur 2. Padampur
Bijapur	Birds KVK, Tukkanatti	Belgaum	Gokak	1. Bailhongal 2. Raibag
Chatha/Jammu	KVK, Kathua	Kathua	Kathua	1. Chhapaki Khurd 2. Sherpur Bala 3. Dhalli
Dapoli	KVK, Deodhe	Ratnagiri	Lanja	1. Haral 2. Assage
Faizabad	KVK, Bahraich	Bahraich	Kaiserganj	1. Rajapur 2. Banpurwa
Hisar	KVK, Sirsa	Sirsa	Sirsa	1. Kharian Panihari 2. Farwain Khurd
Jabalpur	KVK, Chhattarpur	Chhattarpur	Nowgang	1. Chakuda 2. Maanpura
Jorhat	KVK, Khumtai	Golaghat	Kothalguri	1. Thengal Gaon 2. Kachupathar
Kanpur	KVK, Daleepnagar	Kanpur Dehati	Shivrajpur Bill-haur	1. Daleepnagar 2. Saibashu
Kovilpatti	KVK, AC & RI Campus, Madurai	Madurai	Madurai	1. Aylankudi 2. Vavidamaruthur
Ludhiana	KVK, Fatehgarh Sahib	Fatehgarh Sa-hib	Fatehgarh Sahib	1. Badhose Kalan 2. Boranga Zer
Mohanpur	KVK, Ram Krishna	South 24 Para-ganas	Kultali	1. Bongheri 2. Gopalganj
Palampur	KVK, Bara	Hamirpur	Nadavn	1. Mann 2. Treti
Parbhani	KVK, Aurangabad	Aurangabad	Gangapur Au-rangabad	1. Shekta 2. Dhawalapuri
Raipur	Mahasamund	Mahasamund	Mahasamund	1. Jhalkhamaria 2. Malidih
Ranchi	KVK, Palamu	Palamu	Palamau	1. Chianki 2. Sua

Ranichauri	KVK, Ranichauri	Tehri Garhwal	Fakot Chamba	1: Maun 2. Dikholgaon 3. Dargi
Samastipur	KVK, Saraiya	Muzaffarpur	Saraiya	1. Ballisaraiya 2. Bhagwatpur
Solapur	KVK, Baramati	Pune	Baramati	1. Jalgaon 2. Loni
Thrissur	KVK, Malappuram	Malappuram	Malappuram	1. Thavanur 2. Angadippuram
Udaipur	KVK, Rajsamand	Rajasamand	Rajasamand	1:Nakli 2: Bhagwanda

6.2 Staff position

Centre	Agrometeorologist /Jr. Agronomist	Research Associate	Senior Research Fellow
Akola	Dr. Anil Karunakar	Dr. Pradeep Damre	Sri Vishal Chavan
Anantapur	Dr. S.N. Malleswari Sadhineni	Sri V.Dhanujay	Sri B Ramamohan
Anand	Dr. H.R Patel Dr. N.J. Chaudhary	Mss. Bharat. N. Suthar	Sri Dhamresh Prajapati
Bangalore	Dr. M.B Rajegowda/ Dr.N.A. Janardhana Gowda	Sri D.Sridhar	-
Bhubaneswar	Dr. S. Pasupalak	Sri Sanak Mahapatra. B	-
Bijapur	Dr. H. Venkatesh	Sri Jagdeesh R. H	Miss Rajani B. Rajput
Dapoli	Dr. S.T Thorat upto 31st June 2013/ Prof. V.G. Chavan	Sri Mohite N.C	Mr. Burade D.D.
Faizabad	Dr. Padmakar Tripathi/ Dr. A.K. Singh	Sri. Gulab Singh	Sri Arvind Kumar Verma
Hisar	Dr. Diwan Singh	Sri Naresh Kumar. S	Mrs. Mehnaj Tharranum A.
Jabalpur	Dr. Manish Bhan	Sri Rakesh Sharma	Sri Abhishek Sharma
Jorhat	Dr. R. Hussain/ Dr. B. Goswami	Sri Kalyan Kumar. Dutta	Sri Danish Tamuly
Kanpur	Dr. A.P Dubey	-	Sri Ajay Kumar Mishra
Kovilpatti	Dr. A Solaimalai Dr. S. Subbulakshmi	Dr. N. Arun Kumar	-
Ludhiana	Dr. Prabhjyot K. Sidhu Dr. Sandeep Singh Sandhu	-	Sri Sukhpreet Singh
Mohanpur	Dr. Saon Banerjee Dr. Asis Mukherjee	Sri. Agniswar Jha Chakraborty	Sri Monotosh Das Bairagya
Palampur	Dr. Rajendra Prasad	Dr. Anupam Sharma	Miss Sweta Sehgal
Parbhani	Dr. M. G Jadhav	-	Sri M.S. Waghmare
Ranchi	Dr. Ramesh Kumar Dr. Pragyan Kumari	Dr. Bably	Sri Deepak Anuranjan Tirkey

Ranichauri	Dr. R.G. Upadhyay		Sri Sandeep Singh
Raipur	Dr. J.L. Chaudhary	Dr. Praveen Kumar.V	Sri Sandeep Kumar Chandrawanshi
Rakh Dhiansar	Dr. B. C Sharma Dr. Vivak M. Arya	-	Sri Rajeev Sharma
Samastipur	Dr. I.B. Pandey	Sri Manish Kumar	Dr. Irshad Alam
Solapur	Dr. J.D Jadhav	Shri B.T. Jadhav	Shri Ganesh.G. Gadhari
Thrissur	Dr. B. Ajith Kumar	Miss Sreekala P. P	Miss Nimi K.M
Udaipur	Dr. N.S Solanki	-	Sri Gopal Nai

6.3 Budget allocated

S. No	Name of the Centre	Contingency	TA	Total
1	Akola	850000	25000	875000
2	Anand	775000	36000	811000
3	Anantapur	805000	20000	825000
4	Bangalore	1025000	25000	1050000
5	Bhubaneswar	1075000	30000	1105000
6	Bijapur	1100000	23000	1123000
7	Chatha	1070000	40000	1110000
8	Dapoli	800000	28000	828000
9	Faizabad	875000	28000	903000
10	Hisar	725000	25000	750000
11	Jabalpur	800000	12000	812000
12	Jorhat	1100000	60000	1160000
13	Kanpur	1047000	23000	1070000
14	Kovilpatti	875000	33000	908000
15	Ludhiana	1175000	30000	1205000
16	Mohanpur	775000	30000	805000
17	Palampur	1280000	30000	1310000
18	Parbhani	975000	30000	1005000
19	Raipur	975000	35000	1010000
20	Ranchi	750000	28000	778000
21	Ranichauri	800000	25000	825000
22	Samastipur	1000000	20000	1020000
23	Solapur	1225000	40000	1265000
24	Thrissur	1000000	40000	1040000
25	Udaipur	1025000	25000	1050000
Total		**23902000**	**741000**	**24643000**

6.4 Publications

6.4.1 Papers in peer-reviewed journals

1. Bapuji Rao, B., B. Santhibhushan Chowdary, P., Sandeep, V.U.M. Rao., Venkateswarlu, B. (2014). Rising minimum temperature trends over India in recent decades.: Implications for agricultural production. *Global and Planetary Change.,* 117: 1-8.

2. Rao, V.U.M., and Bapuji Rao, B. (2013). Climate change impact on Indian agriculture - Adaptation and mitigation strategies. J. *Res. Punjab agric Univ* 50(3&4): 82-91.

3. Rao, V.U.M., and Bapuji Rao, B. (2013). Role of agromet advisories in climate risk management. *Annals of Agricultural Research* New Series, 34(1): 15-25.

4. B. Bapuji Rao., V. U. M. Rao., Linitha Nair., Y. G. Prasad., A. P. Ramaraj and C. Chattopadhyay. (2013). Assessing aphid infestation in indian mustard (brassica Juncea l.) Under present and future climate scenarios. *Bangladesh Journal Agricultural Research,* 38(3): 373-387

5. B. Bapuji Rao, V.U.M Rao, Linitha Nair, Y.G.Prasad, A.P.Ramaraj and C.Chattopadhyay (2013). Mustard aphid infestation in India: Development of forewarning models. *Journal of Environmental Biology,* Vol. 35, P-P, ISSN: 0254-8704. CODEN: JEBIDP

6. P. Vijaya Kumar, V.U.M. Rao, O. Bhavani, A.P. Dubey, P.K. Sidhu, S.R. Patel and B. Venkateswarlu. (2013). Optimizing sowing dates and selection of varieties of wheat through long-term crop and weather analysis. *Journal of Agrometeorology,*.15 (Special Issue-II): 67-72.

7. Patel, H.R., M.M. Lunagaria., B.I. Karande., Vyas Pandey., S.B. Yadav., A.V. Shah., V.U.M. Rao and S. Nareshkumar. (2013) Impact of projected climate change on groundnut in Gujarat, *Journal of Agrometeorology*, Vol.15, Spl.Issue-I, PP 41-44.

8. Prasad, Y.G., M. Gayathri., M. Prabhakar., P. Jeyakumar., S. Vennila., A.V.M. Subba Rao., I. Bhaskara Rao., K.V. Rao., G. Ramachandra Rao and V.U.M. Rao. (2013). Population dynamics of Spodoptera litura outbreak on soybean vis-a-vis rainfall events, *Journal of Agrometeorology*, Vol.15, Spl.Issue-I, PP 37-40.

9. Pratyusha Kranthi, K.V. Rao, J.V.N.S. Prasad, Rajbir Singh and V.U.M. Rao. (2013). Spatial and temporal assessment of net primary productivity for Andhra Pradesh using MODIS data. *Journal of Agrometeorology*.15 (Special Issue-II): 188-193.

6.4.2 Technical and research bulletins

1. Patel, H.R., M.M. Lunagaria, Vyas Pandey, P.k. Sharma, B. Bapuji Rao and V.U.M. Rao. 2014. El Nino episodes and agricultural productivity in Gujarat. Tech. Bul: 01/2014-15. NICRA-AICRPAM and Centre for Weather Forecasting and Climate Change, AAU, Anand.22pp.

2. Anirudh Prasad Dubey, M.P. Yadav., Naushad Khan, C.B. Singh and V.U.M. Rao. (2013). Farmers Awareness Programme on Climate Change in Central Uttar Pradesh. AICRPAM Tech. Bul. No. 1/2013. AICRP on Agrometeorology, Agronomy, C.S.A. University of Agriculture & Technology, Kanpur. PP.24.

3. Jadhav,J.D., S.B. Thorve, A.V. Bhore, J.R. Kadam, V.R. Bavadekar, S.K. Upadhe, V.U.M.Rao and D.B. Bhanvase. (2013). Agro-Met Advisory A success story. MPKV/RES/PUB.NO./78/2013. AICRPAM-NICRA MPKV Rahuri, ZARS, Solapur.

4. Gaikwad,U.s., J.D. Jadhav, J.R. Kadam and V.U.M. Rao. (2013). Climate Change Impacts on Dairy Animals. MPKV/RES/PUB.No./79/2013. AICRPAM-NICRA, MPKV, Rahuri.

5. Solaimalai,A., S. Subbulakshmi, D. Jawahar and V.U.M. Rao. (2013). Farmer's awareness manual on Climate Change Impact on Agricultural and its Management. ARS, Kovilpatti p.25. (in Tamil).

6. Rajendra Prasad, G.Ravindra Chary, K.V. Rao, Y.G. Prasad., Ch. Srinivasa Rao, D.B.V. Ramana, N.K. Sharma, V.U.M. Rao and B. Venkateswarlu. (2013). District Level Contingency Plans for Weather Aberrations in Himachal Pradesh.CSK HPKV, Palampur, HP & Central Research Institute for Dryland Agriculture. Hyderabad-500 059, India. P.222.

7. Khushu, M.K., Sanjay Koushal., Rajeev Sharma., Charu Sharma., V.U.M.Rao and B.Bapuji Rao. (2013). Weather Based Decisions for Cultivation of Kharif Maize crop in Jammu Region (Technical Bulletin-2) 2013. Agromet Research Centre, Sher-e-Kashmir, University of Agricultural Sciences and Technology- Jammu, J&K.

8. Khushu, M.K., Rajeev Sharma,, Sanjay Koushal,, Charu Sharma and V.U.M.Rao, and B.Bapuji Rao. (2013). Agroclimatic Atlas of Jammu Province (Technical Bulletin-1). Agromet Research Centre, SKUAST- J, Chatah, Jammu.96p.

9. Sthool, V.A., S.K. Upadhaye., J.D. Jadhav., V.U.M.Rao., R.V. Sanglijkar and J.R. Kadam. (2013). Farm Pond – A Boost for Sustainability in Dryland under Climate Change Situation.MPKV/Res.Pub. No. 80/2013.

10. Venkatesh,H., R.B. Rajput., S.B. Nashi., J.R. Hiremath., S,N. Kulkarni., B.Bapuji Rao and V.U.M.Rao. (2013). Farmer, Weather & Climate: Perception of Farmers on Climate and Agriculture. National Initiative on Climate Resilient Agriculture AICRP on Agrometeorology, Technical Bulletin-3, Regional Agricultural Research Station Bijapur, University of agricultural Sciences, Dharwad, Karnataka.

6.4.3 Popular articles

1. Bapuji Rao, B., Rao, V.U.M. Rao, and A.V.M.Subba Rao. (2014). El-Nino-Andhra Telangana rashtrala vyvasayarangaani prabhavitham chaiyanundha? Raythunestham (Agriculture Monthly magazine May.2014. 41-44.

6.4.4 Presentations in National/International conferences/symposia/seminars

1. Raju, B.M.K., C.A. Rama Rao, K.V. Rao, B. Venkateswarlu, Josily Samuel, D. Ravi, A.V.M. Subba Rao, G.R. Maruthi Sankar, Md Osman, K. Ravi Shankar, K. Nagasree, K.A. Gopinath and N. Swapna. Unreaped yield potential in maize in India. International Year of Statistics 2013. Stat 2013. Socio-Economic Challenges and Sustainable Solutions, December 28-31, 2013. Book of Abstracts. Jointly organized by AIMSCS and University of Hyderabad. p. 151

2. Raju, B.M.K., C.A. Rama Rao, K.V. Rao, A.V.M. Subba Rao, B. Venkateswarlu, G.R. Maruthi Sankar and N. Swapna. Identification of sources of productivity growth in sorghum – A multivariate clustering approach. 67th Annual Conference of Indian Society of Agricultural Statistics, December 18-20, 2013. Department of Farm Engineering, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi

3. Rama Rao, C.A., B.M.K. Raju, Josily Samuel, Ravi Dupdal, D. Yella Reddy, A.V.M.S. Rao, V.U.M. Rao and B. Venkateswarlu (2014). Vulnerability of Pigeonpea yields to climate change in India – A panel data regression approach. International Conference on Climate Change and Sustainable Development Global Perspective. Organized by Institute of Public Enterprise, Osmania University Campus, Hyderabad. February 20-21, 2014

4. Raju, B.M.K., C.A. Rama Rao, K.V. Rao, B. Venkateswarlu, Josily Samuel, Ravi Dupdal, A.V.M. Subba Rao, G.R. Maruthi Sankar, Md Osman, K. Ravi Shankar, K.A. Gopinath, M. Srinivasa Rao and N. Swapna (2014). 2nd International Conference on Agricultural & Horticultural Sciences. Unreaped yield potential in cotton in India. Agrotechnol 2014. OMICS Group Conferences. February 3-5, 2014. Vol..2, Issue 4. http://dx/doi.org/ 10.417/2-168/9881. S1.007

5. Rama Rao C.A., B M K Raju, A V M Subba Rao, K V Rao, V U M Rao, Kausalya Ramachandran, B Venkateswarlu and A K Sikka.(2014) Assessment of Vulnerability Indian Agriculture to Climate Change. National Seminar on “Climate Change – Crop Improvement and Management Strategies for Food Security on 25 March 2014 at Agricultural College, Bapatla

6.4.5 Software developed

Bapuji Rao B, Raju BMK, Rao VUM, Rammohan I, Pramod VP, Sandeep VM, Santibhushan Chowdary P and Ravi Kumar N. 2014. **Relator v1.0**, CRIDA, Hyderabad.

Glimpses of climate change awareness programs







Ways in the dissemination of agromet advisories

Field demonstrations

Visit to agromet observatory




Installation of raingauge and mini-observatory in NICRA villages



University of Agricultural Sciences, Dharwad
Indian Council of Agricultural Research, New Delhi
Annual Review Meet: 2012-13
Date : 16-17 Sep., 2013

Central Research Institute for Dryland Agriculture

Santoshnagar, Hyderabad - 500 059