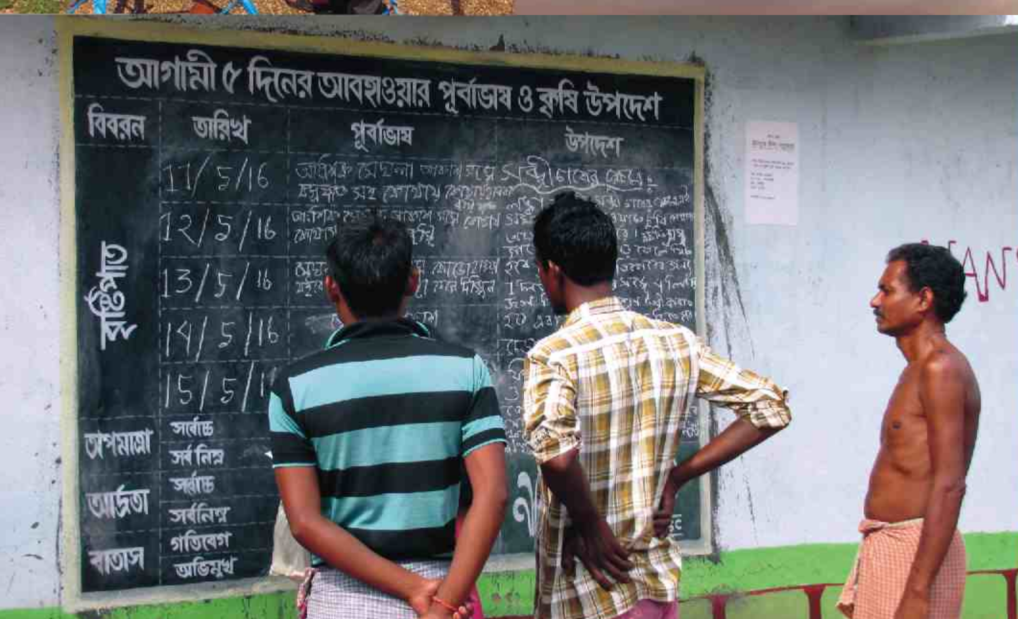
Technical paper on

Weather and Agro Advisory Services to Farmers and Its Benefits



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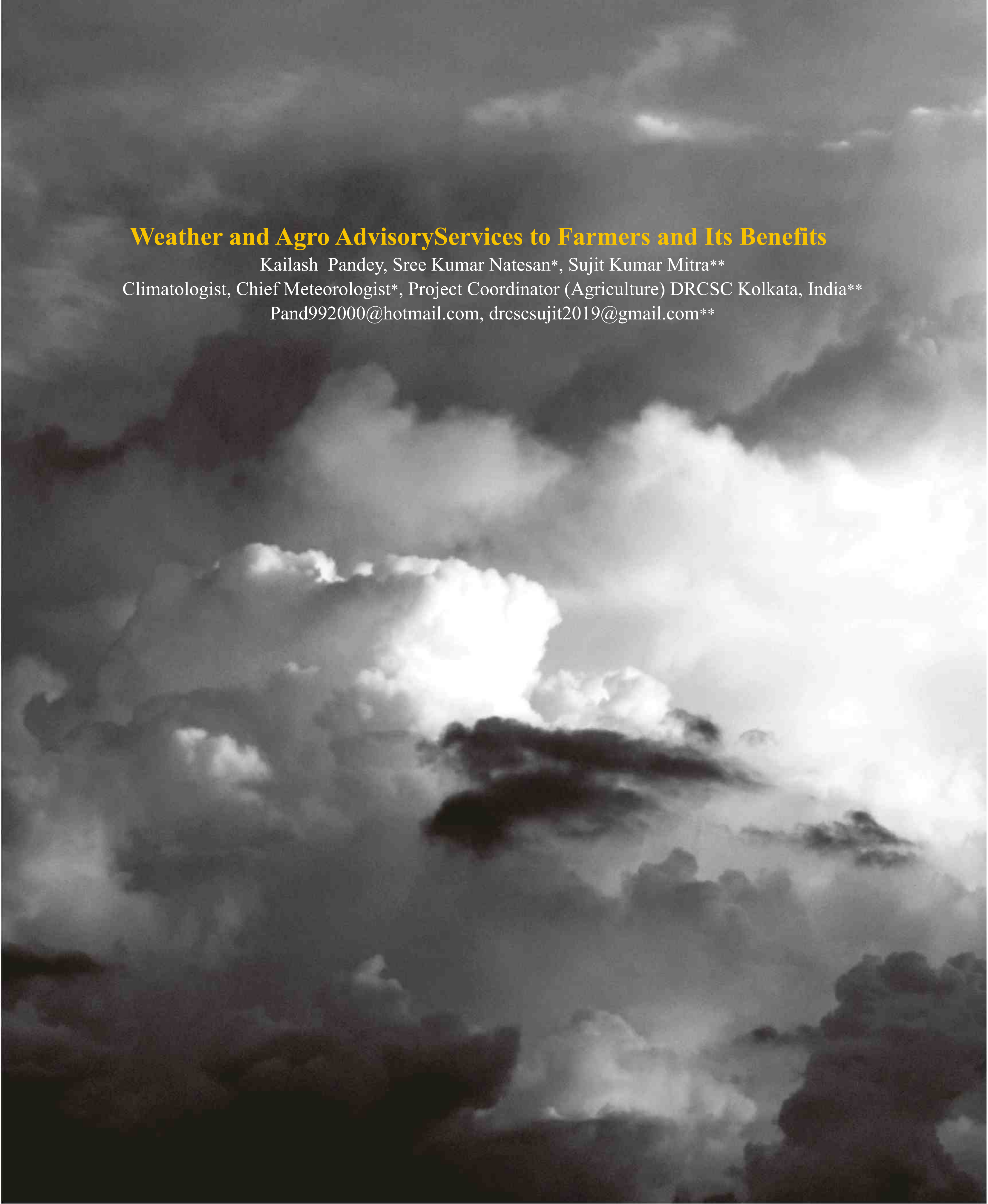

June 2019

Author Kailash Pandey, Sree Kumar Natesan, Sujit Kumar Mitra

Layout and Cover Design Abhijit Das & Team

Photos DRCSC staff

Acknowledgements:

Author is grateful to the Adaptation Fund Board and NABARDfor the support to carry out this study. Thanks are also due to Shri MithunMondol and the Climate Volunteers for theirsupport in providing regular information to farming community and valuable support during the entire study. Special thanks to Dr. Ajay Singh for critical review.

DRCSC

Published by
Ardhendu S Chatterjee, Secretary
Development Research Communication and Services Centre
58A Dharmotala Road, Bosepukur, Kasba, Kolkata 700 042
Phone: 033 91 2442 7311 | Email: drcsc.ind@gmail.com | www.drcsc.org

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Abstract: This study estimates the benefits that Indian farmers derive from agriculture and weather information delivered to their mobile phones by DRCSC. Climatologist conducted a controlled randomized experiment of 40 villages in Purulia and Bankura districts of West Bengal. The farmer's associate information with a number of decisions they make, and we find some evidence that treatment affected spatial arbitrage and crop grading. But the magnitude of these effects is good. We find statistically significant average (12.5-35 %) effect of this information on the crops and input cost reduced by farmers, crop value-added, crop losses resulting from rainstorms, or the likelihood of changing crop varieties and cultivation practices. The purpose of this study is to ascertain whether agricultural and weather information distributed through mobile phones generates economic benefits to farmers. We implement a randomized controlled trial of DRCSC offered by the largest and best-established private provider of agricultural weather information in West Bengal at the time of the experiment. Operating in West Bengal DRCSC distributes weather, and crop advisory information through SMS messages. We offered free subscription to a random sample of farmers to test whether they obtain higher yield for their agricultural product using this information. Results are satisfactory.

Key Words: Weather, Framers, Benefits, Climate, Agriculture, Input cost

Introduction

Climate change could hurt farmers' income by up to 20%-25% in the medium term, according to the India government latest annual economic survey. Extreme weather events, temperature rise and lower rainfall all threaten to derail the India government's agenda of doubling farmers' income across the country[1].

Agriculture is central to Indian economy. It accounts for 50% of the country's employment and 18% of its GDP. And in India about 80% of farmers are small land holders – which is generally considered to mean they have two hectares or less of land. The main crops are wheat, maize, rice, millets, pulses, sugarcane and oil-seeds[2].

Climate change trend in the recent India Meteorological Department report shows that average temperatures are rising across the country and annual rainfall is declining. It also shows a rise in the number of days with extremely high temperatures and a corresponding decline in the number of days with low temperatures[3].

Extreme temperature shocks, when a district is significantly hotter than usual, results in a 4.7% decline in agricultural yields. Similarly, when it rains significantly less than usual there is a 12.8% decline. Areas lacking in irrigation are worst affected by these extreme weather conditions. A temperature shock in an area that is not irrigated reduces yields by 7.6%. Similarly, the effects of extreme rainfall shocks are 14.7% higher in areas without irrigation much larger than the effects these shocks have in irrigated districts[4]

Lower yields mean lower incomes for farmers. The report estimated that extreme temperature shocks will reduce farmers' incomes by 4.3% and extreme rainfall shocks will reduce incomes by 13.7%. In a year where temperatures are 1! higher, farmers' incomes would fall by 6.2% in unirrigated districts. Similarly, in a year when rainfall levels were 100mm less than average, farmers' incomes would fall by 15%[5]. Temperatures in India are likely to rise by 3! to 4! by 2100[6]. It follows that in the absence of any adaptation by farmers, farm incomes will be lower by 20 to 25% on average in the coming years, especially in the unirrigated areas.[7]

Weather and climate are some of the biggest risk factors impacting on farming performance and management. Extreme weather and climate events such as severe droughts, floods, or temperature often shocks the farming community leading to decline in agricultural production, particularly in arid and semiarid zones. Factors such as excessive rainfall variability and large change in temperature contribute to the vulnerability of individual farms, as well as on whole rural communities.

In addition, farmers are expected to manage the more insidious effects of long term climate change that may now be occurring at an unprecedented rate. These existingpressures will demand the development and implementation of appropriate methods to address issues of vulnerability to weather and climate.

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[1]Indian Annual Economic Survey 2016-17
[2]Indian Council of Agriculture Research
[3]India Meteorological Report 2015 "Climate Change Trend India"
[4]National Council of Applied Economic Research (NCAER) 2015 report
[5]Climate Change and Agriculture 2014
[6]Chaturvediet.al.2012
[7]International Journal of Scientific and Research Publications, Volume 4, Issue 4, April 2014 1 ISSN 2250-3153

These will be need to assist farmers to further develop their adaptive capacity with improved planning and better management decisions. More effective approaches to delivery of climate and weather information to farmers through participatory, cross disciplinary approach is being carried out through enhancing awareness of information user groups.

For effective planning and management of agricultural practices such as selection of cultivar, sowing, need-based application of fertilizer, pesticides, insecticides, efficient irrigation and harvest, weather forecasts in all temporal ranges are desirable. Weather forecast in short and medium ranges greatly contribute towards making short-term adjustments in daily agricultural operations which minimize losses resulting from adverse weather conditions and improve yield and quantity and quality of agricultural productions[8].

Broad Spectrum of WeatherAdvisory

Growing weather and climate uncertainties pose a major threat to India's food security. The combination of long term changes and greater frequency of extreme weather events are likely to have an adverse effect on food production in the coming decades. In this regard agro meteorological services, an innovative step meant to contribute to weather information-based crop/livestock management strategies and operations dedicated to enhancing crop production by providing real time crop and location specific agro-meteorological services with a village level outreach. So a mechanism was developed to integrate weather forecast, climatic and agro-meteorological information to prepare agro advisory for enhancing farm productivity in the intervention areas. Weather information should reach the last mile to create impact, enough information. There is a great need to convert the weather information into actionable information for farmers. Linking the weather information with the available technologies and best farming practices is required. Customized, location and crop specific actionable information is the requirement of the small farmers. Theagro met advisory available has avery limited access to farmers, and very generic in nature, not so specific. Considering challenges of small farmers, the broad spectrum of agro met advisory is to make it more easily accessible its advantages are as follows.

1. Helps in enhanced preparedness and thereby increased adaptive capacity
2. Sowing/ transplanting of kharif crops based on onset of monsoon.
3. Fertilizer application based on wind conditions.
4. Delay in fertilizer application based on intensity of rain
5. Irrigation at critical stage of the crop.
6. Quantum and timing of irrigation using meteorological threshold.
7. Advisories for timely harvest of crops
8. Location specific block level weather advisories
9. Prepared in local language (Bengali & Olchiki) and send by text messages
10. Suggest measures to minimise the loss
11. Optimise input in irrigation, fertiliser or pesticides.
12. Early warning function
13. Alerting the implications of various weather events likeextreme temperatures, heavy rains, floods, and strong winds.

[8] Agro Meteorological Services of India Met Department

Climatology of Intervention Areas

Weather and climate of the district is mainly influenced by its continental location, undulating terrain with residual hills, and porous soil with very poor moisture retentive capacity and absence of large water bodies or perennial rivers. In a general term the climate of the district may be called 'tropical sub-humid continental with prolonged dry season. Mean annual rainfall of this area is 1324 mm with standard deviation 259.5. Coefficient of variation is 19.46%, where as monsoon contributes 79-80 percentage of its annual rainfall i.e.1052 mm. Mean rainy days over the area is 75 days. Mean annual maximum temperature is 32.3 °C and mean annual minimum temperature is 21.5 °C. Annual rainfall of last 6 years shows no significant change. Whereas annual mean maximum temperature and annual mean minimum temperature is showing increasing trend in last 20 years. Significant increasing trend has been found in heavy rainfall episode. It has been also observed that, number of days with maximum temperature 40 °C or more is also increasing. There is a significant increase in thunderstorm days. Overall climate is highly variable. During last 10 year extreme maximum temperature was 46.1 °C, recorded on 04 June 2012. Ever recorded rainfall in 24 hours over the area is 354.3 mm on 05 Aug 2018, which has surpassed all the previous record. Previous record was 282.7 mm on 03 July 1922.

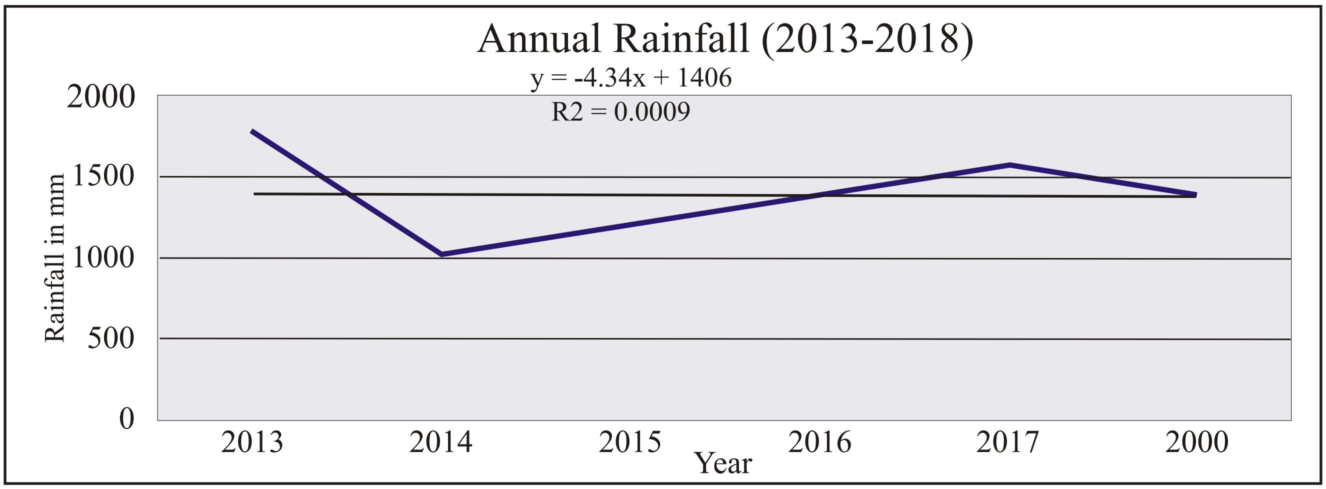


Fig : 1

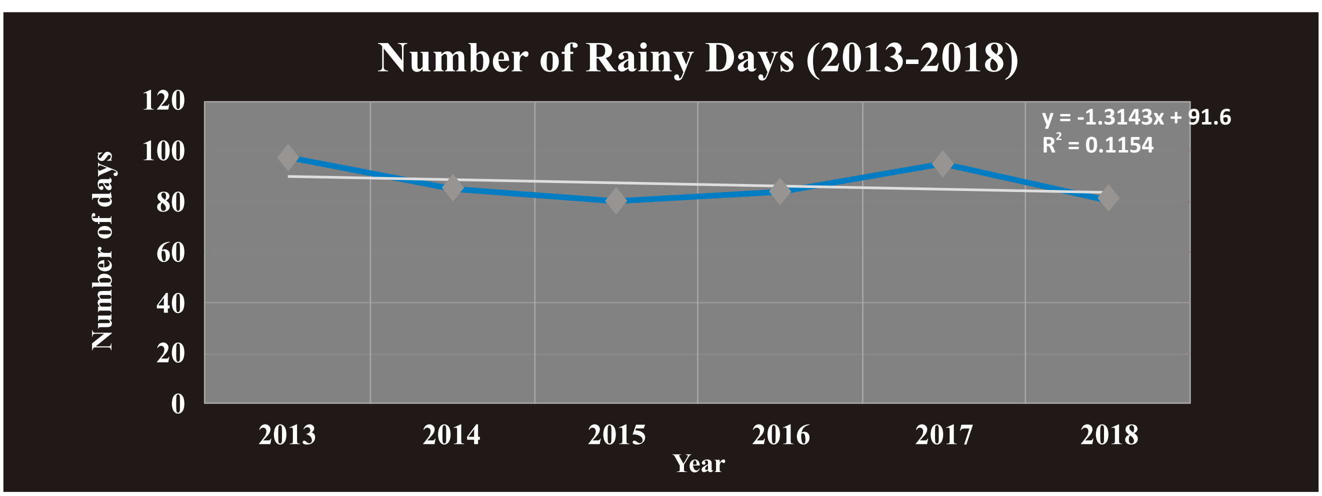


Fig - 2

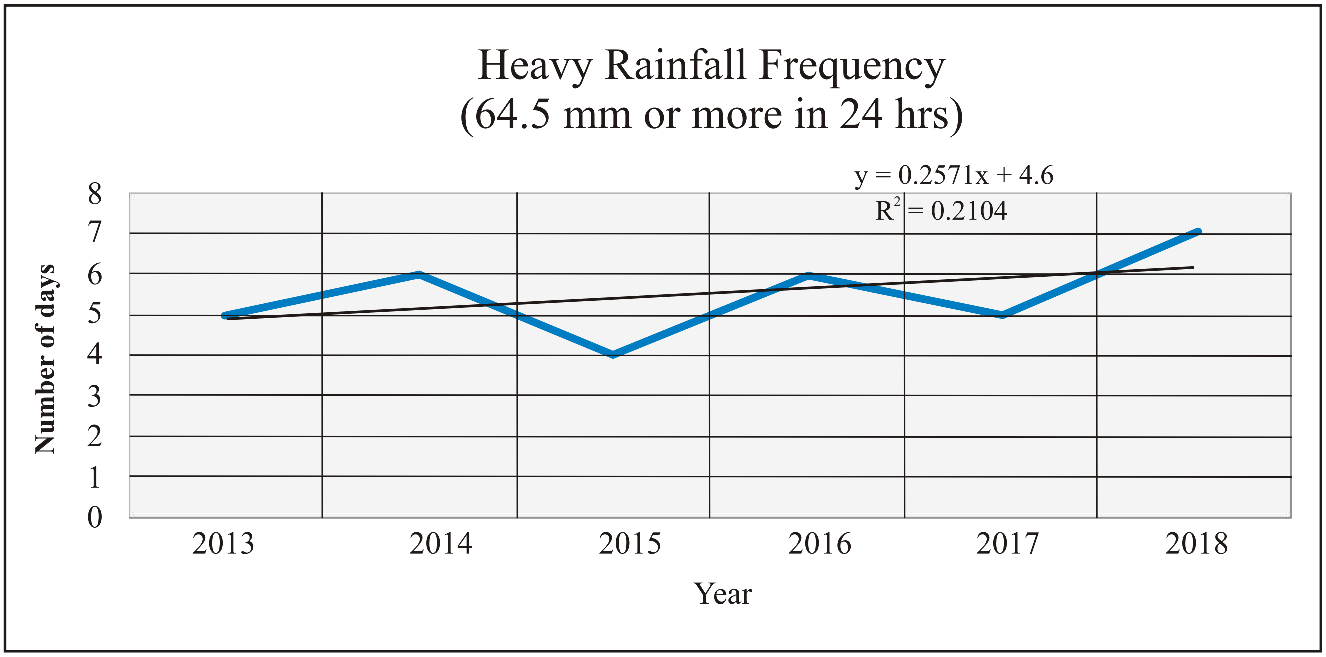

Heavy Rainfall Frequency
(64.5 mm or more in 24 hrs)
y = 0.2571x + 4.6
R^2 = 0.2104
Number of days
8
7
6
5
4
3
2
1
0
2013
2014
2015
2016
2017
2018
Year

Fig - 3

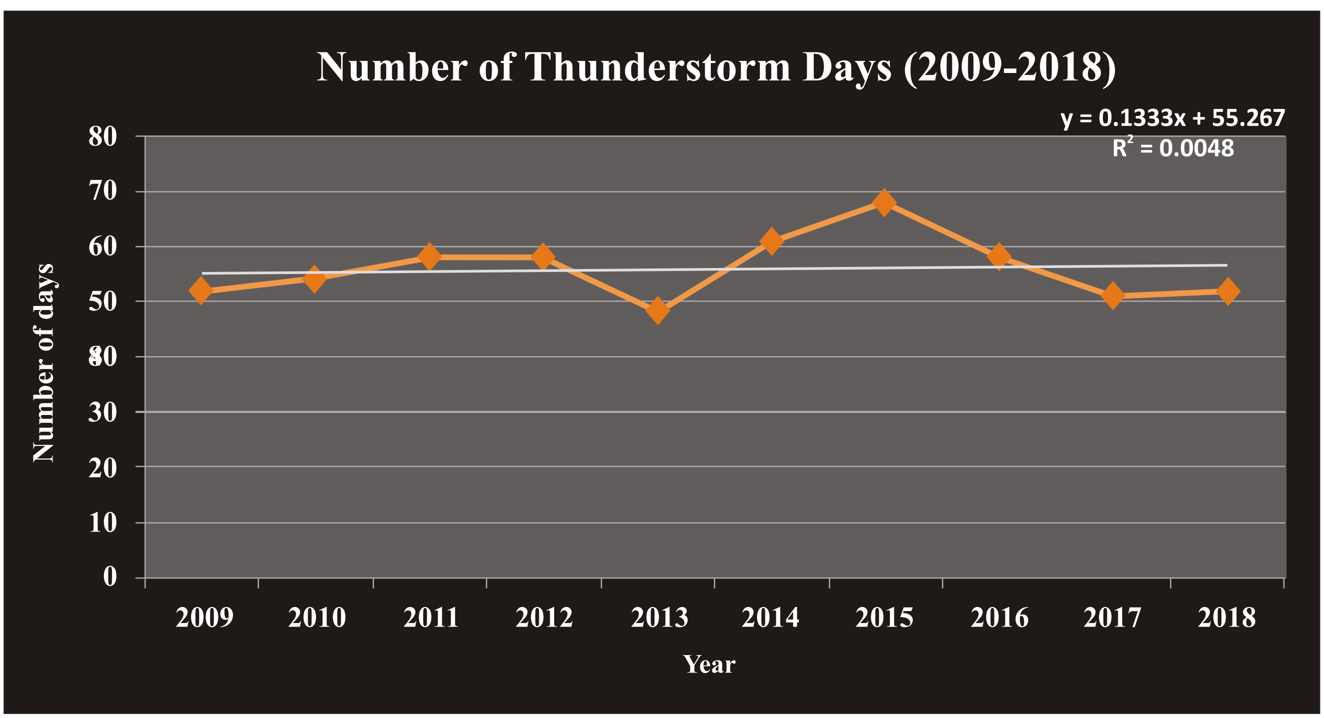

Number of Thunderstorm Days (2009-2018)
y = 0.1333x + 55.267
R^2 = 0.0048
Number of days
80
70
60
50
40
30
20
10
0
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
Year

Fig - 4

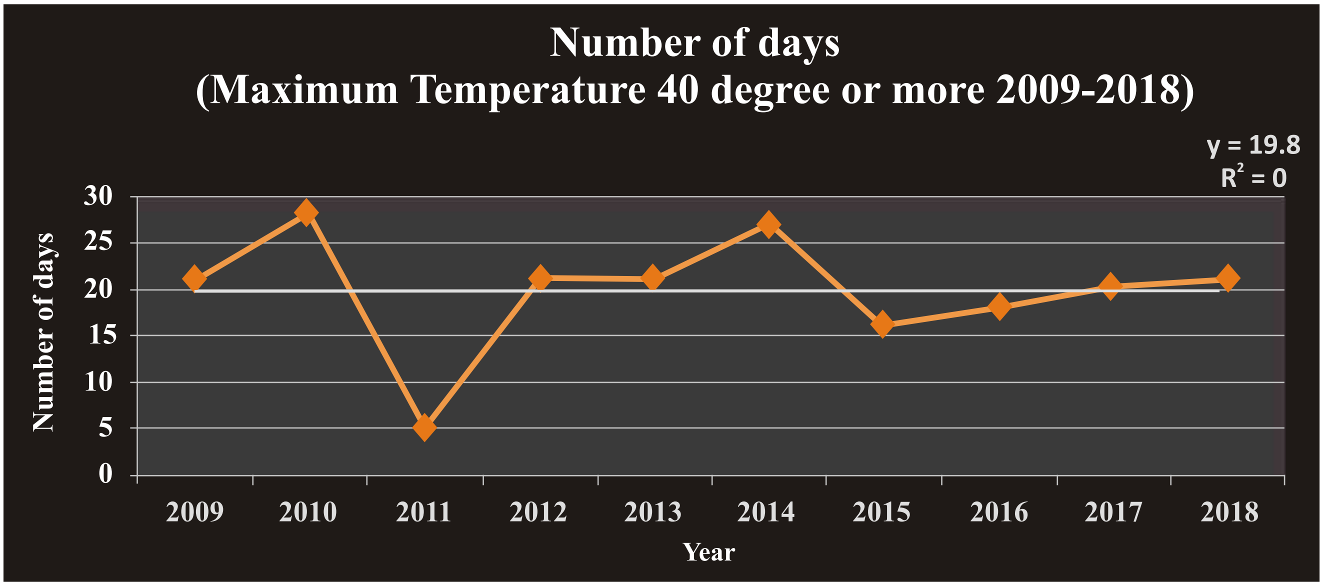
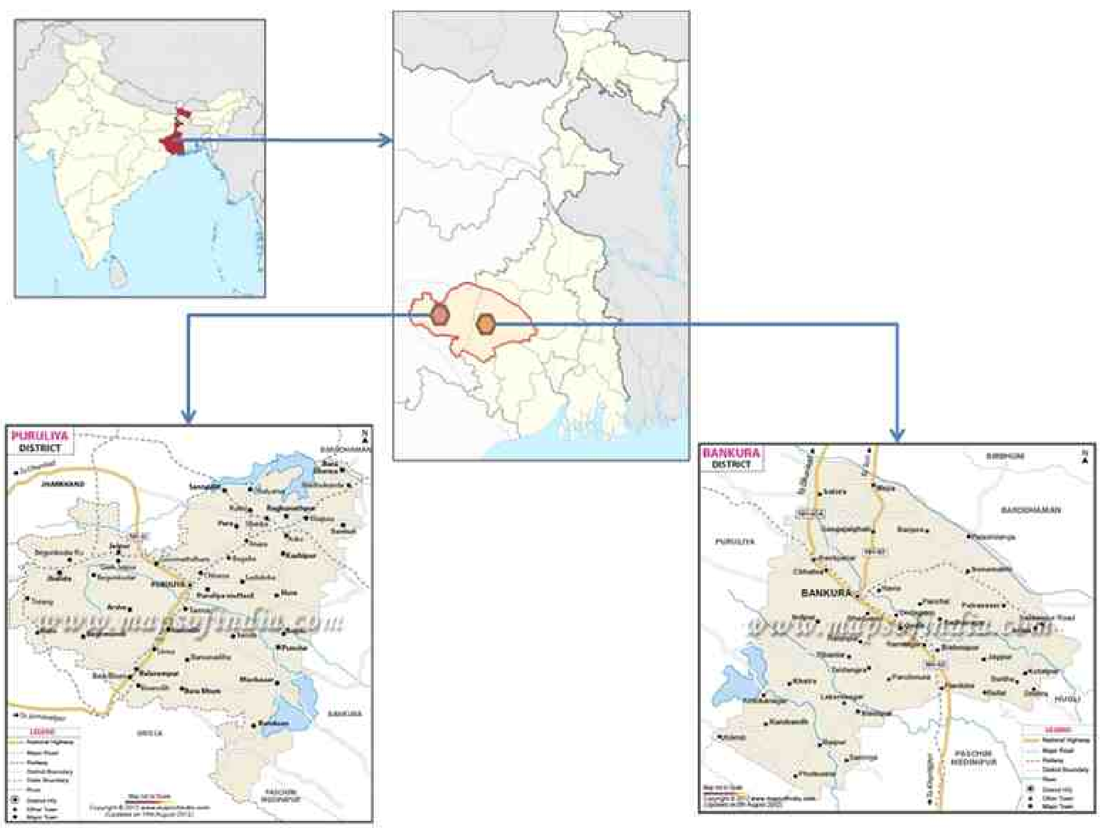


Fig -5

Objective

1. To inform and guide the farmers in advance to undertake various farming activities based on the expected weather in the intervention areas to reduce losses and lowering input costs in agriculture.



Map.1 Intervention Area of West Bengal

Methods

To meet the mentioned objectives, DRCSC has established Six Automatic Weather Station and 12 rain gaugeswith conventional forecasting system and WRF weather model for assimilation and forecasting System. This mainly consists of three components i.e. (i) Data Processing, (ii) Quality Control, (iii) Objective Analysis.The final local weather forecast for the surface weather parameters is obtained by using information from weather model and the prevailing synoptic situation around the location of interest. On the basis of weather forecast crop advisory obtained from Agriculture University and suggested by in house agriculture expert for five days is also included in the services. Value addition to crop advisory is added by this organization. We promote low external input agriculture based on ecological principle.

Weather Research and Forecasting Model

The Weather Research and Forecasting (WRF) Model is a next-generation mesoscale numerical weather prediction system designed for both atmospheric research and operational forecasting applications. It features two dynamical cores, a data assimilation system, and a software architecture supporting parallel computation and system extensibility. The model serves a wide range of meteorological applications across scales from tens of meters to thousands of kilometres. The effort to develop WRF began in the latter part of the 1990's and was a collaborative partnership of the National Center for Atmospheric Research (NCAR), the National Oceanic and Atmospheric Administration (represented by the National Centers for Environmental Prediction (NCEP) and the (then) Forecast Systems Laboratory (FSL).

For researchers, WRF can produce simulations based on actual atmospheric conditions (i.e., from observations and analyses) or idealized conditions. WRF offers operational forecasting a flexible and computationally-efficient platform, while reflecting recent advances in physics, numeric's, and data assimilation contributed by developers from the expansive research community. WRF is currently in operational use at NCEP and other national meteorological centers as well as in real-time forecasting configurations at laboratories, universities, and private companies.

WRF has a large worldwide community of registered users (a cumulative total of over 39,000 in over 160 countries), and there are workshops and tutorials on it each year at NCAR. The WRF system contains two dynamical solvers, referred to as the ARW (Advanced Research WRF) core and the NMM (Nonhydrostatic Mesoscale Model) core. The ARW has been developed in large part and is maintained by NCAR's Mesoscale and Microscale Meteorology Laboratory.

Model Summary

This model is fully compressible Euler non hydrostatic equations with hydrostatic option, scalar-conserving flux form for prognostic variables and complete Coriolis and curvature terms. Nesting is one-way, two-way with multiple nests, moving nests and mass-based terrain following coordinate, vertical grid-spacing can vary with height. Mapping to Sphere, 3 map projections are supported for real-data simulations (Curvature terms included), polar stereographic, Lambert-conformal; Mercator. Arakawa C-grid staggering, Runge-Kutta 2nd and 3rd order time step options.

2nd to 6th order advection options (horizontal and vertical). Positive-definite advection option for moisture, scalar and TKE. Time-split small step for acoustic and gravity-wave modes, lateral boundary conditions, idealized cases, periodic, symmetric, and open radiative. Real cases are specified with relaxation zone and full physics options for land-surface, PBL, radiation, microphysics and cumulus parameterization. Latest version of this model includes real-data and idealized simulations. Various lateral boundary condition options for both real-data and idealized simulations and full physics options. Non-hydrostatic and hydrostatic (runtime option). The model is one-way, two-way nesting and moving nest along with applications ranging from meters to thousands of kilometres.

Boundary Conditions:

Initial Conditions: Three dimensional for real-data, and one, two- and three-dimensional using idealized data. A number of test cases are provided.

Top Boundary Conditions: Gravity wave absorbing (diffusion or rayleigh damping). w = 0 Top boundary condition at constant pressure level.

Bottom Boundary Conditions: Physical or free-slip.

Lateral Boundary Conditions: Idealized cases, periodic, open lateral radiative, and symmetric and in real cases specified with relaxation zone.

Model Physics:

Microphysics: Cumulus parameterizations.
Surface physics. Planetary boundary layer physics. Atmospheric radiation physics.

Microphysics (mp_physics):

Kessler scheme: A warm-rain (i.e. no ice) scheme used commonly in idealized cloud modelling studies (mp_physics)

Lin et al. Scheme: A sophisticated scheme that has ice, snow and graupel processes, suitable for real-data high-resolution simulations.

WRF Single-Moment 3-class scheme: A simple efficient scheme with ice and snow processes suitable for mesoscale grid sizes.

WRF Single-Moment 5-class scheme: A slightly more sophisticated version of the previous that allows for mixed-phase processes and super-cooled water.

Eta microphysics: The operational microphysics in NCEP models. A simple efficient scheme with diagnostic mixed-phase processes.

WRF Single-Moment 6-class scheme: A scheme with ice, snow and graupel processes suitable for high-resolution simulations.

Thompson et al. scheme: A new scheme with ice, snow and graupel processes suitable for high-resolution simulations.

Cumulus Parameterization (cu_physics):

Kain-Fritsch scheme: Deep and shallow convection sub-grid scheme using a mass flux approach with downdrafts and CAPE removal time scale (cu_physics = 1).

Betts-Miller-Janjic scheme: Operational Eta scheme, column moist adjustment scheme relaxing towards a well-mixed profile.

Grell-Devenyi ensemble scheme: Multi-closure, multi-parameter, ensemble method with typically 144 sub-grid members.

Old Kain-Fritsch scheme: Deep convection scheme using a mass flux approach with downdrafts and CAPE removal time scale.

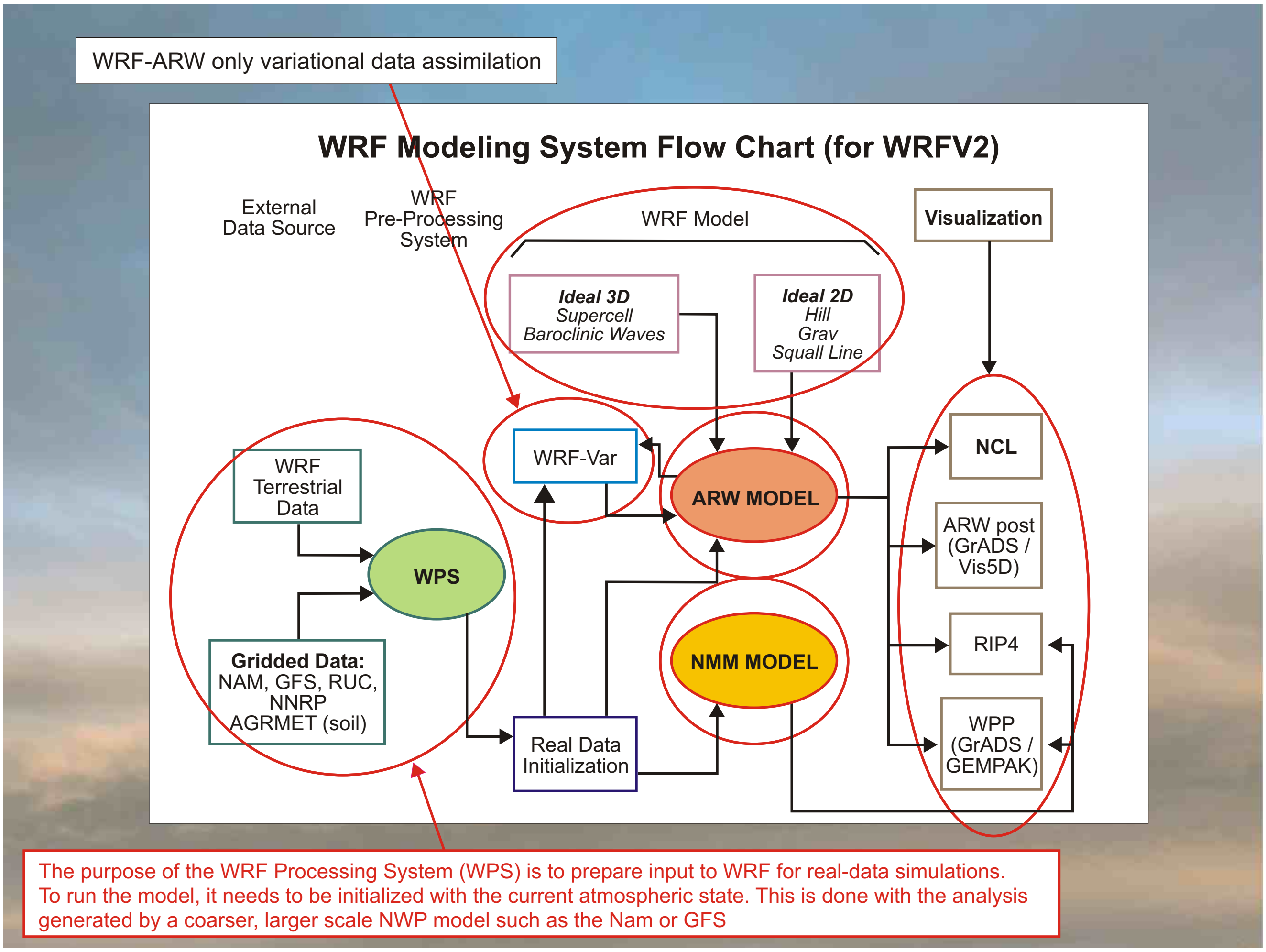


Fig - 6

Process Mechanism

Step.1: Collection of weather data and synoptic situation from the available sources and this weather data/information and their departure from normal value at different temporal and spatial scale is useful information for preparation of weather advisories.

Step.2: In view of DRCSC generating the meteorological products at block level on five days' basis, for the parameters temperature (maximum temperature, minimum temperature, and diurnal temperature variation), maximum and minimum relative humidity, cloud and wind direction/speed, rainfall with the help of mathematical model (WRF) and conventional forecasting system. On the basis of weather forecast crop advisory obtained from Agriculture University and suggested by in house agriculture expert for five days is also included in the services. Value addition to crop advisory is added by this organization.

Step.3: These advisories are location specific (block level) and advisories prepared in local language (Bengali) containing description of prevailing weather and suggestions for taking appropriate measures to minimize the loss and also, optimize input in the form of irrigation, fertilizer or pesticides. The advisories also served as an early warning function, alerting producers to the implications of various weather events such as extreme temperatures, heavy rains, floods, and strong winds. These advisories are disseminated through text messages to farmers, field staff and motivator on their mobiles. Field staff further explores this information on a display board which is placed at village resource center and farmers field school so that whole village will be able to get this advisory.

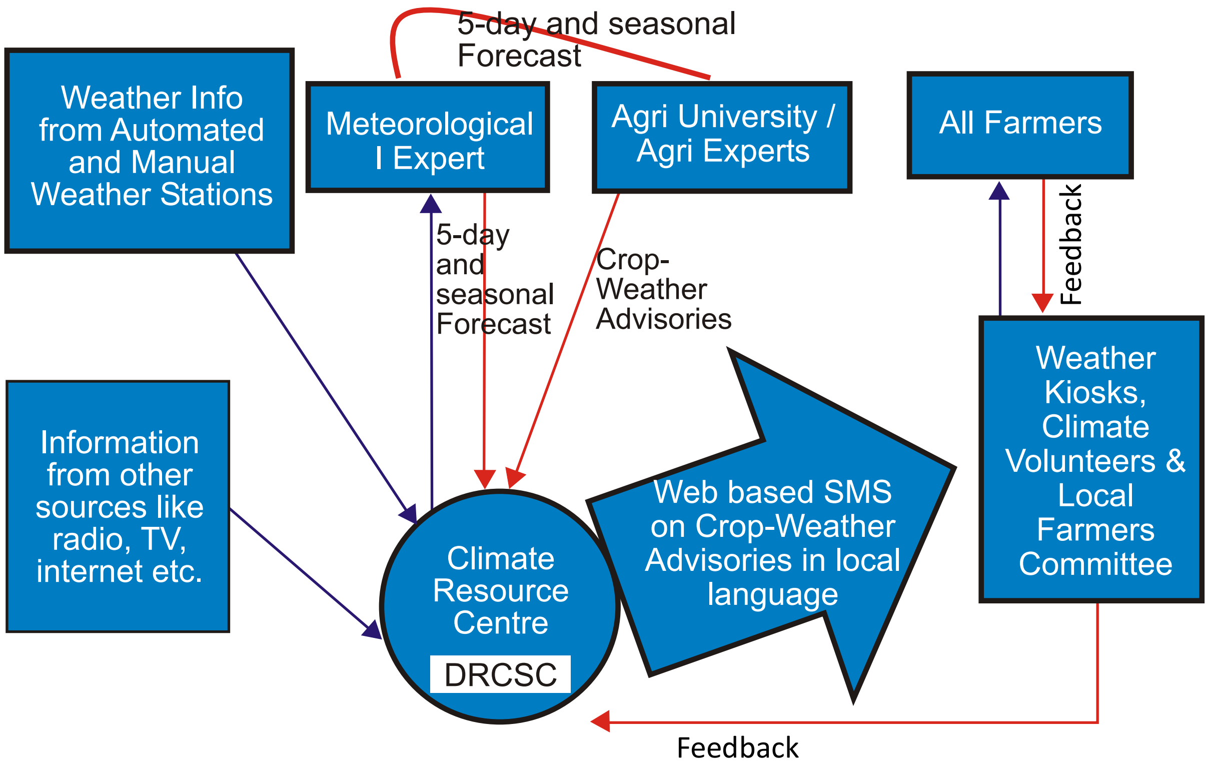


Fig - 6

Feedback & Awareness of Weather Services

In order to improve the quality of the weather and agro advisory services, regular direct interactions are being made by the Project Officers/Climatologist of this organization with the farmers. They have been regularly participating in Farmers Field School and farmer's gatheringsetc. to interact with the farmers personally and collect the feedback from farmers. Using this information farmer plan their agricultural activity and benefit from expenses on irrigation, pesticides, harvesting, sowing etc.

DRCSC also creates awareness about usefulness of weather/climate information, agro met advisory services among the farming community. It is a participatory perception where farmers are involved at data collection, recording, dissemination and feedback process.

- Periodic feedback on worthiness of forecast and usefulness
- Feedback is obtained weekly, monthly & annually.

- Documentation on whether farmers have adjusted day-to-day farming ops in response to the advice
- Annual review meetings held at different locations


Fig.8. Project staff recording AWS data


Fig.9. AWS maintained by villager


Fig.10.Information dissemination through display board in village by farmer


Fig.11. Information dissemination at farmer field school

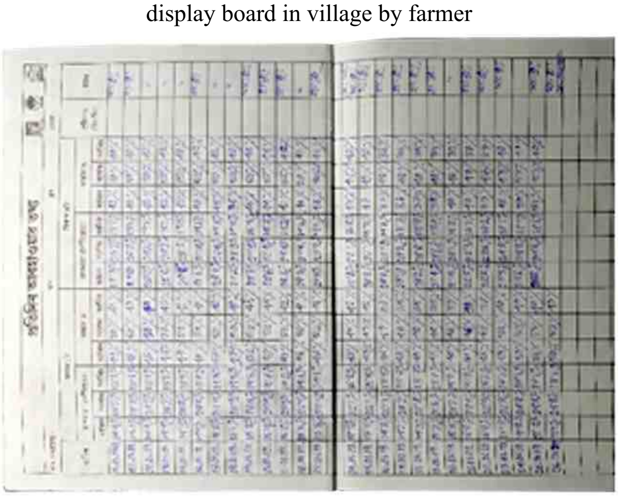


Fig.12. Onsite weather data recorded by a village farmer


Fig.13. Onsite weather advisoryreceived by a village farmer

In each village, near about 50-100 farmers are getting this information through display board placed in the villages and 15-20 % farmers use this in their agricultural practices.

District	No.of Blocks	No. of Village	Male Farmers	Female Farmers
Bankura	1	22	8770	5121
Purulia	1	18	3292	1516
Total	2	40	12062	6637

Table:1

Assessment of the weather advisory services

Analysis of the agro-meteorological services work was carried out in the intervention areas. It included structured interviews and group discussions with farmers and staff from fields. as well as direct consultations with communities involved focus group discussions and visits to community-managed interventions as planned using participatory vulnerability and capacity assessment. A focus on agro-met services was prioritised although this was more explicit in the both the districts. All types of communities were interviewed in both the blocks including women farmers ranging from small and marginal to middle and high level farmers. On the basis of four year experiences the results are as follows.

Climate perceptions and spontaneous adaptation

There was a high degree of continuity in the perceptions of changes in climate over the past 5 to 10 years from all villages. Summer temperature and particularly heatwaves are perceived to have increased. While total amounts of rainfall are either not thought to have changed or declined slightly, the rainfall pattern was cited as most significant change, with the monsoon starting 15 – 30 days later and rainfall less regular, more intense and with longer dry spells in between. Some respondents feel that all seasons had shifted forward and the duration of the winter season had declined. Others added that while summer temperatures were higher, winter temperatures had been lower in recent years. The main spontaneous adaptation measures have been to delay nursery development and transplanting for rice, using earlier maturing varieties for both wheat and rice in order to cope with a shrinking winter season and a later monsoon onset respectively. Two main features should be highlighted – firstly the high degree of agreement between the perceptions of farmers and the scientific evidence of climate change for Northern and East India generally, and secondly the pressure that this exerts on agricultural livelihoods. As climate changes increasingly affect production and the cost of inputs rise, farmers are caught in a vice of incremental stress on their livelihoods that can progressively reduce their ability to develop resilience. The ecological alternative to conventional chemical agriculture that DRCSC promotes addresses both sides of this equation by reducing inputs use,introducing more tolerant indigenous varieties, breeds, plants, promoting integrated farming systemand therefore risk&cost reductionand increasing resilience, productivity and profitability through sustainable, ecological farming methods.

Results and Discussion

In general, very little other forecast information was used by farmers receiving the 5-day forecast, either before the project started or subsequently. Most referred to the one-day forecast through either television or All India Radio but this only gave basic rainfall and temperature data. One group knew about a 2-day forecast in a local newspaper but indicated that this was not used for agricultural decisions. Likewise, farmer field schools had included some general discussion about rainfall and temperature prospects for the next 2 years but not beyond this time frame.

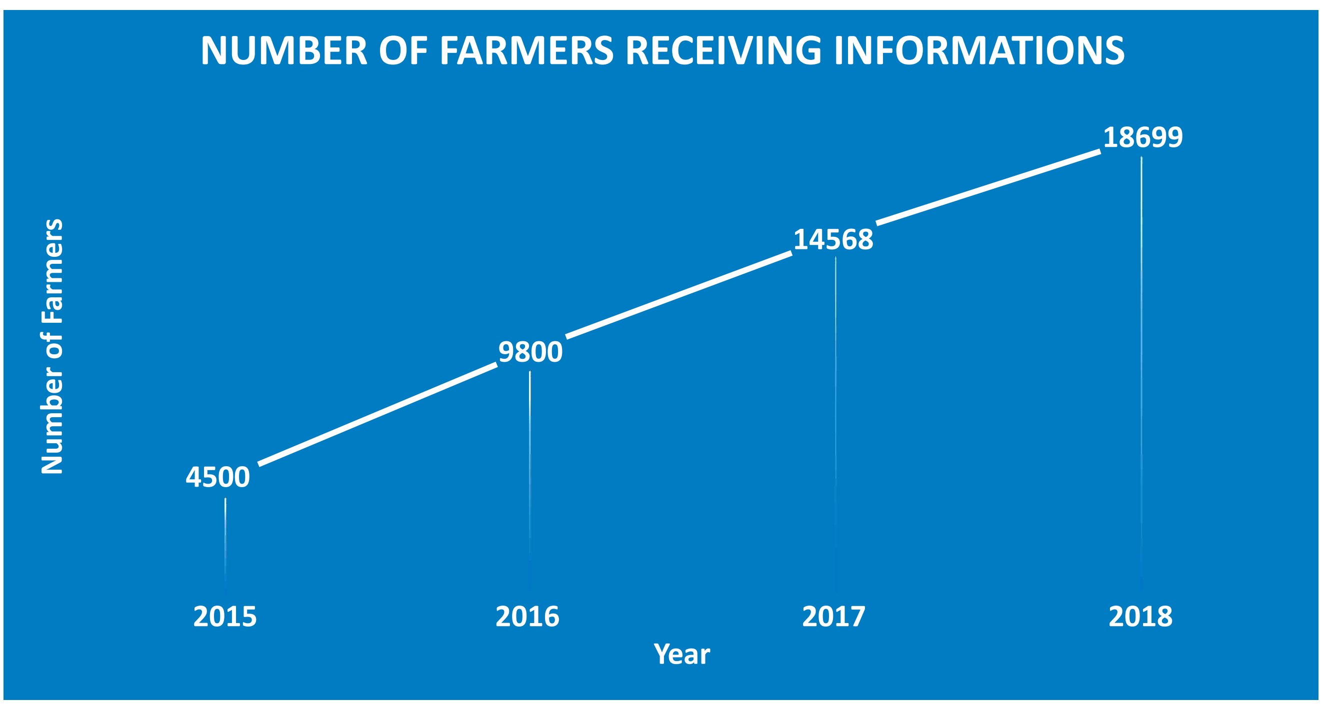
Accuracy of the forecasts was considered good with a range of 80-85%, with no transmission reliability problems that seriously undermine access and use. Most of the groups said that, importance of weather information is 76 % for their agricultural practices. Operations where farmers used this information are sowing, scheduling of irrigation, harvesting, application of fertilizers and bio pesticides. A sizeable number of groups said that, scheduling of irrigation is about 80%. One group explained that they were hesitant for the first 4 months but their initial hesitancy was overcome with increased awareness and knowledge of how to apply the information. The multiple channels of information and the ability to interact with the forecast providers were particularly valued. Groups explained how they received demand for the forecast forwarding the SMS to a variety of family members and friends in neighbouring villages is increasingly common and the notice boards have also generated significant interest both within the village and from those passing through. In terms of specific decisions that farmers assess as improved through using the 5-day forecast, these tend to be related to timing of operations or improved targeting of inputs, including:

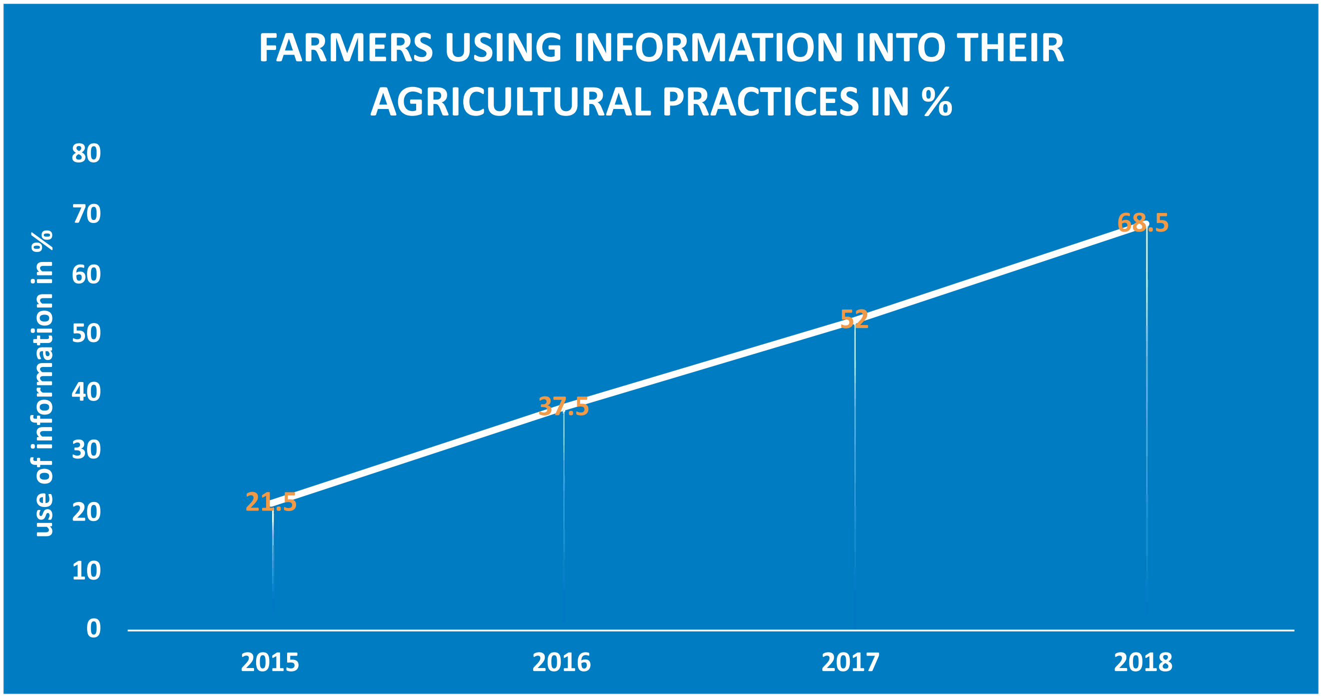
1. Adjusting sowing times to cope with later/more variable monsoon onset dates, in particular when to establish rice seedling nurseries and transplant seedlings so that planting can be synchronised with the reliable onset of rain as well as direct planting of e.g. wheat, potatoes.
2. Irrigation management – to avoid either unnecessary irrigation (and therefore irrigation costs) prior to rainfall or damaging a crop with excess moisture if irrigation is followed by heavy rain.
3. Timing of pest control measures, using humidity and wind speed and direction information to decide bio-pesticide application e.g. applying chilli spray to mustard with an east wind.
4. Timing of frost damage control using irrigation and smoke to mitigate forecast frost episodes.
5. Compost/fertiliser application timed to maximise effects on crop growth and yield e.g. avoiding application prior to heavy rainfall to mitigate fertility loss through soil erosion.
6. Vegetable nursery development based on temperature forecasts, especially for chillies, onions and seasonal leaf vegetables. This includes timing of operations and management of any potential risks e.g. heavy rainfall affected the nursery.
7. Timing the harvest so as to increase the likelihood of grain being stored at optimal moisture content e.g. avoiding cloudy weather that will result in higher grain moisture and therefore higher post-harvest losses.
8. Respondents, especially women, also cited a number of decisions about household welfare that forecasts had also assisted, including, storing more wood, livestock feed and household goods (including food) if there is a forecast for persistent, heavy rain (over 3 or more days) that will reduce access to local markets and mobility locally e.g. through water-logging. Focus on childcare to mitigate risks of colds and other disease. Adjust any travel decisions based on the forecast. Take pre-emptive maintenance to avoid e.g. a leaking roof causing problems within the house.

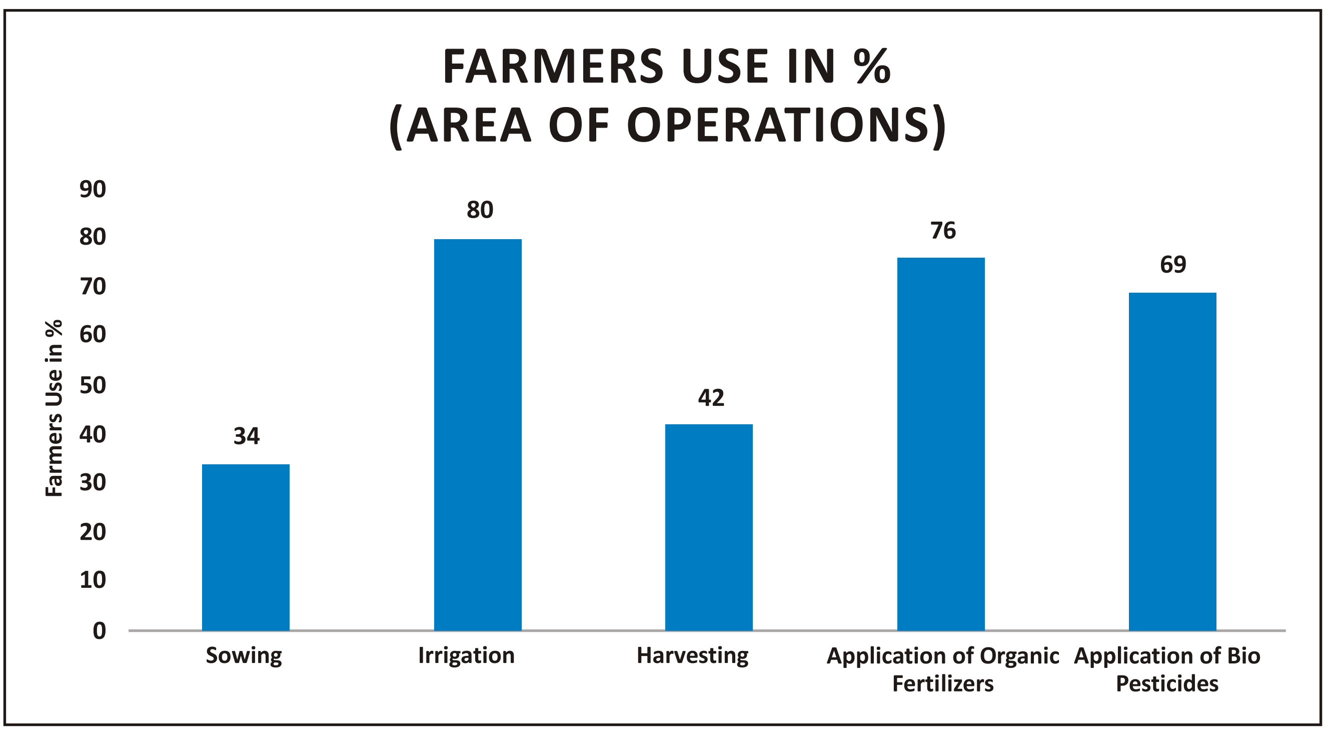
The impact of these improved decisions were described by all communities with an emphasis on cost savings, as a result of either more efficient use of inputs or mitigation of damage to crops, as the most significant reason for use of the forecast.

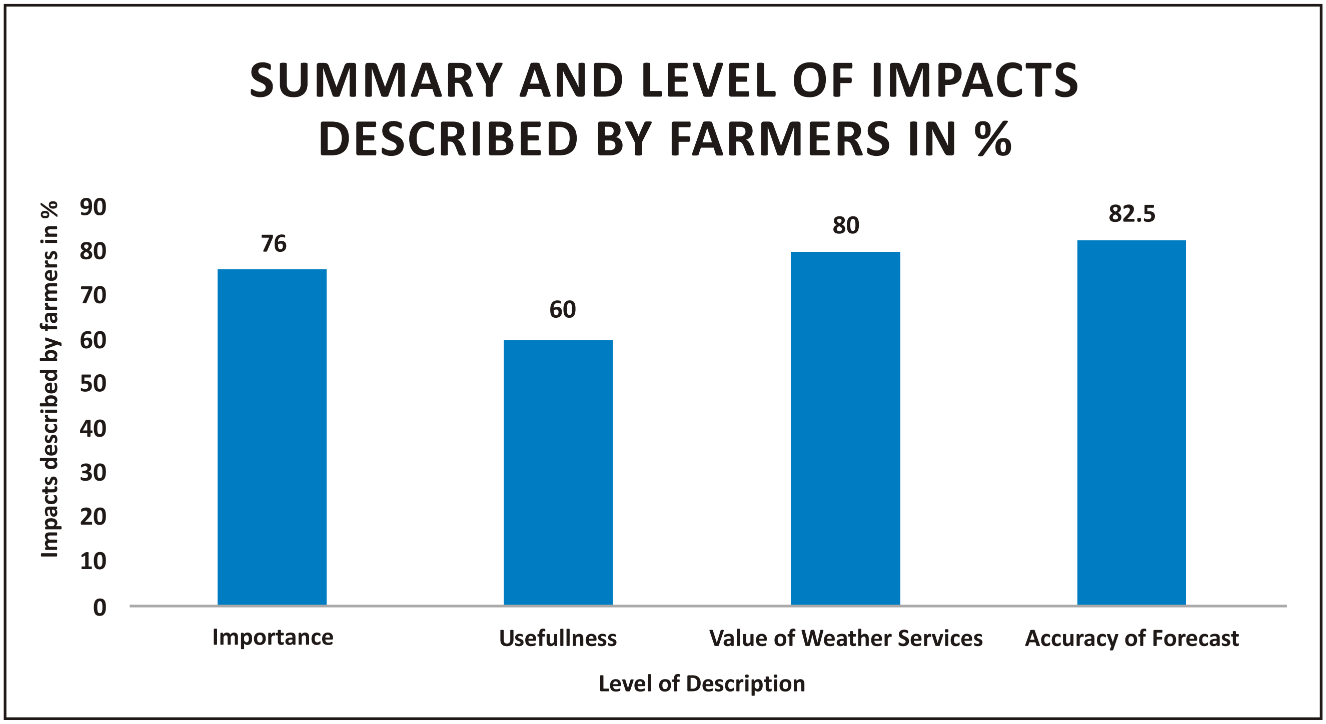
Forty villages also described drought indicators which were perceived as very reliable. Bamboo flowering, fruiting and dying indicated severe drought, as did the winter temperatures – warm in mid-January, cold nights in mid-May and heavy first rains from mid-April to mid-May all suggested a drought year. Opinions ranged from viewing these as very reliable so still used to dying out because (especially younger) people were embarrassed to be seen as relying on traditional views of weather and climate.

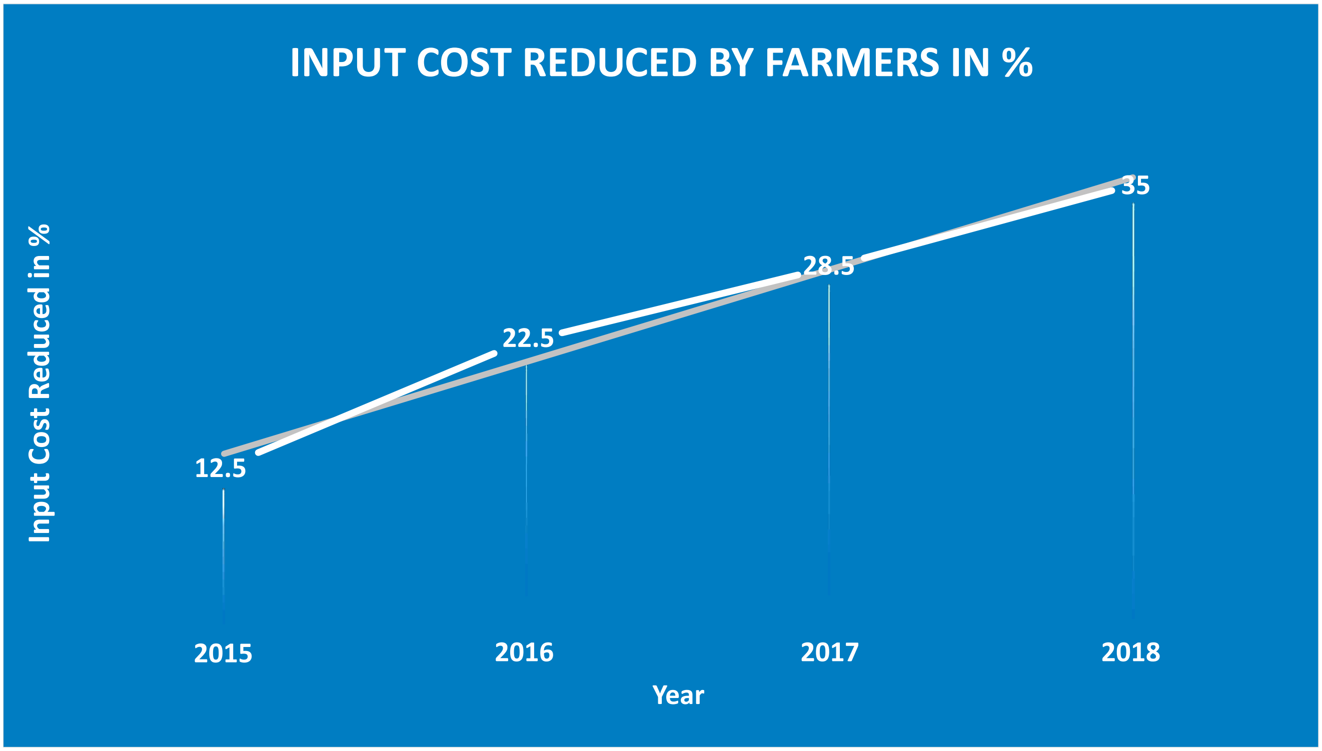
Communities highlighted the importance of weather services as part of the participatory approach and action planning process. Initially, those involved in the participatory vulnerability and capacity analysis were not aware of the various climate services available but the increase in risks associated with climate change such as waterlogging/drought, increased crop pests and diseases, livestock and human health – were the most important categories (especially erratic behaviour of rainfall) cited. Since the action plans were developed, communities have been integrating climate services into its management and implementation in order to increase access e.g. through including registered mobile phone owners on the community map, identifying households that have mobile phones but are not yet registered or including communication methods that ensure those without mobile phones still can receive the information regularly. Monthly review of the forecast to feed back to the suppliers is also part of the action planning process. All communities agreed that the 5-day forecast had been a basis to increase their understanding of climate science and expressed interest in considering other climate services, such as the seasonal forecast, within the same system.




FARMERS USING INFORMATION INTO THEIR AGRICULTURAL PRACTICES IN %
use of information in %
80
70
60
50
40
30
20
10
0
21.5
37.5
52
68.5
2015
2016
2017
2018


FARMERS USE IN %
(AREA OF OPERATIONS)
Farmers Use in %
90
80
70
60
50
40
30
20
10
0
34
80
42
76
69
Sowing
Irrigation
Harvesting
Application of Organic Fertilizers
Application of Bio Pesticides


SUMMARY AND LEVEL OF IMPACTS DESCRIBED BY FARMERS IN %
Impacts described by farmers in %
90
80
70
60
50
40
30
20
10
0
76
60
80
82.5
Importance
Usefullness
Value of Weather Services
Accuracy of Forecast
Level of Description


INPUT COST REDUCED BY FARMERS IN %
Input Cost Reduced in %
12.5
22.5
28.5
35
2015
2016
2017
2018
Year

Conclusions

One clear feature from intervention areas, is the high demand for weather services once end users (i.e. community members, small-scale farmers) have developed confidence in their application through direct training. This is more explicit in the 5-day forecast developed by DRCSC, which is now informing a range of livelihood decisions that end users clearly assess as contributing to their resilience through both saving costs and adding productivity to their agricultural livelihoods. Farmers are saving 12.5-35% input cost by applying these advisories into their agricultural practices. Forecasts are also used for household security decisions, with women emphasising the importance of this value as well as the more direction application to agriculture. SMS use has facilitated rapid spread, with registered users forwarding forecasts on to relatives and friends so that indirect users now outnumber direct users by 5 to 1. The current communication methods are the most popular (SMS, whats app messages, hard copies and notice boards) some forecast users also felt there was potential using radio if it could be locally specific enough and transmitted at the right time of day (usually evening). Climate volunteers in each village are also playing a crucial role in disseminating the information and also in empowering people in application of weather and agro advisories.Regular review every month through farmer field schools was considered a valuable way of interacting with forecast developers, allowing user feedback on the accuracy of the forecast and the usefulness of the related agricultural information it contains. With users describing a change in their attitudes from initial scepticism to considerable enthusiasm for use of weather services, this interaction is an important and likely crucial aspect of understanding, gaining confidence with and applying forecasts to decision-making processes.

Cost Implication

Fixed Cost				**Amount (Rs.)**
AWS machine	Rs. 85000 x 6	=	5,10,000/-	
MDCC	Rs. 20000 x 12	=	2,40000/-	
Protection material	Rs. 25000 x 6	=	1,20000/-	8,70,000/-
Display board	40 nos. @ Rs. 6000/-			2,40,000/-
Smart phone	40 nos @ Rs. 6000/-			2,40,000/-
Laptop+Harddisk & Pendrive				50,000/-
Total Fixed cost				**14,00,000/-**
Variable cost /yearly)				
Consultancy fees & Data Analysis				
Weather Prediction & Advisory	Rs. 5000/- x 73 per year		3,65,000/-	
Mobile recharge cost	40 x100 x 12		48,000/-	
Bluk SMS (Bengali) cost	for 500000		1,10,000/-	
Stationary cost	Rs. 4000 x12		48,000/-	
				5,71.000/-
Human Resources cost	Rs. 20000 x 12			2,40,000/-
Repair & maintenance cost				99,000/-
Total variable cost				**9,10,000/-**
SMS cost per household	= Rs. 1.82			

Sustainability

The Automated Weather Stations and Manual Data Collection devices are now owned and maintained by the community (small and marginal farming families (SC/ST) itself. They have understood the benefits of localised weather information and crop advisory in the changing climatic scenario and hence they have taken the responsibility. Climate volunteers are now present in the revenue villages of Bankura and Purulia who have taken responsibility of data collection and dissemination through different measures. The volunteers also collect feedback from the community on regular basis and share with experts through CRC Manager and DRCSC for making the service more effective and user friendly. These volunteers are very much willing to continue their service even after the project is over.

In order to continue the service with the help of experts it has been calculated that if each family (of 5000 families) contributes Rs.200 per year then it can sustain on its own. The village institutions made with the facilitation of DRCSC is quite capacitated now to manage this activity after the project period.

Apart from this, there remains possibility to extend and converge with RKVY Scheme (Department of Agriculture, Govt. of West Bengal) to increase the preparedness of the farmers of West Bengal.

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