IMPACT ASSESSMENT OF THE AGRO-METEOROLOGICAL ADVISORY SERVICE OF
The National Centre for Medium Range Weather Forecast (NCMRWF)

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Introduction

Temporal and spatial variability in weather conditions make significant impact on Indian agriculture. Besides, catastrophic events like droughts, floods and cyclones, spatial and temporal changes in important weather parameters like rainfall, temperature, wind, cloud cover, humidity, etc. effect crop yields by influencing farmers' decision about selection of cultivar, use of inputs, crop management practices, etc. These decisions, influence the year-to-year fluctuations in crop yields, as well as aggregate agricultural output, which in turn has impact on the economy of the country as a whole. Decrease in food production, increase in prices of agricultural and other commodities, low employment, pessimistic economic environment, etc. directly impact the economy, and rural poor are the most immediate sufferers. Therefore, any forecast on weather would have tremendous benefits in terms of ex ante management of the negative impacts of vagaries of weather. This is because the cost of ex ante management of risk due to weather is much smaller than the ex post management of the losses.

A number of initiatives are taken by the Government of India to provide various types of weather forecasts. The Indian Meteorological Department (IMD) usually provides short and long-range weather forecasts. The short-range forecasts by IMD are provided in qualitative terms to the meteorological centers located in the state capitals. Such conventional weather forecast, using subjective methods, is normally available one day in advance. Hence, these forecasts are inadequate for planning weather based agricultural practices because the lead-time needed for taking precautionary measures in agriculture is longer. Modern agricultural practices such as sowing of weather-sensitive high yielding varieties, need-based application of fertilizer, pesticides, insecticides, efficient irrigation and planning for harvest require weather forecast with higher lead time which enable the farmers to take ameliorative measures. Thus, for agricultural sector, location-specific weather forecast in the medium range is very important. Further, the forecast has to be translated into changes in agricultural practices for its effective use by farmers. In order to meet these requirements, the National Center for Medium Range Weather Forecasting (NCMRWF) was established in 1988 by Government of India as a scientific mission, to develop operational Numerical Weather Prediction (NWP) models for forecasting weather in the medium range (3-10 days in advance) scale and setting up of agro advisory service units in the 127 agroclimatic zones of the country.

Objectives of NCMRWF

The following are specific objectives of the Centre:
1. Development of global and regional scale numerical weather prediction (NWP) models for forecasting weather in medium range (3-10 days) time scale.
2. Set up a state-of-the-art super-computing infrastructure to develop suitable NWP models to issue medium range weather forecasts.
3. To inform and guide the farmers in advance to undertake various farming activities based on expected weather.
4. Set up Agro-meteorological Advisory Service (AAS) units, each unit representing one of the 127 agro-climatic zones spread all over India, to prepare/issue/disseminate AAS bulletins based on weather forecasts and to provide user feedback as well.
5. Set up a stable/fast dedicated communication network with AAS units.

To meet out the above objectives, NCMRWF is having the Super Computer CRAY X/MP-14 system procured in 1988, was upgraded to X/MP-216 in 1992. The computer system was since being used for the preparation of medium range weather forecast for AAS units and other users. One VAX8810 system was being used as front-end to Cray and another (VAX8250) was being used as Gateway to Cray. Two 4-processor ORIGIN200 systems in fail-safe mode along with peripherals were installed in June, 1999 by the Cray maintenance agency to serve as back up system to Cray. A DEC-ALPHA distributed memory architecture based parallel system along with peripherals was installed at the Centre during June-August, 1999. A two-node (eight processor) PARAM10000 was installed during June-August, 1999. The Super computer Cray XMP-216 has been recently replaced with a much faster and near state of the art computer CRAY SV1 to meet the ever-increasing demand of running the higher resolution global and meso-scale models. With this, NCMRWF has become the only organisation in the country and perhaps in the Indian Sub-continent to have fastest computing facility. Scientists of the Centre have contributed significantly to the development of the numerical prediction model. There are a number of global, regional and meso-scale forecast models run operationally at present:

**Global Model:**
T-80L18 Global forecast model is a Spectral Model with a triangular truncation at 80 waves in the horizontal and has 18 layers in the vertical (T80L18). The model is run once a day with 00 UTC initial conditions and generates forecasts unto 7 days. A higher resolution global model T-170L28 (75x75 km resolution in the horizontal and 28 layers in the vertical) has recently been installed.

**Regional Spectral Model**
Regional Spectral Model (RSM) is a limited area atmospheric numerical model which is run at NCMRWF, RSM (50 km grid) is an aiding tool to improvise upon a relatively good global model forecast with its higher resolution features

**Mesoscale Models**
High-resolution mesoscale models such as MM5 and ETA are run on real-time basis for forecasting mesoscale systems viz., the western disturbances, severe thunderstorms, tropical cyclones and heavy rainfall episodes. The products of these models are being extensively used in the Mountain Meteorology Program of NCMRWF.
Agrometereological Advisory Services

The NCMRWF in collaboration with IMD, Indian Council of Agricultural Research (ICAR) and State Agricultural Universities (SAUs) is providing Agrometereological Advisory Services (AAS) at the scale of Agroclimatic Zone to the farming community based on location-specific Medium Range Weather Forecast (MRWF). The NCMRWF provides AAS in the form of Agromet Advisory Bulletins, which contain expert; advise on crop, soils and weather to the farming community. Thus, the AAS set up exhibits a multi-institutional, multi-disciplinary synergy to render an operational service for the use of farming community.

Over the past decade, the NCMRWF has established an impressive infrastructure and also developed suitable methodologies for giving quantitative medium range weather forecasting services. Starting with 5 units in 1991, the Centre has now established 107 Agrometereological Advisory Services (AAS) Units in a phased manner. These units are located within SAUs headquarters, their regional research stations and ICAR institutes.

Location-specific weather forecast for six parameters, viz. rainfall, cloud cover, wind direction and speed, and minimum and maximum temperature are obtained twice a week from a T-80 General Circulation model with a resolution of 150 km x 150 km. These forecasts are further subjected to statistical and synoptic interpretation by the experts.

Weather forecasts are given by NCMRWF to AAS Units biweekly (Tuesday and Friday). The forecast, in quantitative terms, is issued for above-mentioned six parameters. The temporal range of the forecast is four days. Moreover, the cumulative weekly precipitation (mm) is also provided. The AAS Units assisted by an advisory board consisting of agricultural scientists representing wide spectrum of agricultural disciplines discuss the forecast of their zone to prepare the AAS Bulletins. These advisories contain location specific and crop specific farm level advisories prepared in local language containing description of prevailing weather, soil & crop condition, and suggestions for taking appropriate measures to minimize the loss and also, optimize input in the form of irrigation, fertilizer or pesticides. The Bulletin contains the forecast on six parameters (as given by NCMRWF) along with their likely impact on crops. The Bulletin also provides the advice to farmers on the measures to be taken to maintain crop yields and to minimize weather-induced losses. The AAS Bulletin is disseminated to farmers by mass media (TV, radio, newspapers) in vernacular language. The Bulletin is also disseminated to the contact farmers in several villages by phone, post, or by hand.

As most of these AAS units have been in operation since 1995. Therefore, it is pertinent to assess the impact of AAS for making them more effective by taking appropriate mid-course corrections. This note outlines the impact assessment framework of AAS with the basic objective to make it more effective and efficient.

**Why economic impact studies are required?**

**User requirement**

The types of economic decision which require agrometeorological products can be categorized according to three time scales:

- Long-term planning for agricultural development (rational allocation of land, choice of crops, selection of species and varieties)
Medium-term planning for the next season (choice of farming area, crop varieties, etc.);
Short-term decisions regarding imminent farming operations (choice of optimal sowing and harvest dates, dates and quantities for fertilization, dates and quantities for irrigation, etc.).

Each type of decision requires the appropriate meteorological information. In the first of the three categories listed above, this will involve basic climatological data and long-term forecasts. In the second case, it will involve seasonal forecasts, monthly forecasts, and various agrometeorological forecasts on moisture availability, yield etc. In the third case, it will involve short-term forecasts, medium-term forecasts, and special recommendations for crop-growing. In the present study, the problem has been addressed only to the third requirement of the user.

Service requirement:
Internal perspectives
- To establish the worthiness of the service: Economic impact has to be carried out in order to know its potential benefits.
- Service credibility:- Credibility is always closely linked to forecast verification. Hence economic impact studies need to be carried out to establish credibility in the eyes of the potential users if optimum benefits are to be derived from the marketing of the service.
- Service accountability or justification: Assessment of the service helps justifying the costs and the ongoing need and existence of such a service

External perspectives
- By quantifying the benefits of this service one comes to know the needs of the users, their level of satisfaction and their further expectation. Consequently the progressive user provides a positive feedback & increased response of progressive users drive the service. The outcome includes better services over time, services with better utility and most likely with better-perceived accuracy. Secondly, through these interactive educational initiatives, policy makers and other clients become sensitized to and better informed about the value of these services, which results in improved decision making.

Global scale
- On the global scale, more knowledgeable decision-making leads to improved practices and attitudes, enhanced productivity, a more internationally relevant economic society and more socially acceptable practices.

Benefits or expectations from these studies
- Will give an insight into forecasting skill and reach of the service and also its economic value in terms of money
- Will help in taking better decision. Application of these methods for assessing economic and social benefits can produce information leading to the efficient production and supply of services.
- Cultivar selection, their dates of sowing/planting/transplanting, dates of intercultural operations, dates of harvesting and also performing post harvest operations
- Site-specific forecast information and advisories will help maximize output and avert crop damage or loss. The service can also help growers anticipate and plan
for chemical applications, irrigation scheduling, disease and pest outbreaks and many more weather related agriculture-specific operations.

- Agromet advisories will increase profits by consistently delivering actionable weather information, analysis and decision support for farming situations such as:
  1. To manage pests through forecast of relative humidity, temperature and wind.
  2. Progressive water management through rainfall forecasts
  3. To protect crop from thermal stress through forecasting of extreme temperature conditions

Above all, along with many other situations the study will help increase the crop protection, hence knowledge needs to improve the bottom line, protect resources and preserve the environment.

**Objective of the study**

Keeping the purpose and expectation of economic impact in mind, the following objectives have been out lined. The impact assessment, however, does not cover the evaluation of the capacity and methods of weather forecasts, which is beyond the scope of this study. The impact assessment framework entails reliability and adequacy of weather forecasts, mechanisms of flow of weather information, extent of use of weather forecasts by farmers, and economic and other impacts. Some of the main objectives are listed out as follows

1. Adoption of the forecast by the user community and its realization
2. To work out weather based farming strategies based on the economic impact of Agromet Advisory Services.
3. To account and assess the needs of the farming community for increasing the farm produce.
4. To assess the economic Impact of the AAS services in various crops under different farm environmental conditions.

**Impact Assessment Framework**

A number of approaches and methods have been used in the literature to assess the value and impact of weather forecast. Important among these are assessment of the value of weather forecast, economic benefits to farmers or individual firms, and economic and social benefits for a sector or country as a whole. The cost-loss analysis, expected utility approach, stochastic programming approach, simulation model, economic surplus, and computable general equilibrium model are most frequently used methods. The cost-loss analysis is used mainly to assess the value of weather forecast for individuals, which in turn determines the use of measures to mitigate weather risk in crop production. This approach estimates the controllable losses due to weather risk and costs associated with the actions taken to reduce the losses. These estimates are further adjusted with the probability of reliable forecast. Meteorologists have used this method extensively to assess the value of the forecast and likelihood of an individual to use it. Expected utility and simulation models also estimate economic benefits to the decision maker by comparing the ‘with’ and “without’ forecast scenarios. Stochastic programming approach
is used to assess the set of actions of individuals and their associated economic outcomes ‘with’ and ‘without’ weather forecast. The computable general equilibrium and economic surplus models are mostly used for assessing the sectoral or economy-level impact accruing to the society as a whole. These methods are analytically more sophisticated and data-intensive, and are mostly used by economists. One commonality in the studies using all the methods mentioned here has been that these have estimated the impact of seasonal or long-term weather forecasts.

The selection of analytical method is determined by objective of the study, availability of required data and computational skills. Since main objective of this study is to assess the adequacy, use and impact of the medium range weather forecasts, an analytical method focusing more on farm level impact would be more appropriate. In our case, the selection of method is also influenced by the fact that policy makers can easily understand the results and the method can be applied with moderate analytical skill. Therefore, it is proposed to use simple farm-level indicators for the impact assessment. The impact assessment framework proposed here includes estimation of accuracy of the forecast, adequacy and reliability of the forecast from farmers’ perspective, use of the forecast, and farm-level impacts.

Use of Weather Forecast

Reliability of forecast, expected weather-induced risk or weather-induced losses, and farmer’s attitude towards risk will affect the use of weather forecasts. All these factors will be captured through the survey of farmers. Farmer’s risk bearing ability (income and assets) and individual characteristics will determine his attitude towards risk. This combined with expected weather-induced losses will decide whether a farmer will be willing to use weather forecast. Chances of using the forecast are much higher if it is reliable, the expected losses are high and farmer is risk averse. However, based upon his experience of traditional weather forecast and expected losses due to adverse weather at different stages of crop growth, extent of use of forecast at different season and crop growth stage may vary. Thus, there could be a number of categories of forecast user farmers. For the purpose of our analysis, all farmers will be classified into three categories: (a) receivers and users (complete or partial users) of weather forecasts, (b) receivers but non-users, and (c) non-receivers and non-users. Since weather-induced risk may not vary from farmer to farmer for a crop in a given agro-climatic region, information on farmers’ perception on adequacy, accuracy and timeliness of weather forecasts and the advisory services will be obtained in detail. The survey will also include questions on socio-economic characteristics of farmers. The effect of size of holding (a proxy for farmer’s risk bearing ability), education, technology, infrastructure like irrigation, and expected losses on use of forecast will be studied using simple tabular analysis, or multiple regression framework. This information can be used to increase the use of weather forecasts.

Dissemination method of information also affects its use. Accessibility to dissemination media (TV, radio, newspaper etc) can increase use of weather forecasts. In order to assess effectiveness of dissemination mechanism of the AAS Bulletins, a discussion with researchers of relevant disciplines (agronomy, crop protection, social scientists, etc) and extension workers was conducted to ascertain (a) information covered, (b) appropriateness of bulletin design, (c) use of language, (d) possibility of distortion or information loss, (e) scope and measures for improvement. A few questions on these aspects have also been included in the questionnaire for the farm survey.
Impact Indicators

Two key impact indicators have been used: (a) ability of the forecast to influence decision of farmers and adopt appropriate measures to reduce weather-induced losses, and (b) economic and other benefits accruing to farmers due to change in their farm management decisions due to weather forecast. The economic benefits are either in terms of cost saving or reduction in yield losses. Estimation of these benefits involves getting information on use of weather forecasts in decision making, changes in farmer’s decisions, changes in cultivars, date of sowing, inputs use, yields, etc. These changes have been computed using a ‘with’ and ‘without’ approach. Difference in input use, cost and crop yield will be tested for their statistical significance. A list of these indicators is given in Table 1. Information on these variables has been collected through a farm survey with the help of the questionnaire designed for this purpose. As seen from the questionnaire, first set of questions relates to reliability and use of weather forecast and the second set relates to changes in decisions regarding different farm operations and input use.

Table 1. List of farm level impact indicators

<table>
<thead>
<tr>
<th>S No.</th>
<th>Impact area</th>
<th>Indicator</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Awareness about AAS</td>
<td>Percentage of farmers knowing about AAS</td>
</tr>
<tr>
<td>2.</td>
<td>Usefulness</td>
<td>Percentage of farmers considering AAS bulletin reliable</td>
</tr>
</tbody>
</table>
| 3.    | Use of information                       | • Percentage of farmers using weather forecast  
                            | • Use of forecast by season, crop, crop growth stage, farm operation, etc. |
| 4.    | Economic impact                          | Impact on farmers’ decisions w.r.t. changes in input use  
                            | Field preparation (early/ late/ timely), Number of irrigation, NPK use (kg/acre), pesticide use (Rs./per acre), labour use (mandays) between AAS and non-AAS contact farmers |
|       | Cost                                     | Difference in total paid out cost (per acre) between AAS and non-AAS contact farmers |
|       | Profits                                  | Return over paid out cost (Rs./ acre), and net benefit (Rs./per acre) between AAS and non-AAS contact farmers |
|       | Utility                                  | Improvement in utility |

Sampling Framework

1. Farm survey is being conducted in 15 agro-climatic zones where AAS Units are working effectively for quite some time (Plate 1).
2. From each zone, a representative district where AAS Unit is operating was selected purposively for conducting the farm survey. The selection of the district was based on similarity of the district with the zone in terms of cropping pattern, irrigated area, rainfall and soil type.
3. From the selected district, a list of villages where AAS Unit is operating was prepared to select two villages randomly.
4. For the two selected villages, a list of all the AAS contact farmers was prepared by category of their size of holding (small, medium, large), and a total of 20 farmers from the list were selected using random sampling technique.

5. Similarly, a list of villages having no AAS contact farmers from the same district was prepared and two villages were selected at random. For the two selected villages, a list of all the farmers (non-AAS contact farmers) was prepared by category of their size of holding (small, medium, large) and 20 farmers having no AAS contact were selected at random from each village.

Thus from a village 20 farmers were selected following random sampling. This makes the sample size to 80 for a district. In order to keep the data to a manageable size, information on important crops (at least one each for kharif and rabi, but not more than four crops) were selected for taking detailed information on use and impact of weather forecasts. Information on farmer’s characteristics, reliability and use of weather forecasts, cropping system, inputs use, crop management practices, yield, etc. were collected. In order to ensure reliability of the results, data were collected for two agricultural years, i.e. 2003/04 and 2004/05.

**Monitoring and Review Process**

The entire exercise of impact assessment of the AAS of NCMRWF is being guided and monitored by a national committee of experts constituted for this purpose. A planning-cum-training workshop was organized by NCMRWF and the proposed plan and methodology was shared with the participating AAS Units. The work progress is monitored through annual workshops convened by NCMRWF for this purpose. In these workshops, all participating AAS Units present their work progress. Final workshop will be conducted in 2007 to discuss results of the study.

The participating AAS are responsible for completing the exercise for their respective zones and adequate resources are being provided to them for this work. However, NCMRWF is responsible for overall coordination of the work and preparing the final report. The consultants are providing technical support to complete the work under the guidance of the National Steering Committee. Since the Units, implementing the survey are conducting the study, there is a possibility of bias creeping in farmers’ responses. Therefore, due care is being taken to minimize this bias in the study.

As per the guidelines laid the units selected the samples for survey. The study so has been carried out in *Rabi*-2003-04, 2004-05 and *Kharif*-2004, 2005. Details of the *Rabi*-2003-04, 2004-05 and *Kharif*-2004 survey has been received from most of the units. Analysis has been done for certain crops from the complete corrected data set received from a few units.

**Summary of the analysis from data set:**

The AAS units selected 3 to 4 villages for the study. In general units selected 40 AAS and 40 non-AAS farmers for survey work. The farmers chosen by random sampling for both categories (AAS & non-AAS) by all units generally are literate (metric) in the middle-aged group having medium to large land holdings. Table 2 gives the summary of socio-economic status of the sample farmers at all the 15 units.
### Table 2: Socio-economic status of the sample Farmers

<table>
<thead>
<tr>
<th>Unit’s Name</th>
<th>Age group(%)</th>
<th>Education level(%)</th>
<th>Land holding(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>25-40</td>
<td>40-60</td>
<td>&lt;60</td>
</tr>
<tr>
<td>Anand</td>
<td>50</td>
<td>33</td>
<td>6</td>
</tr>
<tr>
<td>Bangalore</td>
<td>10</td>
<td>40</td>
<td>50</td>
</tr>
<tr>
<td>Bhubaneswar</td>
<td>10</td>
<td>81</td>
<td>9</td>
</tr>
<tr>
<td>Coimbatore</td>
<td>80</td>
<td>131</td>
<td>29</td>
</tr>
<tr>
<td>Hisar</td>
<td>41</td>
<td>35</td>
<td>14</td>
</tr>
<tr>
<td>Hyderabad</td>
<td>27</td>
<td>60</td>
<td>13</td>
</tr>
<tr>
<td>Jaipur</td>
<td>47</td>
<td>40</td>
<td>13</td>
</tr>
<tr>
<td>Jodhpur</td>
<td>26</td>
<td>40</td>
<td>14</td>
</tr>
<tr>
<td>Kalyani</td>
<td>26</td>
<td>13</td>
<td>1</td>
</tr>
<tr>
<td>Ludhiana</td>
<td>28</td>
<td>41</td>
<td>11</td>
</tr>
<tr>
<td>Pantnagar</td>
<td>7</td>
<td>14</td>
<td>19</td>
</tr>
<tr>
<td>Pune</td>
<td>19</td>
<td>19</td>
<td>2</td>
</tr>
<tr>
<td>Raipur</td>
<td>30</td>
<td>59</td>
<td>11</td>
</tr>
<tr>
<td>Solan</td>
<td>17</td>
<td>22</td>
<td>1</td>
</tr>
<tr>
<td>Thrissur</td>
<td>14</td>
<td>34</td>
<td>32</td>
</tr>
</tbody>
</table>

**Crop data:**

The perusal of data reveals that the input quantity used significantly varies for AAS and non-AAS farmers. Significant differences are observed in human labour, fertilizer and plant protection chemical used. The timely and proper agro-advisories given for various farm operations viz. irrigation, application of fertilizer and plant protection chemicals save the crop from the moisture stress, nutritional stress and pest attack, which contributes to better growth and development of crop, both in terms of qualitative and quantitative. The non-AAS farmers also use the same quality of inputs but their timing of application is different with respect to AAS farmers, which do not affectively control nutritional stress and pest attack, which ultimately leads to the differences in crop yields. The brief discussion of the season-wise preliminary results is given below in table 3.

**Cotton:**

1. **Hisar:**

   The input quantity varies for AAS and non-AAS farmers. The significant difference is observed in fertilizer and pesticide quantity. The AAS farmers applied more quantity of fertilizer and pesticides, which contributes to better growth and development of crop. The agro-advisories given for these operations save the crop from the nutritional stress and pest attack. The non-AAS farmers also use the same quality but their timing of application is different with respect to AAS farmers, which is less affective in managing nutritional stress and pest attack, which ultimately leads to the reduction in cotton yield for non-AAS farmers. The AAS farmers increase the yield up to 14% due to the effective use of weather-based agro-advisories at the time of application of fertilizer and pesticides. Even though the overall cost of production for AAS farmer increased by 1% but at the same time the overall benefit increased by 10%.

2. **Coimbatore:**

   The AAS farmers used more fertilizers and pesticides whereas the human labours and machine hours is more used by non-AAS farmers. The increase in yield for AAS farmers is 16%. The total cost of production is more for the non-AAS farmers by 4% per
acre where as gross return is more for AAS farmers by 16% per acre. But the net return for both the farmers is in –ve. This may be due to the use of more FYM utilization.

**Rice**
1. **Ludhiana**
   The inputs viz. seed, fertilizers, herbicides, human labour and machine hours used by the non-AAS farmers are slightly more. The pesticides utilization by the AAS farmers is more than non-AAS farmers. The increase in main product yield is 9% per acre for the AAS farmers. This may be attributed to the more use of inputs. Cost of production for the non-AAS farmers increase by 6% per acre. The AAS farmers get more net return than the non-AAS farmers by 18% per acre.

2. **Kalyani**
   The inputs viz. seed, fertilizers, pesticides and human labour are more used by the non-AAS farmers than the AAS farmers. By the use of more inputs by the non-AAS farmers the cost of production is increased by 3% per acre for non-AAS farmers. By the judicial use of inputs the AAS farmers able to get more grain yield and byproduct. The net return for AAS farmers is 29% more than the non-AAS farmers.

**Wheat**
1. **Ludhiana**
   The AAS farmers used plant protection chemicals (pesticides and herbicides) more than the non-AAS farmers whereas fertilizer utilization by the non-AAS farmers is more than the AAS farmers. The increase in the yield for the AAS farmers is 9% per acre. The costs of production for the non-AAS farmers increase by 6% per acre whereas the net return increases for AAS farmers by 17% per acre.

**Mustard**
1. **Hisar:**
   The inputs viz. fertilizers used by the AAS farmers is higher than the non-AAS farmers. The agro advisories given for these operations protect the crop from the nutritional stress and pest attack. The increase in the yield for the AAS farmers is 8% per acre. The costs of production for the non-AAS farmers increase by 3% per acre whereas net return for the AAS farmers form non-AAS farmers increased by 13% per acre.

Table 3: Economic Impact of AAS of NCMRWF: Preliminary results

<table>
<thead>
<tr>
<th>Crop</th>
<th>Station name</th>
<th>% Increase /Decrease in cost of production (per acre)</th>
<th>% Increase /Decrease in crop yield (per acre)</th>
<th>% Increase /Decrease in Profit (per acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cotton</td>
<td>Hisar</td>
<td>1</td>
<td>14</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Coimbatore</td>
<td>-4</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>Rice</td>
<td>Ludhiana</td>
<td>-6</td>
<td>9</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>Kalyani</td>
<td>-3</td>
<td>21</td>
<td>29</td>
</tr>
<tr>
<td>Wheat</td>
<td>Ludhiana</td>
<td>-6</td>
<td>9</td>
<td>17</td>
</tr>
<tr>
<td>Mustard</td>
<td>Hisar</td>
<td>-3</td>
<td>8</td>
<td>13</td>
</tr>
</tbody>
</table>
Conclusion

AAS farmers received medium range weather forecast based agro-advisories including optimum use of inputs for different farm operations. Due to judicious and timely utilization of inputs, cost of production for the AAS farmers reduced approximately by 3-6%. At the same time yield level of the AAS farmers also increased. The increased yield level and reduced cost of production, led to increased net return for AAS farmers. These are the preliminary results. Survey is still going on and data is being to be analyzed.
Plate 1: Network of AAS units participating in economic impact study.