



Weather and agro advisory services to farmers and its benefits

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This study estimates the benefits that Indian farmers derive from agriculture and weather information delivered to their mobile phones by GEAG. Climatologist conducted a controlled randomized experiment of 20 villages in East U.P. The farmers 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 (10-25 %) 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 GEAG offered by the largest and best-established private provider of agricultural weather information in U.P and Bihar at the time of the experiment. Operating in U.P. and Bihar GEAG 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.

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 [Indian Annual Economic Survey 2016-17]. 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 are 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 [Indian Council of Agriculture Research].

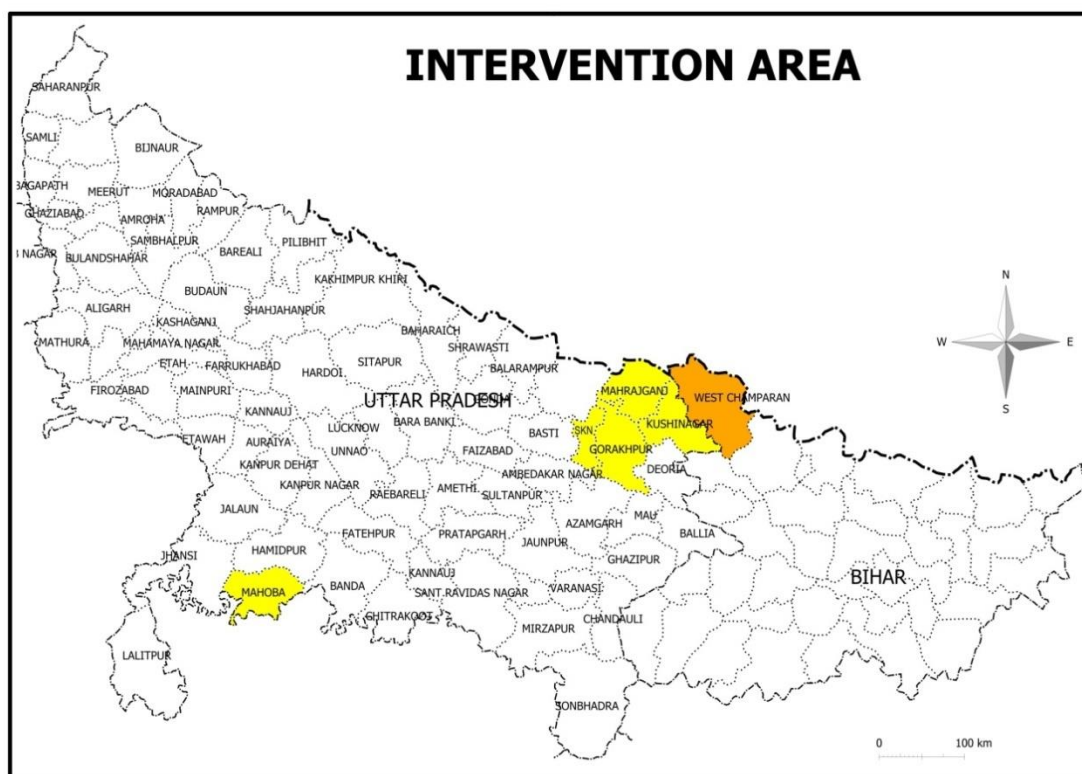
Climate change trend in the recent India Meteorological Department report shows that average temperatures are rising across the country and annual rainfall is declining. It also shows a rise in the number of days with extremely high temperatures and a corresponding decline in the number of days with low temperatures [India Meteorological Report 2015 "Climate Change Trend India"]. 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 [National Council of Applied Economic Research (NCAER) 2015 report]. 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°C 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% [Climate Change and Agriculture, 2014]. Temperatures in India are likely to rise by 3°C to 4°C by 2100 [Chaturvedi et al. 2012]. 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 [International Journal of Scientific and Research Publications, Volume 4, Issue 4, April 2014, ISSN 2250-3153]. 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.

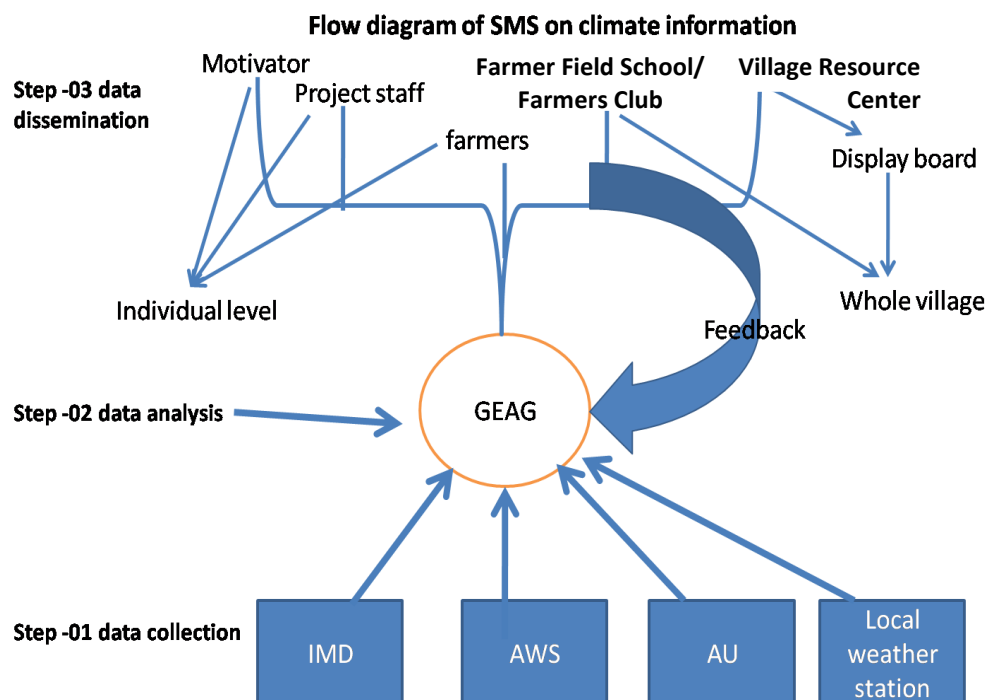
In addition, farmers are expected to manage the more insidious effects of long term climate change that may now be occurring at an unprecedented rate. These existing pressures will demand the development and implementation of appropriate methods to address issues of vulnerability to weather and climate.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

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Map1 Intervention Areas in U.P. and Bihar



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 [Agro Meteorological Services of India Met Department].

Broad Spectrum of Weather Advisory

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 (Map 1). 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. The agro met advisory available has a very 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. Sowing/ transplanting of kharif crops based on onset of monsoon.
2. Fertilizer application based on wind conditions.
3. Delay in fertilizer application based on intensity of rain
4. Irrigation at critical stage of the crop.
5. Quantum and timing of irrigation using meteorological threshold.
6. Advisories for timely harvest of crops
7. Location specific block level weather advisories
8. Prepared in local language (Hindi) and send by text messages
9. Suggest measures to minimise the loss
10. Optimise input in irrigation, fertiliser or pesticides.
11. Early warning function
12. Alerting the implications of various weather events like extreme temperatures, heavy rains, floods, and strong winds.

Objective

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.

METHODS

To meet the mentioned objectives, GEAG has established two Automatic Weather Station and 12 rain gauges with 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.

Process Mechanism

Step.1: Collection of weather data 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 GEAG 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 (Hindi) 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 centre and farmers field school so that whole village will be able to get this advisory.

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 gatherings etc., 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.

GEAG 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 (Figures 1-6).

- 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

In each village, near about 250-300 farmers are getting this information through display board placed at village resource center (VRC) and 10-15 % farmers use this in their agricultural practices (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 Gorakhpur district. Four communities were interviewed in each block including women farmers ranging from peri-urban to rural. On the basis of four year experiences the results are as follows.



Fig.1. Temperature data recording by model farmer



Fig.2 Rainfall data recording by model farmer



Fig.3. Information dissemination through display board at village resource center



Fig.4. Information dissemination at farmer field school



Fig.5. Onsite advisory message received on farmer phone



Fig.6. Onsite advisory message received by women farmer

Table 1 Farmer's information through display board placed at village resource center (VRC)

District	No. of Blocks	No. of Village	Male Farmers	Female Farmers
Gorakhpur	4	60	3800	1700
Maharajganj	1	15	1000	550
Kushinagar	1	15	750	450
Santkabinagar	1	15	750	360
Mahoba	1	15	950	350
West Champaran	2	30	980	560
Total	10	150	8230	3970

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 heat waves 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 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 GEAG promotes addresses both sides of this equation by reducing inputs use and therefore cost and 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 85–90%, with no transmission reliability problems that seriously undermine access and use. Most of the groups said that, importance of weather information is 70–75% 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 6 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.

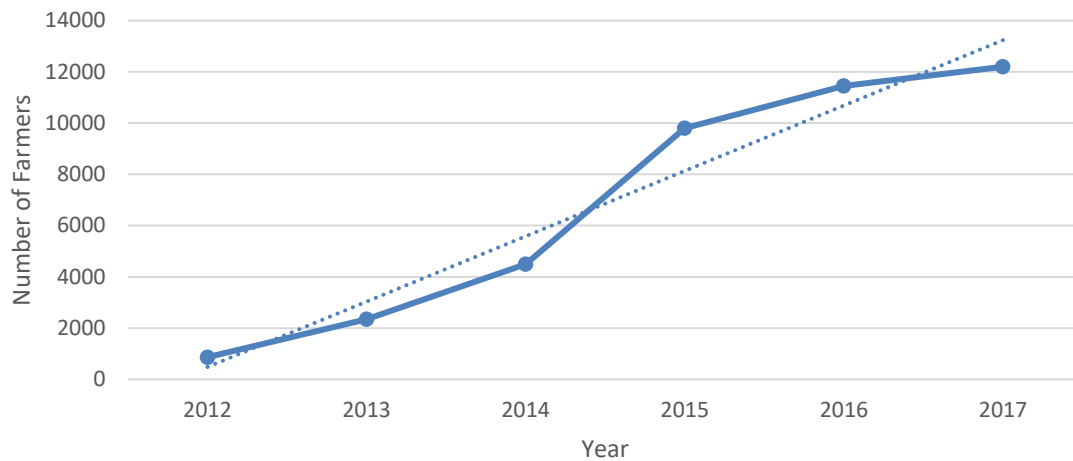
2. Irrigation management – to avoid either unnecessary irrigation (and therefore irrigation costs) prior to rainfall or damaging a crop with excess moisture if irrigation is followed by heavy rain.
3. Timing of pest control measures, using humidity and wind speed and direction information to decide bio-pesticide 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.

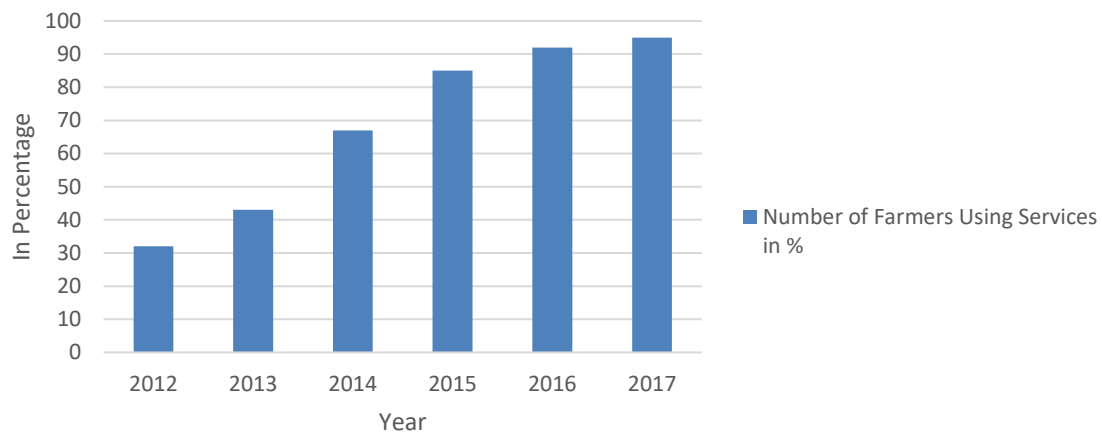
Twenty-five villages also described drought indicators which were perceived as very reliable. Bamboo flowering, fruiting and dying indicated severe drought, as did the winter temperatures – warm in mid-January, cold nights in mid-May and heavy first rains from mid-April to mid-May all suggested a drought 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, increased crop pests and diseases, livestock and human health – were the most important categories (especially waterlogging) 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

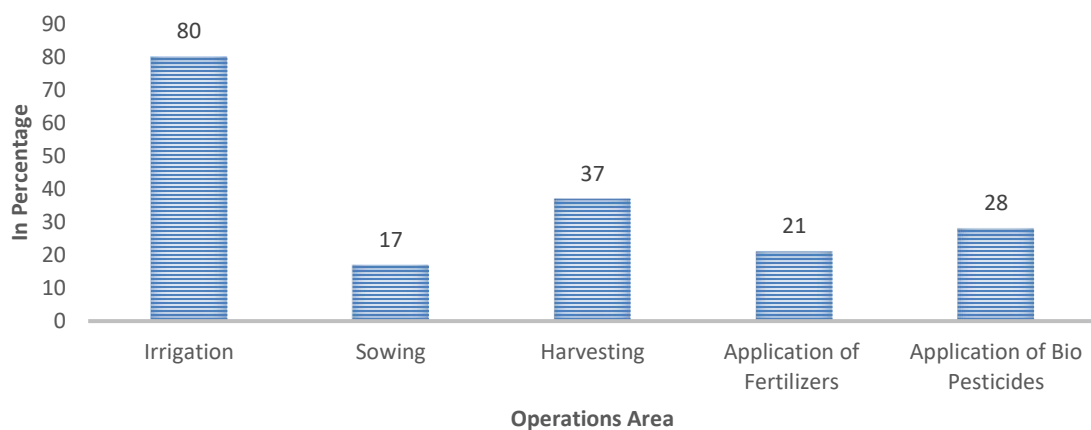
Number of farmers receiving services

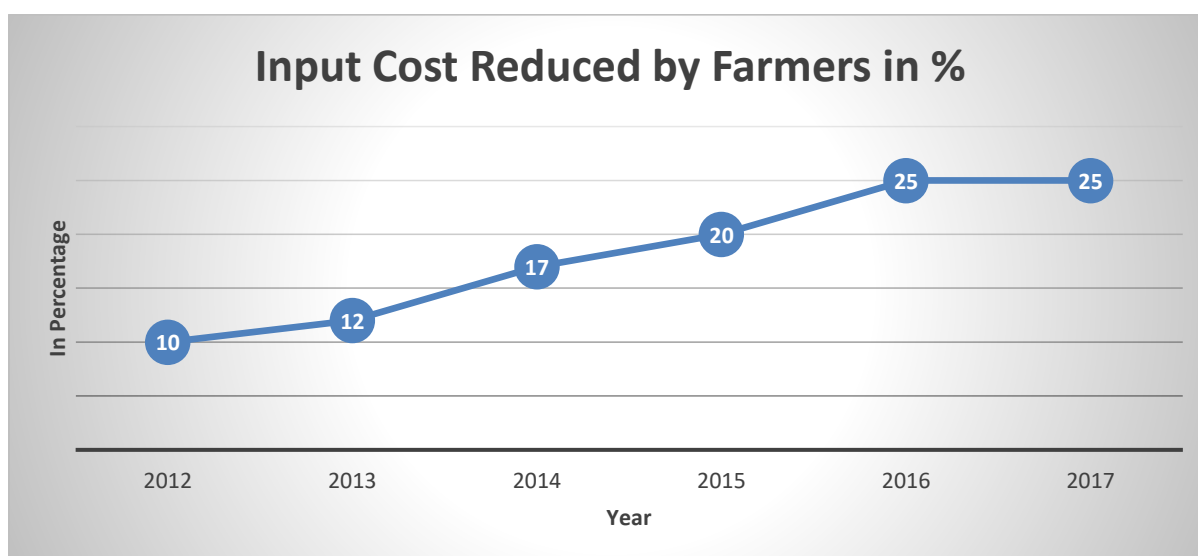
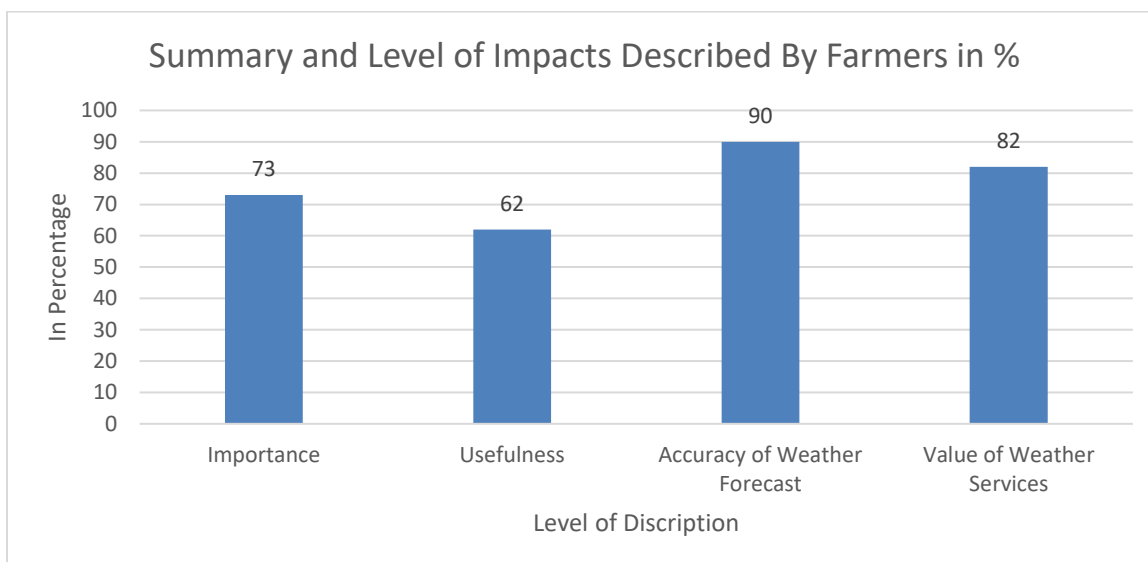


Number of Farmers Using Services in %



FARMERS USE IN % (AREA OF OPERATIONS)





science and expressed interest in considering other climate services, such as the seasonal forecast, within the same system.

CONCLUSION

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 GEAG, 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 10-25% 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 two most popular (SMS 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). 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.

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