Assessment of India's Agro-Meteorological Advisory Service from a farmer perspective

Working Paper No. 54

CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS)

Kalpana Venkatasubramanian
Arame Tall
James Hansen
Pramod Aggarwal

CGIAR
RESEARCH PROGRAM ON Climate Change, Agriculture and Food Security
CCAFS

Working Paper

Assessment of India's Integrated Agro-meteorological Advisory Service from a farmer perspective

Working Paper No. 54

CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS)

Kalpana Venkatasubramanian
Arame Tall
James Hansen
Pramod Aggarwal

Correct citation:
Venkatasubramanian, K., A. Tall, J. Hansen, P. K. Aggarwal 2014. Assessment of India's Integrated Agro-meteorological Advisory Service program from a farmer perspective. CCAFS Working Paper no. 54. CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). Copenhagen, Denmark. Available online at: www.ccafs.cgiar.org

Titles in this Working Paper series aim to disseminate interim climate change, agriculture and food security research and practices and stimulate feedback from the scientific community.

This document is published by the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS), which is a strategic partnership of the CGIAR and the Earth System Science Partnership (ESSP). CCAFS is supported by the CGIAR Fund, the Danish International Development Agency (DANIDA), the Australian Government Overseas Aid Program (AusAid), Irish Aid, Environment Canada, Ministry of Foreign Affairs for the Netherlands, Swiss Agency for Development and Cooperation (SDC), Instituto de Investigação Científica Tropical (IICT), UK Aid, and the European Union (EU). The Program is carried out with technical support from the International Fund for Agricultural Development (IFAD).

Contact:
CCAFS Coordinating Unit - Faculty of Science, Department of Plant and Environmental Sciences, University of Copenhagen, Rolighedsvej 21, DK-1958 Frederiksberg C, Denmark. Tel: +45 35331046; Email: ccafs@cgiar.org

CCAFS Working Paper no. 54

stated herein are those of the author(s) and do not necessarily reflect the policies or opinions of CCAFS, donor agencies, or partners.

Abstract

This report summarizes the results of the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) commissioned evaluation of India's Integrated Agro-meteorological Advisory Service (AAS). Conducted June-July of 2012, this assessment was a joint endeavour of CCAFS, the International Crops Research Institute for the Semi-Arid Tropics, and the India Meteorological Department (IMD). The assessment sought to offer transferable lessons that can guide investment in climate/agro-meteorological advisory services elsewhere in the world. Researchers conducted focus groups and individual interviews with 132 male and female farmers in eighteen villages across six states about how they receive and use AAS advisories, perceived gaps, and suggestions for improvement. The assessment uncovered the key role of diverse communications approaches. In villages where many communications channels were used to disseminate AAS information, such as SMS and voice messaging, meetings and trainings with agricultural extension officers, local knowledge centers, farmers clubs, and announcements over the microphone in villages, awareness and use of AAS advisories was higher. Farmers noted that trainings and discussions with agricultural extension officers at the village level were their preferred form of receiving information. However, ensuring wide representation in discussions is critical. In villages where women were fully engaged in receiving and disseminating AAS information, use and potential benefit from the program were maximized. Women overall had lower awareness of AAS than men do, indicating the importance of targeting women and information that responds to the demands of women in communications efforts. The establishment of specific trainings and discussions on AAS for women farmers in the villages was recommended by farmers, as were trainings and interactions with scientists that all farmers can attend. Membership in women's or farmers groups may be a positive factor in increasing awareness of AAS information, and extension services targeting existing local groups could be a strategy for increasing the impact of AAS information.

Keywords

climate services; agro-meteorological advisory services; India; South Asia.

About the authors

Kalpana Venkatasubramanian is a doctoral candidate in Geography at Rutgers University. Contact: kalpanav@eden.rutgers.edu.

Arame Tall is a climate services scientist with the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS), based at the International Food Policy Research Institute. Dr. Tall's work focuses on strengthening the contribution of the CGIAR to climate services for agriculture. Contact: A.tall@cgiar.org.

James Hansen is a Research Scientist at the International Research Institute for Climate and Society (IRI), where he leads CCAFS Theme 2: Climate Risk Management. Contact: Jhansen@iri.columbia.edu.

Pramod Aggarwal is the Regional Program Leader for CCAFS South Asia. He is based at the International Water Management Institute in New Delhi, India. Contact: P.k.aggarwal@cgiar.org.

Acknowledgements

This evaluation was made possible thanks to the generous support of the following organizations: the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS), the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and the India Meteorological Department (IMD).

CCAFS is supported by the CGIAR Fund, the Danish International Development Agency (DANIDA), the Australian Government Overseas Aid Program (AusAid), Irish Aid, Environment Canada, Ministry of Foreign Affairs for the Netherlands, Swiss Agency for Development and Cooperation (SDC), Instituto de Investigação Científica Tropical (IICT), UK Aid, the Government of Russia and the European Union (EU). The Program is carried out with technical support from the International Fund for Agricultural Development (IFAD).

The following organizations need to be acknowledged for their support and facilitation of field study: IMD, State Agricultural Universities, AMFUs, Regional Meteorological Centres and KVKs in Andhra Pradesh, Himachal Pradesh, Tamil Nadu, Gujarat, Punjab, and West Bengal, and local field teams who helped carry out the surveys in each location.

Thanks is also owed to CCAFS intern Namhee Yun, who provided analysis of individual interview data, and CCAFS interns Vivienne Dersin and Matthias Pfaff, who assisted in collection of survey data.

Contents

Acronyms

AAS	Agro-meteorological Advisory Service
ATMA	Agricultural Technology Management Agency
AWS	Automatic Weather Station
AICRPAM	All India Coordinated Research Project on Agro-Meteorology
AMFU	Agro-Meteorological Field Unit
CSC	Common Service Center
DAO	District Agricultural Offices
DIT	Department of Information Technology
ICAR	Indian Council of Agricultural Research
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
ICT	Information and Communications Technology
IIT	Indian Institute of Technology
IMD	India Meteorological Department
IVRS	Interactive Voice Response System
IT	Information Technology
KVK	Krishi Vigyan Kendra
MME	Multi-Model Ensemble
MSSRF	M.S. Swaminathan Research Foundation
MWS	Manual Weather Station
NCMRWF	National Centre for Medium Range Weather Forecasting
NGO	Non-Governmental Organization

NREGA	National Rural Employment Guarantee Act
NWP	Numerical Weather Prediction
SAU	State Agricultural University

Introduction

Managing the risk associated with climate variability is integral to any comprehensive strategy for adapting agriculture and food systems to a changing climate. Although farming communities throughout the world have survived by mastering the ability to adapt to widely varying weather and climatic conditions, increasingly erratic climate variability and the rapid pace of other drivers of change are overwhelming indigenous knowledge and traditional coping practices. Effective climate information and advisory services offer great potential to inform farmer decision-making in the face of increasing uncertainty, improve management of climate-related agricultural risk, and help farmers adapt to change.

However, many challenges confront efforts to use climate-related information to improve the lives of smallholder farmers. Based on a review of climate services pilot projects and national programs across Africa and South Asia, and the consensus of experts at the December 2012 workshop Scaling Up Climate Services for Farmers in Africa and South Asia[1] (Tall 2013), these challenges are identified as:

- *Salience:* tailoring content, scale, format and lead-time to farm-level decision-making;
- *Access:* providing timely access to remote rural communities with marginal infrastructure;
- *Legitimacy:* ensuring that farmers own climate services, and shape their design and delivery;
- *Equity:* ensuring that women, poor and socially marginalized groups are served; and
- *Integration:* providing climate information as part of a larger package of agricultural support and development assistance, enabling farmers to act on received information.

Several initiatives in sub-Saharan Africa and South Asia have used innovative approaches to overcome these challenges. A few national agro-meteorological advisory services reach a significant proportion of their farming populations on a sustained basis with information and guidance. One of the oldest and longest standing of these national initiatives is the Integrated Agro-meteorological Advisory Service (AAS) in India, which has recently received a lot of publicity for reaching three million farmers via mobile phone, and for its efforts to scale up its reach. Improving climate-related information products and services for agriculture and food security is part of the agenda of the CGIAR Research Program on Climate Change, Agriculture and Food Securing (CCAFS), under its Research Theme on Climate Risk Management. CCAFS is working to synthesize knowledge and evidence on institutional arrangements and communication processes for enhancing climate services for farmers. As part of these efforts, CCAFS partnered with the India Meteorological Department (IMD) and the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) to conduct an in-depth study of AAS, with a focus on capturing what is happening at the village level and how it is impacting rural communities.

[1] For more information on this workshop please see www.scalingup.iri.columbia.edu.

The overall objective of the AAS assessment is to provide evidence of use and benefit from AAS advisories at the village level; and insights about factors that have contributed to their uptake, impact and sustainability. It envisages strengthening of evidence and offering transferrable lessons that can guide investment in climate/agro-meteorological services elsewhere in the world. The documentation of best practices and challenges in the provision and use of agro-meteorological advisories is expected to guide further investment and targeted efforts in climate/weather services in India, the rest of South Asia, and Africa. Although India's national initiative still faces challenges related to the complexities of communicating and applying seasonal forecast information, the program demonstrates good practice and provides valuable insights for efforts to bring climate services to scale in other countries and regions.

Background

AAS Program in India

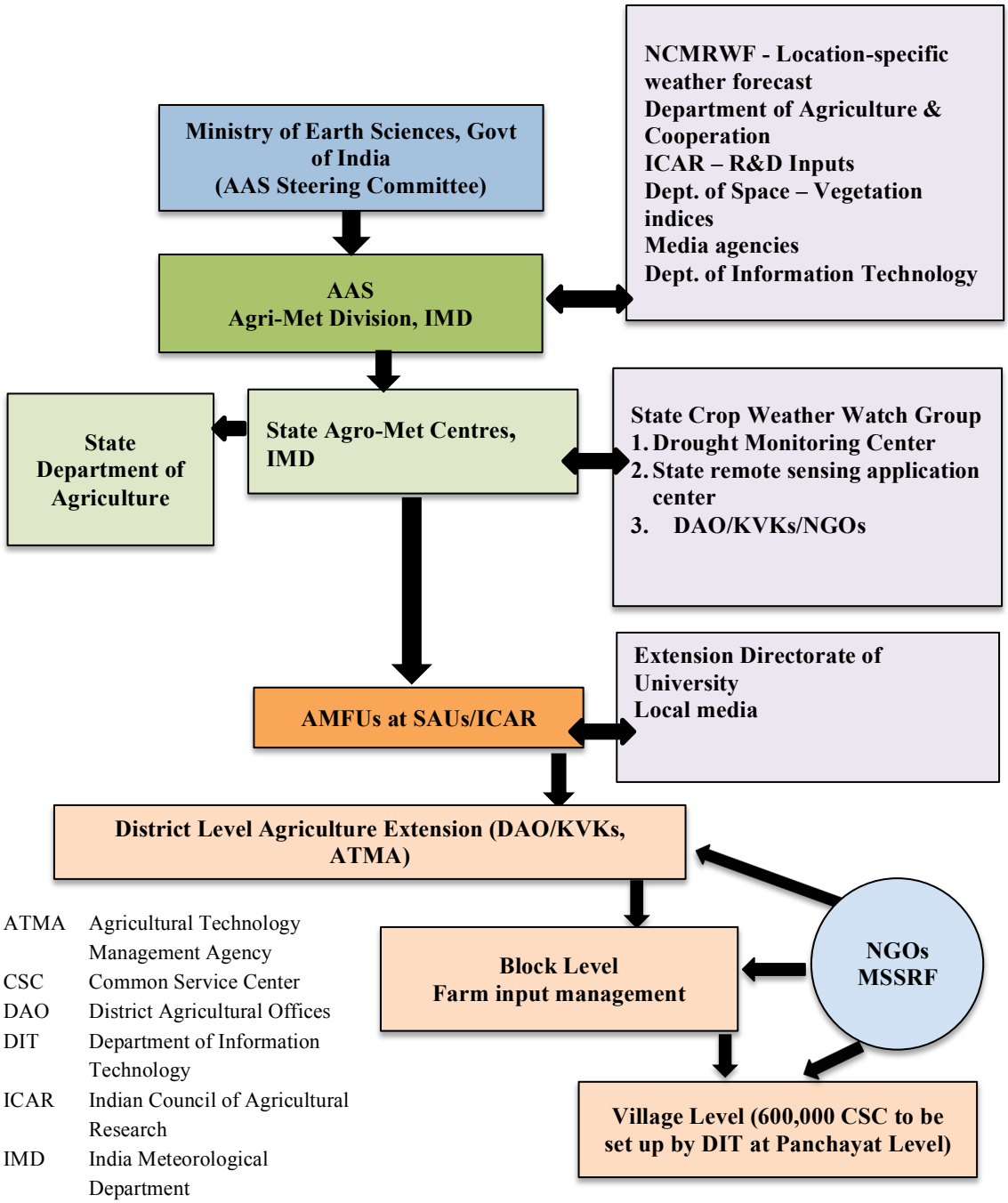
Agriculture being the mainstay of a majority of people in India and an important contributor to economic growth, advances in agro-meteorological expertise and its application in agricultural planning and production has been a significant agenda of the Indian Government as early as the 1930s, when the division of agro-meteorology was started. Since then, a number of initiatives have been undertaken to improve and expand on agro-meteorological faculties and facilities across the country. Agro-meteorological advisories were first initiated in 1976 to provide state level forecast-based advisories to farmers based on short-range weather forecasts issued by the IMD. Made available to farmers one day in advance, it was believed that these advisories could be expanded to enhance planning for weather based agricultural practices and/or undertaking precautionary measures, which required a much longer lead-time.

In agriculture, location-specific weather forecasts in the medium range (3-10 days in advance) hold greater potential for salience. In addition, forecasts issued can be fine-tuned to the specific requirements of farmers, particularly in recommending activities and modifications to specific agricultural practices. Keeping these in mind, the National Centre for Medium Range Weather Forecasting (NCMRWF) was established in 1988 by the Government of India as a scientific mission to develop operational Numerical Weather Prediction (NWP) models for forecasting weather in the medium range. For disseminating these forecasts and for building forecast based agricultural advisories, Agro-Meteorological Field Units (AMFUs) were created across the country in 127 agro-climatic zones, with infrastructural and technical support jointly from the Department of Science and Technology (DST), IMD, Indian Council of Agricultural Research (ICAR) and State Agricultural Universities (SAUs) around the country.

By 2006, 86 fully functioning AMFUs located in SAUs were receiving medium range weather forecasts twice a week valid for a 4-5 day period from the NCMRWF. Based on these forecasts, the AMFUs prepared weather-based agro-advisory bulletins in consultation with a team of agricultural scientists. The advisories, prepared in both English and a local

language were then disseminated to farmers through a variety of communication channels including radio, television, newspapers and telephones. Due to the expansive nature of its production and dissemination, the AAS was soon held as an example of a successful multi-institutional and multi-disciplinary operation rendering a valuable service to the farming community in India.

In 2007, the AAS was integrated with IMD under the Ministry of Earth Sciences and the District-level Agro-meteorological Advisory Service (DAAS) was launched in June 2008. DAAS aims to generate district level agro-meteorological advisories based on weather forecasts and improve dissemination of advisories to farmers to help with decision making in crop and livestock management. DAAS continues to be a multi-institutional project involving a variety of stakeholders including the ICAR, SAUs, Krishi Vigyan Kendras (agricultural extension centres (KVKs)), Department of Agriculture and Cooperation, State Departments of Agriculture/Horticulture/Animal Husbandry/Forestry, NGOs and media agencies (figure 1). The entire project runs through a series of services across a four-tier structure that includes meteorological (weather observation and forecasting), agricultural (identification of weather-sensitive stress and preparing suitable advisory using weather forecast), extension (two-way communication with users) and information dissemination services (media, Information and Communications Technology (ICTs) and others). In 2011, the provision of experimental block (sub-district) level forecasts for a few states was initiated and is currently in the process of expansion.



ATMA	Agricultural Technology Management Agency
CSC	Common Service Center
DAO	District Agricultural Offices
DIT	Department of Information Technology
ICAR	Indian Council of Agricultural Research
IMD	India Meteorological Department
KVK	Krishi Vigyan Kendra
MSSRF	M.S. Swaminathan Research Foundation
SAU	State Agricultural University

Figure 1. Collaborating organizations and their linkages under AAS

Source: IMD, New Delhi

Today, IMD issues quantitative district level 5-day weather forecasts twice a week using a Multi-Model Ensemble (MME) technique based on forecast products from models available in India and other countries (Ramakrishna 2013). Weather forecasts for seven parameters

(rainfall, maximum and minimum temperatures, wind speed and direction, relative humidity and cloudiness) as well as weekly cumulative rainfall forecasts are generated. These products are disseminated to Regional Meteorological Centres and Meteorological Centres of IMD located in different states. Experts in these centres value-add to IMD forecast products, which are then communicated to 130 AMFUs located within SAUs, ICAR Institutes, and Indian Institutes of Technology (IITs).

The AMFUs represent each of the 130 agro-climatic zones in the country, each covering 4-6 districts. Apart from recording agro-meteorological observations for their respective zones through manual and automatic weather stations, these units are assisted by an advisory board consisting of agricultural scientists representing a wide spectrum of agricultural disciplines in preparation of district-wide agro-advisories. These advisories contain location and crop-specific farm-level advisories as well as descriptions of prevailing weather, soil and crop conditions, and suggestions for taking appropriate measures to minimize losses and optimize inputs in the form of irrigation, fertilizer or pesticides.

The AMFUs are also responsible of dissemination of advisory bulletins to farmers in their respective zones. This is done through several communication channels (figure 2) including mass media (newspapers, television and radio) and through the involvement of district level agencies (District Agricultural Offices, KVKs, Kisan (farmer) Call Centres, NGOs) to build on existing extension channels. More recently, cellular phones (voice mails and SMS) and the Internet are also becoming popular channels of dissemination. SMS service already reaches 2.5 million farmer users across 16 states and voicemails via an Interactive Voice Response System (IVRS) reach 30,000 farmers across five states. In addition to reaching famers to communicate agro-advisory bulletins, a feedback mechanism has been developed in order to receive inputs from farmers on the quality of forecasts, relevance of advisories, and effectiveness of dissemination channels. New initiatives are underway to improve and expand dissemination to reach more farmers in a timely manner.

Web-based services have been greatly improved and expanded to provide agro-meteorological information to users at all times through the Internet. Beginning with 25 centres across different agro-climatic zones in the country, the All India Coordinated Research Project on Agro-Meteorology (AICRPAM) of ICAR has launched a website (Crop Weather Outlook) for easy and immediate access to agro-meteorological information and value added services provided by agricultural institutions. In several states, district-wise advisories issued bi-weekly are available online for immediate use by users. Linkages are also provided to other institutional web-links that can provide further information on agro-meteorological operations to users.

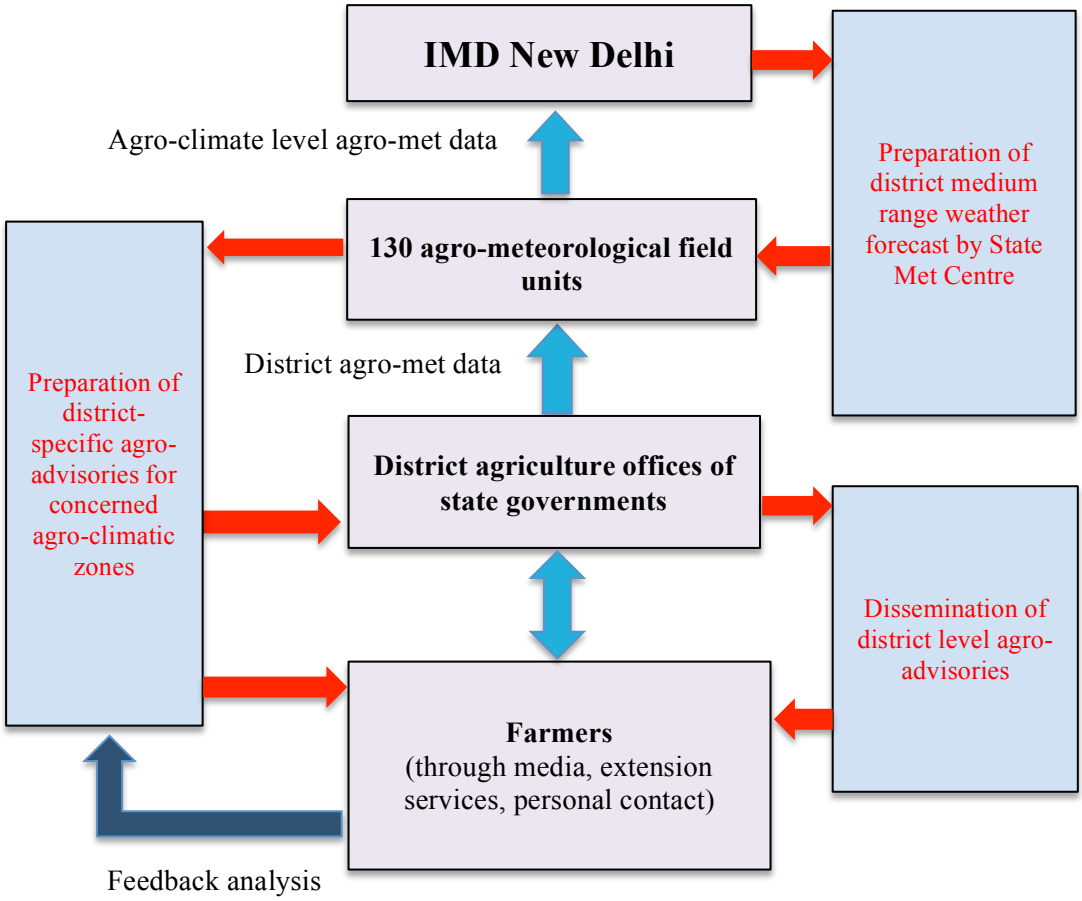


Figure 2: AAS institutional mechanism to reach farmers

Source: IMD

Progress and assessment of AAS program

Progress and future plans

Several important investments have been made to expand the meteorological infrastructure to improve data collection. Automatic Weather Stations (AWS) are being installed in all AMFUs across the country. Currently more than 40 have been installed with AWS that relay weather data directly to the Earth Station at Pune for further processing.

IMD issues district-level forecasts for over 500 districts (~75% of all districts) across India to 130 AMFUs for preparation of district level agro-advisories. AMFUs value-add to the weather forecasts and prepare agro-meteorological advisory bulletins. They are also engaged in collecting weather indicators through Manual Weather Stations (MWS) in their districts. In several cases, farmers have been trained to record weather data every day and facilitate its compilation. To improve dissemination of advisories and reach, linkages have been established with KVKs in all participating districts, which help organize vocational training programs for farmers on the latest technologies. Further, links are also being made with the Agricultural Technology Management Agency (ATMA) program, which has a well-

defined structure at the state, district and block level to help with dissemination of AAS information.

Going forward, block-level advisories based on medium range weather forecasts are being contemplated, and have been underway on an experimental basis in a few states since 2011. Detailed plans are being drawn up in identified areas to increase application of agro-meteorological expertise and reduce farmer vulnerability, including agricultural insurance and greater links with fisheries and livestock sectors. Use of remote sensing techniques as well as crop growth simulation models are further being considered to improve reliability and relevance of agro-advisories. Finally, plans to augment extension services to scale up services from three to 10 million farmers include establishment of AMFUs at the district level, and creating linkages with Common Service Centers being set up by the Department of Information Technology, Government of India that provide a range of services to the farming community.

Feedback from AAS stakeholders and recommendations

Discussions with staff at IMD, Regional Met Centres, AMFUs and other institutional representatives (NGOs, KVKs) involved in the development and dissemination of the forecast advisories revealed important aspects of the functioning of the program. This section presents the overall feedback received from their offices for further improvement of the AAS program.

Several KVK officers contended that those farmers who received and had begun to use the advisories to inform their decision-making had begun to trust and value the information and benefit from it. However, they added that there was still scope for integrating farmers' perspectives and knowledge into the AAS process, which would greatly enhance reach and usability amongst the farming community.

Representatives from AMFUs and KVKs sought greater support for collaborating with and training of local bodies like village Panchayats (village governing body), farmer clubs, women's groups and local community organizations to use their existing links with farmers in dissemination of AAS. Greater infrastructural support, particularly enhancement of Information Technology (IT) capacity at the district/village level was also recommended to ensure speedy receipt of advisories through the Internet and their timely dissemination in the village.

Representatives from AMFUs opined that the uptake and response from use of AAS was very encouraging amongst 'progressive'[2] farmers. However, amongst marginal farmers, awareness was still low. More trainings were required to generate interest and motivate farmers to learn about the AAS and use it. Moreover, targeted trainings were necessary to ensure that all marginal groups are comprehensively included. Sustained efforts were required to encourage use of AAS in decision-making, enhance trust and aid effective use.

2 'Progressive' or 'model' farmers are typically wealthier and better educated relative to the majority of farmers, and use newer farmer technologies and practices. They may provide advice and information on farming practices to other farmers.

In some states, AMFU and Regional Meteorological Centre representatives indicated the need the strengthen capacities of KVKs and improve coordination between KVKs and AMFUs. This was seen as crucial to plug the current holes in the dissemination process.

While ties with other departments are part and parcel of the AAS process, representatives recommended more systematic ties and procedures among the Department of Agriculture, Horticulture, Soil Services and Animal Husbandry on the dissemination front to leverage the vast network and resources for reaching the end-users.

Assessment

Intent and goal

A comprehensive understanding of the pathways through which AAS has come to impact the lives of participants was beyond the scope of this assessment. Such an effort would require village-level studies of individual farmer behaviour and social networks, as well as a comprehensive effort to gauge both current agricultural production and measure it against a of reconstructed production baseline. The NCMRWF commissioned a 2003-2007 study to assess the economic impact of AAS, carried out by the National Centre for Agriculture Economics and Policy Research. The study covered 15 AMFUs for 3 *kharif*[3] and 3 *rabi*[4] seasons during 2003-2007, and concluded that farmers could avoid significant losses of farm inputs such as seeds, water, and pesticides and increase yields through the use of AAS advisories in their decision making. Farmers using AAS information were found to achieve a 10-15% increase in yield and a 2-5% reduction in the cost of cultivation over farmers not using AAS.

The present assessment sought to capture aspects of the AAS program that have influenced its ability to reach farmers by collecting farmers' perspectives on the products provided by the program in terms of their *salience* to farmers' decision-making, ability of farmers to *access* products, *legitimacy* of the information provided, and *equity* in reach. Preliminary results were shared at the December 2012 workshop Scaling Up Climate Services for Farmers in Africa and South Asia.

Field site selection

In consultation with the IMD, six states across India were chosen for the study: Punjab in the northwest, Himachal Pradesh in the north, West Bengal in the northeast, Andhra Pradesh in the southeast, Tamil Nadu in the south and Gujarat in the west. To ensure good representation and also to identify and emphasize variability in forecast- based advisories and their applicability and use, three villages located in two to three different agro-climatic zones were selected in each state for the purpose of surveying farmers. These zones were chosen for their variability in geography, climate, agricultural

[3] Monsoon crop in the Indian sub-continent. Usually sown with the beginning of the first rains in July, during the southwest monsoon season. Rice is the main *kharif* crop.
[4] Winter crop in the Indian subcontinent, grown mid-November to April. Wheat is the main *rabi* crop.

landscape and crops farmed, thus enabling the examination of AAS across variable contexts.

Figure 3. CCAFS study site selection.

Six states were selected across India. In each state, three villages from three different agro-climatic zones were randomly selected.

Methodology

The study relies on analysis of a mix of qualitative and quantitative coded survey data to offer a narrative that helps strengthen evidence and offer transferable lessons in climate/weather services for farmers. Annex 1 provides further detail on methods.

The study included a review of the higher level institutional aspects of the program, including a review of program documents from IMD, Regional Meteorological Centres and, AMFUs, and semi-structured interviews with staff at IMD, Regional Meteorological Centres, AMFUs and other institutional representatives (NGOs, KVKs) involved in the development of the forecast advisories and in their dissemination.

The field portion of the study, conducted over a period of two months from 15th June to 15th August 2012, involved focus group discussions (FGDs) with male and female farmer groups in chosen villages and structured individual interviews with male and female farmers selected from FGDs. Annex 1 contains the FGD questionnaire and individual survey instrument.

In each village field interactions began with FGDs with separate male and female groups of farmers. Across all villages, a total of 490 farmers participated in FGDs, 222 female (~45%) and 268 male (~55%).

The FGDs followed a funnel approach whereby farmers were asked a number of questions related to their agricultural practices. These included questions about kinds of crops (livestock) grown (maintained), reasons for these choices, main activities in each crop (livestock), crop wise and activity wise constraints, overall constraints in agriculture (livestock), and risk management practices. The main purpose was to involve farmers in discussions regarding challenges in agriculture and in their livelihoods and in doing so observe the extent to which weather/climate and the associated variability played a significant role in influencing their activities, livelihoods and decision-making.

If, and only if, farmers directly or indirectly alluded to weather or climate-related factors as a significant influence and mentioned forecast-based advisories as being useful, were more direct questions about the relevance and usefulness of AAS brought up in the FGDs. FGDs with male and female farmers lasted approximately an hour and a half each.

FGDs with male and female farmers were followed by structured individual interviews with three to four farmers identified from each group. The selection criteria for individual interviewees was as follows: ensure a broad range of socio-economic classes wherever possible, variable knowledge of AAS, extent and use of AAS, and extent of participation in the FGDs to ensure that those who did not speak much in FGDs were selected for individual interactions

Across six states, a total of 132 farmers were interviewed, 71 female (~54%) and 61 male (~46%). Individual interviews focused on farmers' awareness of the AAS program, and perceptions of the accuracy, relevance, usefulness, and trustworthiness of AAS information. The emphasis here was to seek out specific instances of use of AAS, the kinds of information used, channels through which advisories are received, perceived gaps in content or communication channels and recommendations for improvement of the service. Individual survey results were used to measure criteria including awareness of the AAS program, usefulness, trust and relevance of AAS information, communications channels by which information is accessed, and perceptions of accuracy, for comparison across locations.

Results from both focus group discussions and individual surveys provided information on the implementation of AAS in different locations, agricultural and livelihood practices, climate-related constraints to agriculture, and the role of women in agricultural decision-making. This provided a context for understanding the effectiveness of the implementation of AAS in different locations as measured by individual survey

responses, and for determining good practices in AAS along with specific areas for further improvement.

Results

Key characteristics of research sites

Farming system characteristics

Across the villages in all states surveyed, agriculture was the main source of livelihood and practiced throughout the year, with the exception of Arnej, Gujarat, where agriculture is practiced only once during the dry or *rabi* season from November to April. In ten out of eighteen villages surveyed, agriculture is predominantly rainfed. This was particularly so in Andhra Pradesh and Tamil Nadu where groundwater was in lower supply, and less so in the other states where some form of irrigation (canals, check dams and groundwater) did exist.

In addition to agriculture, livestock (cows, buffaloes, bulls, goat, sheep and chicken) provide additional resources such as milk, meat, manure, and draught power. Many farmers also engaged in other occupations either seasonally or yearly for supplementary income, such as day labour or jobs in nearby towns and villages, local businesses (stitching and tailoring for women in particular) and support from the National Rural Employment Guarantee Act (NREGA) employment income guarantee scheme.

While it is difficult to rank crops across all villages, one can identify major crops that are more common than others and other crops that are important in specific regions. The most common crops across the villages surveyed are paddy rice, maize, cotton, mustard, sugarcane, millets and a variety of vegetables. The more region-specific crops are betel leaves in Prasadpur (West Bengal), tea in Melchowhutty (Tamil Nadu), and horticulture in Chong (Himachal Pradesh) consisting of primarily apples, followed by pears, plums, peaches, apricots and pomegranates.

Characteristics of each state are as follows:

Andhra Pradesh: India's fourth largest state by area and fifth by population, Andhra Pradesh lies on the southeastern coast of India, bordered to the East by the Bay of Bengal and inland by the states of, from north to south, Orissa, Chhattisgarh, Maharashtra, Karnataka and Tamil Nadu. Andhra Pradesh has been historically known as the rice bowl of India; the top five crops by area are rice, cotton, groundnut, pulses, and maize (Government of India, 2011).

Out of the nine agro-climate zones of Andhra Pradesh, the CCAFS team selected two zones for its investigation: Central Telangana Zone (Warangal district) and Southern Telangana Zone (Nalgonda district and Mahbubnagar district). In each zone, one village was randomly chosen to conduct the survey: Baironpalli (Warangal), Nemani (Nalgonda) and Gorita (Mahbubnagar).

In all three villages surveyed, agriculture served as the primary source of livelihood. In addition livestock (cow, bulls, sheep, goat and poultry) provided additional resources. A few male farmers also worked as day labourers and in local businesses. In addition, farmers also engaged in opportunities with NREGA. Key crops across the villages were cotton, paddy, maize, turmeric, pulses, castor and vegetables. All villages face water shortages; groundwater is available but in short supply. Irrigation is done only for a few crops, most prominently paddy in all villages. The rest of the crops are predominantly rainfed.

Himachal Pradesh: Literally translated from Sanskrit as "in the lap of the Himalayas," Himachal Pradesh lies in the northern tip of India, at the foothills of the Himalayas, bordered by Jammu and Kashmir to the north, to the West by Punjab, South by Haryana and Uttar Pradesh, Uttarakhand on the south-east, and by the Tibet Autonomous Region to the East. The top five crops in Himachal Pradesh by area are wheat, maize, rice, pulses and barley (Government of India, 2011).

With agriculture, notably horticulture, as the state's main source of income, Himachal Pradesh is India's fastest growing economy and produces hydroelectric power from its abundant rivers which it sells to neighbouring states. Himachal Pradesh is sub-divided into four agro-climatic zones in all. Rainfall differences are stark from the hilly to valley zones.

The CCAFS team selected three of the four agro-climate zones in Himachal Pradesh for its investigation: the mid hills (Kangra district), the low hills (Una district) and the high hills (Kullu district). In each zone, one village was randomly chosen to conduct the survey: Amtrar in the middle hills of Kangra, Bhanjal in the valley area of Una, and Chong in the highlands of Kullu.

Agriculture and horticulture were the primary livelihood activities. In addition, livestock (cow, bulls, sheep and goat) provided supplementary support and livelihood. A few male farmers also engaged in day labour in nearby towns and women were involved in commercial stitching and tailoring activities as well. Major crops across all villages were wheat, paddy, maize and vegetables. In the hilly village of Chong, horticulture dominated with apples, plums, peaches and apricot being the most important crops.

In Amtrar and Chong irrigation is provided through canals and check dams. Bhanjal, being closer to the plains, is predominantly rainfed agriculture and faces water shortages often. In 2012, with the delayed monsoon, Bhanjal was showing signs of water stress when the team visited. They relied upon a government provided rig for drinking water.

Punjab: Punjab lies in the northwest of India, bordered by Paskistan to the west, Rajhastan and Haryana to the south, and Himachal Pradesh to the east. Straddling both the low plains and western Himalayas regions, Punjab has a mix of plains and hill agriculture. The top five crops in Punjab by area are wheat, rice, cotton, maize and potato (Government of India, 2011).

Out of the four agro-climate zones of Punjab, the CCAFS team selected three zones for its investigation: the Piedmond alluvial/Central plain zone (Ludhiana district), the

Southwest alluvial plain (Bhatinda district) and the Undulating subregion/Siwalik hills (Hoshiarpur district). In each zone, one village was randomly chosen to conduct the survey: Panglian (in Ludhiana), Mehma Sarja (in Bhatinda) and Achalpur (in Hoshiarpur).

Agriculture served as the primary livelihood for farmers surveyed. In addition, livestock (buffalo, cows, sheep, goat and bulls) provided additional resources. Key crops across all villages were wheat (winter crop), paddy (summer crop), cotton, maize, millet (sorghum and pearl millet) and vegetables. In Panglian and Mehma Sarja, farmers relied on groundwater (extracted through tubewells) for irrigation purposes. In Achalpur, reliance on rainwater was higher, though some farmers used groundwater to irrigate a small proportion of their fields. Women in the villages surveyed had a minimal role in agriculture. They are primarily housekeepers in addition to taking care of livestock in some cases.

West Bengal: India's fourth most populous state with over 91 million inhabitants, West Bengal is bordered by the countries of Nepal, Bhutan and Bangladesh, and, from east to south, by the Indian states of Assam, Sikim, Bihar, Jharkhand and Orissa. The top five crops by area in West Bengal are rice, jute, rapeseed, potato, and wheat (Government of India, 2011).

West Bengal is sub-divided into five main agro-climatic zones spread across the sub-Himalayan and Himalayan regions in the north and the Gangetic floodplain in the south. Rainfall, topography and climate differences are stark from the hilly to valley zones.

The CCAFS team selected three zones for its investigation: the Gangetic floodplain zone (Nadia district), the coastal floodplain region (South 24 Parganas district) and the undulating lateritic region (Pashim Midinipur district). In each zone, one village was randomly chosen to conduct the survey: Chandamari (Nadia), Prasadpur (South 24 Parganas) and Keshpur (Pashim Medinipur).

Agriculture serves as the primary livelihood for farmers across the three villages. In addition livestock (cow, goat, and chicken) provides additional resources. Male farmers noted a growing trend towards seasonal migration for wage labour in nearby cities, other states and even out of the country. Farmers (both male and female) engaged in local business as well. Key crops across all villages are paddy, jute and mustard (Chandamari), Betel leaves (Prasadpur), sesame oil and groundnut (Keshpur) and vegetables. Irrigation in Chandamari and to some extent in Keshpur was provided through shallow pumps and mini wells respectively. In Prasadpur, agriculture was predominantly rainfed.

Tamil Nadu: Tamil Nadu lies on the southernmost part of the Indian peninsula. Bordered, from north to west, by the Union territory of Pondicherry, the states of Andhra Pradesh, Karnataka and Kerala, Tamil Nadu is bound by the Eastern Ghats in its northern flanks, the Nilgiris, Anamalai Hills and Palakkad to the west, by the Bay of Bengal, the Gulf of Mannar and Palk Straight to the east and southeast, and by the Indian Ocean in the south. The top five crops by area in Tamil Nadu are rice, pulses, groundnut, coconut, and sugar cane (Government of India, 2011).

Out of the seven agro-climate zones of Tamil Nadu, the CCAFS team selected 3 zones for its investigation: the Western zone (Dhindugul district), the High altitude and hilly zone (Nilgiris district) and the Northwestern zone (Namakkal district). In each zone, one village was randomly chosen to conduct the survey, respectively Kannivadi (Dhindugul), Melchowhutty (Nilgiris) and Vadavattur (Namakkal).

In all villages surveyed, agriculture served as the primary source of livelihood. In addition, livestock (cow, buffaloes, goat, chicken) provided additional resources. A few male farmersengaged in wage labour on larger agricultural landholdings. Farmers also participated in NREGA. Women farmers mentioned tailoring, stitching and social work as other side occupations. In Kannivadi, maize, cotton and coconut were main crops; in Melchohutty, potato, tea and vegetables dominated; and in Vadavattur, onion, groundnut and fodder crops (sorghum and maize) were primary.

Agriculture is primarily rainfed in all villages. In all villages, less than 50% is served by groundwater irrigation through tubewells.

Gujarat: Located on the northwest coast, Gujarat is bordered by the states of Rajasthan to the north, Maharashtra to the south, Madhya Pradesh to the east, and the Arabian Sea and Pakistan on the west. The top five crops in Gujarat by area are cotton, groundnut, wheat, pearl millet, and rice (Government of India, 2011).

Out of the eight agro-climate zones of Gujarat, the CCAFS team selected three zones for its investigation: North Gujarat (Ahmedabad district), Middle Gujarat (Kheda district) and Southern Gujarat (Bharuch district). In each zone, one village was randomly chosen to conduct the survey, respectively Arnej (Ahmedabad), Dharampura (Kheda) and Nikora (Bharuch).

In all villages surveyed, agriculture served as the primary source of livelihood. In Arnej however, agriculture is practiced only once a year during the dry season from November to April. In addition, livestock (cow, buffaloes) provide supplementary support and livelihood. Male farmers also engaged in agricultural labour and other jobs around the village. Key crops across the villages were wheat, cotton, millet, sugarcane, potato, chickpea and banana. In Dharampura and Nikora, agriculture was based on tubewell irrigation. In Arnej, where dry season agriculture was practiced, agriculture was largely rainfed.

Climate-related challenges

Across all the states, shortage of water was the most cited constraint to agriculture, the predominant reason being erratic and irregular monsoon rains and poor irrigation facilities.

The team however had reason to believe that citation of water shortage as the chief constraint to agriculture may have been influenced by the delayed monsoon in India at the time of field work, which was already beginning to affect water availability and by extension, crop sowing times, choice of crops, and other significant decisions for the season.

Farmers associated irregular and erratic rainfall with several problems. Delayed rainfall (particularly during the southwest monsoon) leads to reduced water for land preparation, delayed sowing, or on certain occasions complete abandonment of staple crops for alternative options or simply leaving the field fallow. Extended interruptions in rainfall also led to poor irrigation and poor crop quality. Erratic rainfall was also linked with wastage of fertilizers and crop protection products, particularly if a rainfall event followed an application resulting in washing away of chemicals. Unanticipated rainfall during harvest time (October-November), particularly in rice and wheat, also poses risk for harvested grains and their rotting and germination. Finally, excess rainfall proved challenging for water drainage from the fields with risk of waterlogging in fields and rotting of crops.

Mitigation in these cases was often post-event unless farmers rely on advisories and the advisories themselves proved accurate in predicting such events. Post-event mitigation included tapping into groundwater resources in case of low or delayed rainfall. However, groundwater extraction is not possible in Gujarat, where groundwater levels are already depleted, or in West Bengal, where saltwater intrusion is a limitation. If rain occurs during harvest, most farmers held that there was significant risk of damage to harvested crop unless it is transported to storage facilities quickly enough, or put out to dry.

Following water shortages, pests and disease were mentioned as the second most important constraint in agriculture across all states. Reasons for heavy pest and disease incidence were associated with weather parameters, foremost being rainfall, temperature and humidity. Examples include ‘angari’ disease in betel leaves during monsoon time (Prasadpur, West Bengal); thrifts in bitter gourd due to irregular rainfall (Chandamari, West Bengal); insects in mustard during winter (Keshpur, West Bengal); potato disease due to heavy fog in winter (Keshpur, West Bengal); looper pest in beans due to sudden temperature increases (Melchowhutty, Tamil Nadu); blight disease in tea leaves due to sudden increases in temperature (Melchowhutty, Tamil Nadu); and sheath blight in onion due to frost (Vadavattur, Tamil Nadu).

Other important constraints mentioned were wild animal attacks (wild boars, wild cows), low profits due to high input costs and decreasing market rates from selling agriculture produce, and labour issues.

In the case of both rainfall variations and pest and disease constraints, farmers often went into heavy debt due to loss of crop, low yields, or borrowing to re-sow their lands. In particularly drought-ridden years, farmers look for alternate sources of employment and income. Pest and diseases require higher investment in pesticides and add further to production costs without any equivalent increase in the price of produce in the market, which leads to low profits, sometimes not even enough to cover input costs and save for the following season’s cultivation.

The two chief constraints being associated with weather parameters thus make evident the potential and scope for weather based agro-advisories to influence agricultural decision making, but more importantly mitigate constraints and improve management of limited resources. In several cases, farmers disclosed that early forecasting of rainfall

events, or variations in rainfall and other weather indicators helped them to better prepare and manage potential losses associated with weather issues and pests and diseases.

Factors influencing farm-based decision-making amongst farmers

In four out of the six states surveyed (Himachal Pradesh, Punjab, West Bengal, and Gujarat), farmers disclosed that they predominantly rely on personal experience, traditional framing practices, the lunar calendar and traditional agricultural festivals as indicators for farm-based decision-making. In some cases they added that they received information on advisories from the agricultural university (this was usually in the village at closest geographical proximity to the agricultural university), while some also mentioned referring to the agricultural calendars that they received during Kisan Melas (Farmer Fairs) in their village (Punjab). While radio and TV were mentioned as a source of information on weather forecasts, these farmers observed that the information was not very specific to their village and hence not helpful.

In Andhra Pradesh and Tamil Nadu, famers expressed considerable confidence in AAS information. In Andhra Pradesh, farmers noted that since the last two years with better communication of advisories in their villages, they were increasingly relying upon AAS to make decisions. In Tamil Nadu, farmers added that they regularly used AAS to determine sowing time, pesticide and fertilizer application and harvesting time (Kannivadi, Tamil Nadu). In Vadavattur, livestock owners observed that advisories had been very useful for them to decide on livestock management and they relied upon them often.

In three out of six states surveyed (Himachal Pradesh, Andhra Pradesh and Tamil Nadu), farmers ranked advisories and related support from the agricultural university/research station or local NGO/extension institution like the KVKs high on the list of agricultural support services they received. In two cases (Himachal Pradesh and Tamil Nadu) they were ranked highest. In the other states, farmers did not declare any support services as preferential.

Implementation of AAS by location

Implementation of the AAS program varies across the diverse agro-climatic zones in the villages surveyed, particularly in terms of the communications channels by which agro-meteorological information and advisories are accessed. The social context of each village also had an impact on how information is accessed and who has access to it.

Andhra Pradesh: Farmers across the three villages surveyed in Andhra Pradesh reporting receiving AAS information through a number of channels: AAS bulletins distributed by the village Met Centre representative and displayed at prominent spots in the village; meetings with the village representative associated with local NGOs; word of mouth and discussions with agro-meteorological scientists or representatives; farmers' club meetings in villages; announcements over the microphone; and local television channels and radio stations.

Women farmers in particular expressed appreciation that they could openly speak to the village representative from the Met Office about the advisories and learn more from him.

Broadcast of AAS information over the microphone was also identified as particularly helpful, especially for farmers who could not read the bulletins or required help to interpret them.

Members of farmers' clubs, particularly in Baironpalli, had better knowledge about the AAS program and could use its information for their benefit. Women farmers in Baironpalli expressed concern that only male members could be part of the farmers' club, limiting their access. That also meant that families with no male members were excluded from membership. Membership was also based on an annual fee, which some farmers felt was unaffordable, thus keeping them out of the farmers' club.

Farmers across all villages in Andhra Pradesh pointed out that in the last two to three years, use of AAS information had increased considerably in all the three villages. While farmers noted that they have traditionally relied on personal experience and on the lunar calendar to determine the type and timing of agricultural operations, they were now increasingly relying on AAS to inform their decision-making.

This was particularly true in Baironpalli, where improved communication channels such as displaying the bulletin in prominent places in the village and announcements over the microphone, as well as interventions by local NGOs to make the AAS program more useful for farmers, has improved usability amongst farmers. Farmers in Baironpalli added that they tend to exclusively rely on AAS now rather than traditional practices to inform farm-based activities. AAS was beginning to significantly influence farm-based decision-making in Nemani and Gorita as well.

However, fee-based membership in male-only farmers' clubs, the main outlet for transmission of agro-meteorological advisories, remains a barrier to women and other socially marginalized groups' access to agro-meteorological advisories.

Himachal Pradesh: Farmers across the three villages surveyed in Himachal Pradesh reporting receiving AAS information through multiple channels, including: meetings at the block level[5] with SAU scientists and experts; radio and television news programs; local newspapers; organizations like the National Bank for Agriculture and Rural Development working in select villages; women's collectives (especially in Amtrar); Panchayat (village governing body) meetings; village level programs such as the World Bank watershed program in Chong; and through KVK extension officers in Bhanjal.

Advisories and agriculture-related information that farmers received from the SAU and trainings at the horticulture research centre were identified as most pertinent and useful. Kisan Melas (Farmers Fairs) and block level meetings with agricultural experts were also mentioned as particularly favourable in receiving information on type and quality of seeds and other related matters. Both male and female farmers supported trainings and discussions in villages as superior forms of dissemination channels. Moreover, the team also observed that because Amtrar is in closer proximity to the SAU in Palampur, farmers

[5] Block' is an administrative division in India. It a sub-division of a district

there are better able to establish channels of communication with the University for timely dissemination of advisories.

With respect to information through extension officers from KVKs, women farmers in Bhanjal lamented that such dissemination was restricted to larger landholders in the village and a majority of smallholder farmers were not part of this network. There also seemed to be gender differences in the type of channel preferred. While male farmers in both Amtrar and Bhanjal identified radio and television as good channels to reach them, women farmers expressed their inability to listen to radio or watch television during the day due to lack of time and engagement with other household and field related activities.

Punjab: Farmers across the three villages surveyed in Punjab reported receiving AAS information through interactions with AMFUs or State Agricultural University experts; agricultural programs on television; newspapers; Kisan Melas (farmer fairs) in the villages; SMS; and the Internet.

Women in all three villages were completely unaware or had little knowledge about the AAS program. They lamented being left out of trainings or meetings in the village and felt that trainings specifically for women should be held.

In Panglian and Mehma Sarja, the better-off 'progressive' farmers received AAS information regularly and were able to benefit from it. They had greater access to the programme due to their connections with AMFUs or extension officers and resources such as Internet access. In some cases they helped organize trainings in the village to disseminate information to other farmers; however, this was not always the case. Moreover, in cases where a project was taking place in a village, such as the climate change project in Achalpur, those associated with it were more likely to be aware of and benefit from advisories than those who were not part of the project, thus creating information asymmetries.

West Bengal: Farmers across the three villages surveyed in West Bengal reported receiving AAS information through seminars and discussions with SAU agro-meteorological scientists; local NGOs (Ramakrishna Mission); women's self help groups; discussions amongst farmers in village teashops; and media including newspapers, television and radio.

In particular, farmers in both Chandamari and Prasadpur pointed out that only a few farmers who had links with the SAU or were part of experimental projects had knowledge about the AAS program and were in a position to benefit from it. While local NGOs such as the Ramakrishna Mission or Sahid Khudiram Sheba Mission did not deliver AAS bulletins, farmers appreciated the agricultural related information on seeds, soil quality and extreme weather forecasts that were disseminated through these organizations.

Women farmers for the most part lamented that they were not part of any meetings and did not directly receive any information about the AAS. They only got some information through their husbands and other male farmers. They insisted that they be included in trainings and meetings on AAS and other agriculture related ones.

Male farmers in both Chandamari and Prasadpur pointed out that only a few farmers, those who were closely associated with the agro-meteorological experts at the SAU and those who were part of experimental projects in Prasadpur, received most of the information from AAS and in a position to use the information appropriately. The majority, they said, were left out of the communication.

Women for the most part were not aware of the AAS program, with the exception of a few women in Keshpur who had some knowledge of it. This could be linked to the minimal role of women in agriculture, as women across the state are mostly involved in household-related work. In Prasadpur, women help with livestock. In agriculture, women go to the fields only when additional labour is required.

Tamil Nadu: Farmers across the three villages surveyed in Tamil Nadu reported receiving AAS information through channels including: AAS bulletins displayed on village bulletin boards; trainings conducted by local institutions or extension units (including the M.S. Swaminathan Research Foundation (MSSRF) Village Knowledge Centre in Kannivadi, the Horticulture Research Station in Melchowhutty, and the KVK in Vadavattur); SMS and phone calls; forecasts on local television channels; and the Internet.

In Kannivadi, farmers remarked that while voicemails delivered to mobile phones was in theory an effective way to receive information, it was not working well so far due network issues in the village. Farmers also indicated that reach and use of AAS was more effective in the case of farmers who were members with the MSSRF Village Knowledge Centre. Most information was communicated through trainings, which only members could attend. Non-members are therefore unable access this information on the same scale and depth that the members are able to.

In Melchowhutty, farmers reported receiving advisories on their mobile phones through SMS. However, several of them could not read the advisories because they were provided in English and not their local language. Some farmers were also not familiar with reading SMS messages on their phones and required additional training.

In Kannivadi, women farmers engaged in agriculture typically during the sowing, weeding and harvesting time. Women farmers have taken a significant interest and initiative in getting information from the MSSRF Knowledge Centre in the village about AAS and other agriculture related information. One of the women farmers has also been a volunteer for recording of weather data from the MWS in the village. Due to her interaction with other women farmers in the village, there was a great deal of enthusiasm amongst women farmers in the village about the usefulness of AAS and on further improvements in it.

Gujarat: Farmers across the three villages surveyed in Gujarat reported receiving AAS information through interactions with SAU or KVK staff at Dharampura; local television channels; and AAS bulletins on the village notice board.

In all three villages in Gujarat, women did not participate much in agriculture. They were not much aware of AAS nor did they receive any AAS information directly and if at all, only through their husbands. They were also not invited for agricultural trainings, meetings or discussions and felt that special efforts needed to be taken to include them in trainings and in information dissemination channels.

Additionally, political divisions were rife in one of the villages. Therein, the current Sarpanch (head of the village government) was found to be part of a political faction, which is different from the previous one. The village was divided into two groups, and when meetings are arranged in the village, if one group came the other stayed out of it. This has created problems of uneven dissemination in the village with asymmetry in access and use of advisories.

Overall AAS program impact from a farmer perspective

This section draws from interviews conducted with male and female farmers across the six states selected. The villages chosen for site visits in each state were based on the need to make the survey geographically varied and yet adequately representative. However, contextual variations at the village level owing to various social, political and economic factors, as well as the presence and absence of interventions by local and international organizations rules out expectations of evenness or similarities amongst villages. The results presented here are intended to capture some salient aspects of the AAS intervention from farmers' perspectives and needs to be treated more as an indication of diversity rather than aiming to be exhaustive.

I. Awareness

In individual interviews, farmers were asked whether they were aware of the AAS program. Across the six states, a total of 67 % of farmers had some awareness about the AAS. Men fared far better than women with 85% awareness, while only 55% of all women farmers interviewed had any awareness of AAS (figure 4).

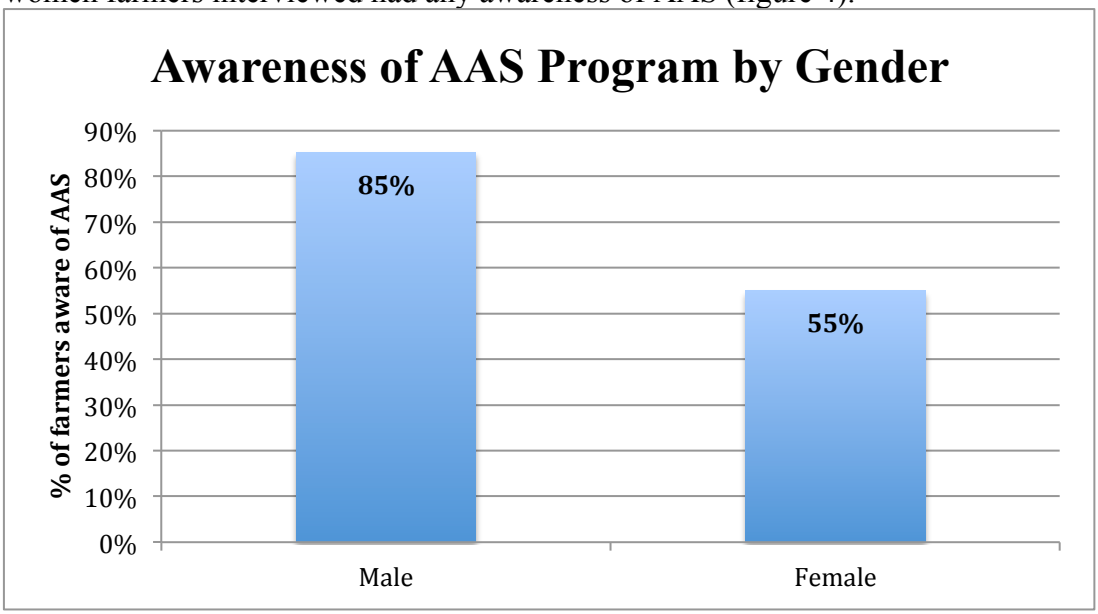


Figure 4. Farmer awareness of AAS by gender.

Male and female farmers interviewed individually in selected villages in Andhra Pradesh, Himachal Pradesh and Tamil Nadu were collectively more aware of AAS as compared to other states. Farmers' awareness of AAS is lowest in West Bengal, at about 50% (figure 5).

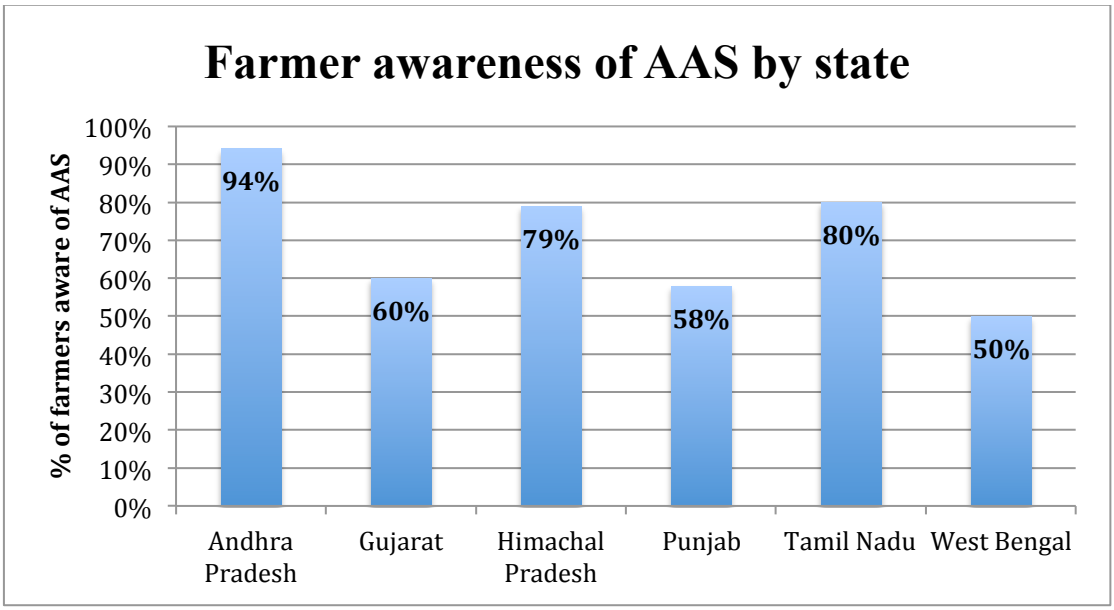


Figure 5. Farmer awareness of AAS by state.

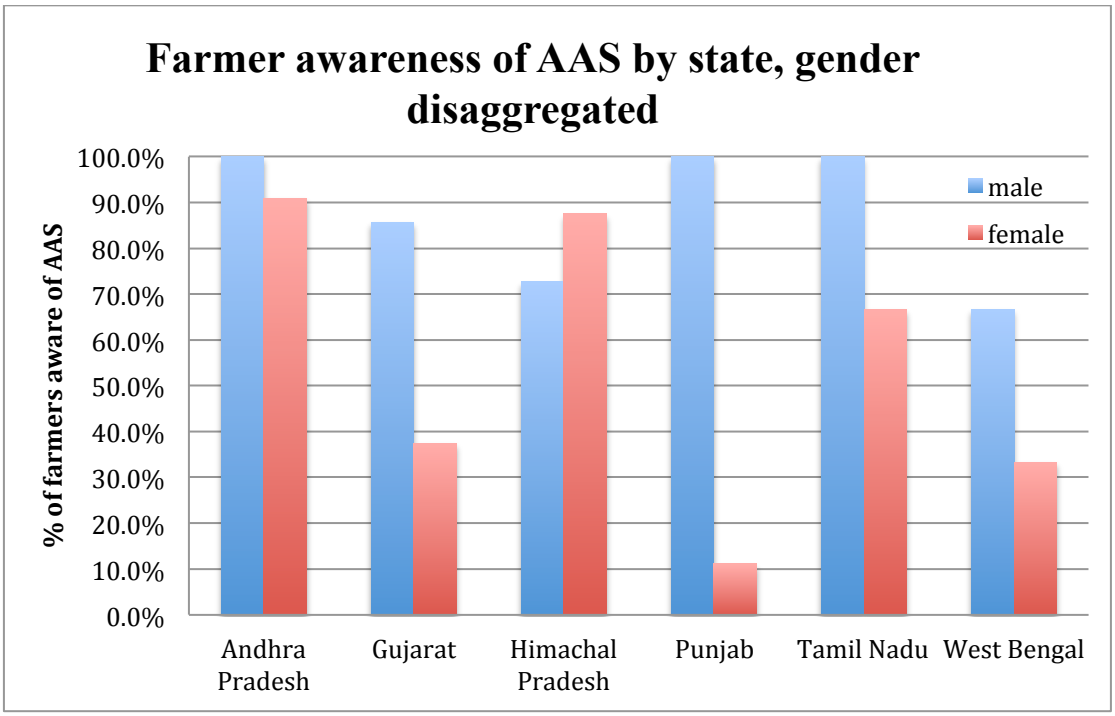


Figure 6. Farmer awareness of AAS by state, gender disaggregated.

In Punjab, while male farmers were as aware as in Andhra Pradesh and Tamil Nadu, the women farmers interviewed had much lower awareness of AAS at 11%. Moreover, in states where women's participation in agriculture was higher in the villages surveyed (Andhra Pradesh, Himachal Pradesh and Tamil Nadu) the percentage of women farmers interviewed that knew about AAS was higher than in other states (figure 6)**.** In Punjab and Gujarat, while awareness of AAS among male farmers was high, women farmers were left out of dissemination channels, and awareness is relatively low. In both states, this is coupled with negligible to no female participation in agriculture in the villages surveyed. In Tamil Nadu, women in the villages surveyed did not have high participation in agriculture, but women's participation in agriculture in the state overall is relatively high. About 67% of women farmers surveyed in Tamil Nadu were aware of AAS. Coupled with data on knowledge of AAS according to farmers' or women's group membership (figure 7), this could be an indication that social networks play an important role in disseminating knowledge about AAS through farmer-to-farmer interaction across villages.

Membership in a farmers' or women's group may have an impact on whether farmers are aware of the AAS program (figure 7). Farmers that indicated attendance at farmers' or women's groups were more likely to be aware of AAS than farmers that did not attend group meetings, highlighting the potential role of groups as a communications vehicle for AAS information. In some villages, it was noted that women's groups are an effective means for disseminating knowledge through word of mouth. However, in some locations (noted in Andhra Pradesh), membership in male only farmers' clubs (as the main outlet for transmission of agro-meteorological advisories) remains a barrier to women and other socially marginalized groups' access to agro-meteorological advisories.

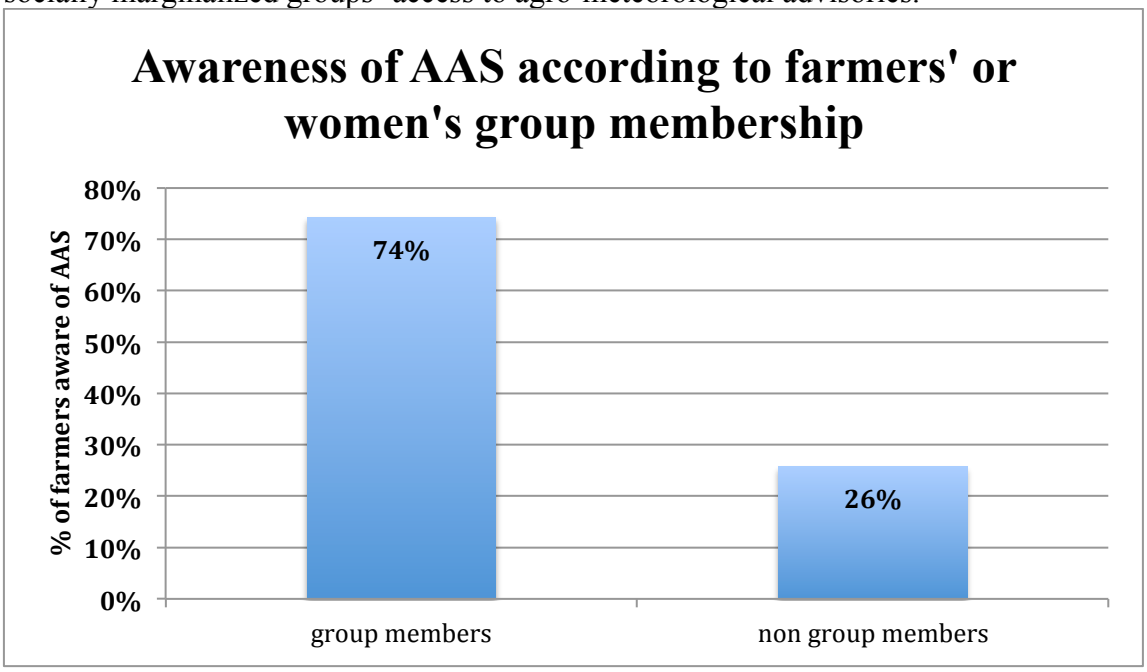


Figure 7. Farmer awareness of AAS according to group membership.

II. Usefulness and frequency of use of AAS

In individual interviews, farmers were asked, "how useful is the AAS advice/information provided to you?" Responses were coded as not useful=1, somewhat useful=3, or useful=5. An average was taken across each state (figure 8), and is also shown disaggregated by gender (figure 9).

AAS information was rated as being most useful in Andhra Pradesh, Tamil Nadu and Punjab, with Himachal Pradesh nearly as high (figure 8). Andhra Pradesh, Tamil Nadu and Himachal Pradesh were also the states with the highest percentages of awareness, while awareness in Punjab was much lower (figure 6).

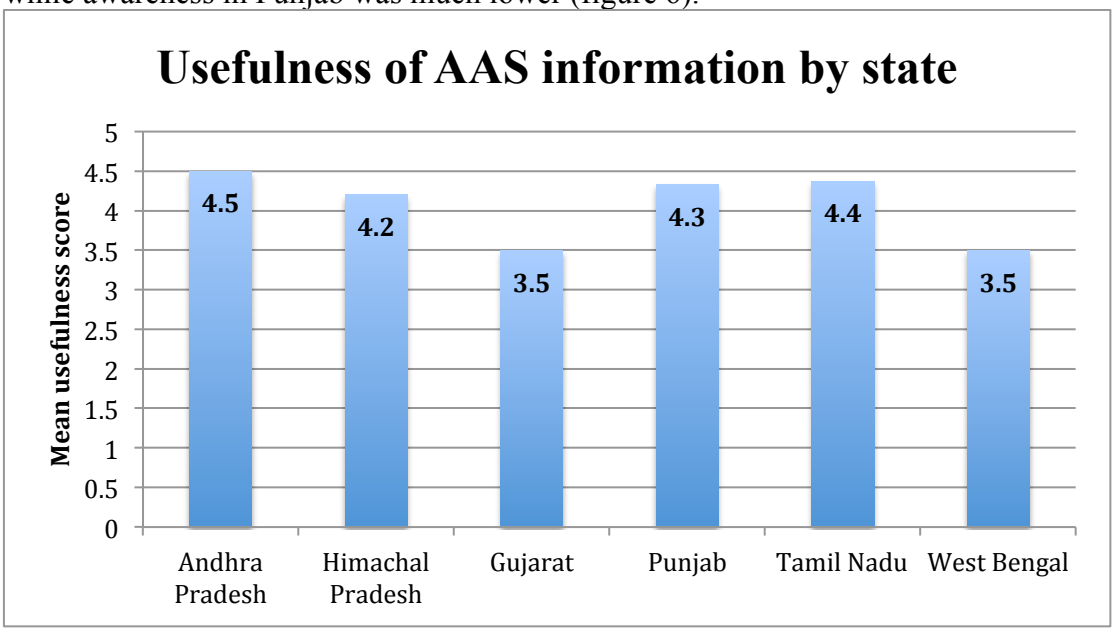


Figure 8. Usefulness of AAS information by state

Women farmers rated AAS information as being more useful than male farmers did in Himachal Pradesh, Gujarat, Tamil Nadu, and West Bengal, while male farmers in Andhra Pradesh rated AAS's usefulness more highly than female farmers did. Female farmers in Punjab did not provide an answer to the usefulness question.

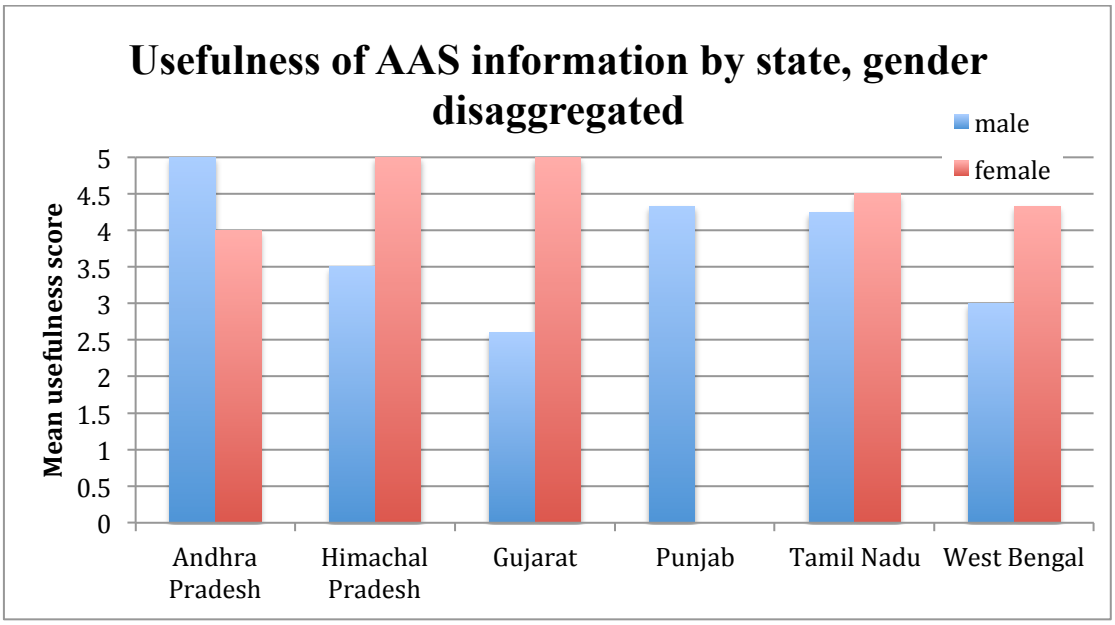


Figure 9. Usefulness of AAS information by state, gender disaggregated

For male farmers interviewed, states where awareness was highest coincided with states where usefulness was highest (Andhra Pradesh, Punjab, and Tamil Nadu)(figures 6 and 9). For female farmers interviewed, those in Himachal Pradesh, Gujarat, and Tamil Nadu had the highest usefulness ratings (figure 9). For female farmers interviewed, Himachal Pradesh and Tamil Nadu were among the highest rated for awareness. Gujarat in fact had a fairly low awareness rating for female farmers, at 38% (figure 6).

In several cases, 'progressive' farmers were in a better position to access and use the advisories in their decision-making. Other reasons for low usability amongst farmers who knew about AAS included the size of land and scale of operations. Some small farmers observed that information from the advisories didn't matter to them much and their traditional practices and experience were enough to manage their fields. In several cases, particularly that of women farmers, they could not use advisories to inform their decision-making due to inability to read the advisories, lack of time to watch radio or television where advisories were relayed or low participation in dissemination activities including meetings and discussions in the village. In a few villages, gender related cultural norms prevented women farmers from participating or joining discussions and trainings that were solely attended by male farmers. In addition, marginal farmers with low resources often found it difficult to follow the recommended doses of fertilizers or pesticides due to high costs or shortage of fertilizers in the local market.

A number of factors come together to ensure that farmers are aware and are able to use AAS to inform their decision-making. Here we give a few important indications of what worked to increase awareness and use of AAS information in the surveyed states:

Andhra Pradesh: In recent years improvements in channels of dissemination have played a big role in increasing awareness and use of advisories in the villages visited. Improved communications include regular (bi-weekly) display of AAS bulletins in prominent places in the village, announcements over the microphone, and dissemination of advisories through local NGOs or through representatives of international projects.

Farmers, particularly women farmers, expressed satisfaction with the increased ability to openly access information through NGO representatives in the village who visit often. Broadcast of AAS information over the microphone was also very helpful, especially for farmers who could not read the bulletins or required help to interpret them. Finally, appointment of local farmers from villages to manage and record data from MWS in the village also goes a long way in making the process of information collection and dissemination more inclusive and open. It also increases discussions amongst farmers and spreads information through word of mouth. The relatively higher levels of awareness and perceived usefulness in Andhra Pradesh may be an indication of the effectiveness of multiple dissemination channels in reaching a larger audience.

Tamil Nadu: Presence of local agriculture-related organizations, particularly the M.S. Swaninathan Research Foundation Knowledge Centre, in villages (in Kannivadi for example) has increased both awareness and use of advisories. The presence of such an organization also helps to ensure regular dissemination of advisories. One of the women farmers in Kannivadi has also been a volunteer for recording of weather data from the MWS in the village. Her role as key personnel in collection of weather data has improved awareness amongst other women. Her interaction with other women farmers in the village has created a great deal of enthusiasm amongst women farmers in the village about the usefulness of AAS and further improvements in it. Regular trainings and discussions with the knowledge centre as well as with staff from the SAU has also helped to improve comprehension and use of AAS. In Vadavattur, advisories are focused on livestock and developed by the Veterinary Laboratory. They focus on the providing livestock-related advisories based on weather forecasts and came out as extremely useful for livestock farmers.

Himachal Pradesh: In some villages (Chong and Amtrar) women played a much larger role in agriculture and had also been organized into community groups who often attended trainings in the agricultural university, horticulture department, interacted with agro-meteorologists and agricultural and horticultural scientists and received information on AAS directly. These women's groups were useful to gather important information and disseminate it in their village through discussions and word of mouth. They have also been useful to increase trust in advisories by encouraging use and showcasing benefits through personal experience. In addition, advisories and agricultural related information that farmers received from the agricultural university and trainings at the horticulture research centre came out as most pertinent and useful. Kisan Melas (Farmers Fairs) and block level meetings with agricultural experts were also mentioned as being particularly favourable for receiving information on type and quality of seeds and other related matters.

Punjab: In some villages, (Panglian and Mehma Sarja) 'progressive' farmers received AAS information regularly through their own initiative and were able to benefit from it. They had better access to it due to their connections with AMFUs or extension officers and resources such as internet and phone access. 'Progressive' farmers also helped organize trainings in the village with other farmers to disseminate information about AAS and its uses. This greatly helped in improving awareness and usability. Moreover, in the case of special projects in a village, such as the 'Climate Change' project in Achalpur,

those associated with it were also exposed to AAS information and advice on how to use it to inform their decision-making.

West Bengal: Farmers here identified seminars and discussions with scientists from SAUs, AMFUs and information channels through local NGOs (Ramakrishna Mission) as being very useful. In some villages women mentioned receiving information through women's self-help groups. Farmers noted that increased informal discussions of AAS information amongst farmers in village teashops also increased awareness.

Gujarat: Farmers perceived dissemination of AAS through SAU extension officers as an important and useful communication channel. In addition, farmers also receive specific information through personal contacts with the Cotton Research Institute, particularly for pests and pesticide application in cotton crop.

II. Frequency of use of AAS

In individual interviews, farmers were asked "how often do you follow the AAS advice provided?" Responses were coded as rarely=1, sometimes=3, or often=5, with an average of each score taken for each state (figure 10), and disaggregated by gender (figure 11).

Farmers in Himachal Pradesh, Punjab, Gujarat and Andhra Pradesh responded that they use AAS information the most frequently (figure 10). West Bengal scored lowest for frequency of use.

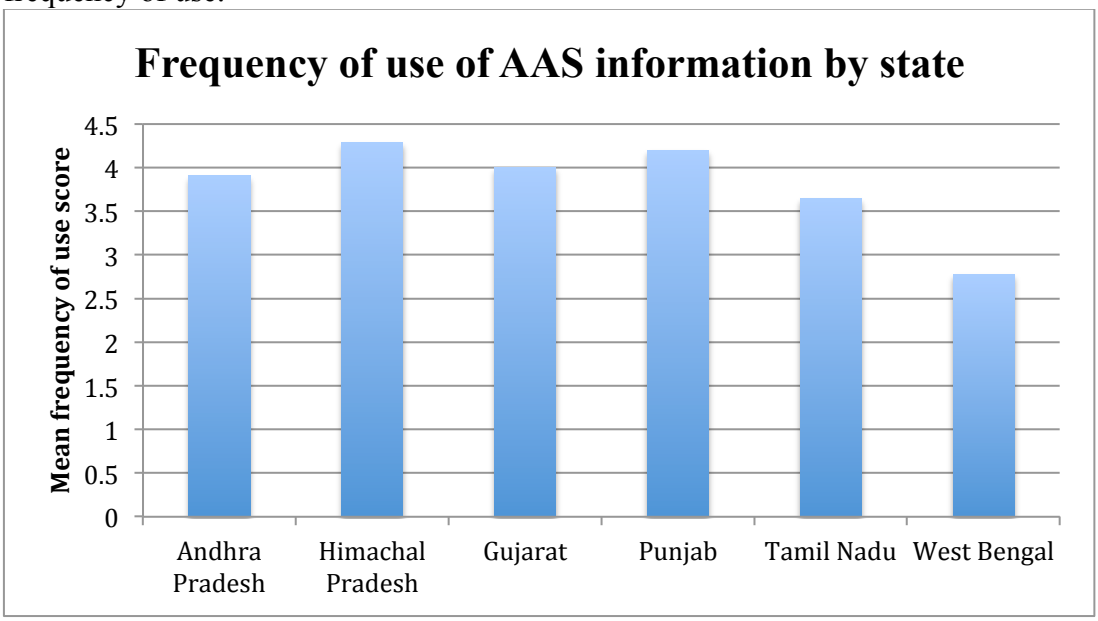


Figure 10. Frequency of use of AAS information by state.

Women farmers responded that they use AAS information most frequently in Himachal Pradesh, Gujarat and Tamil Nadu. Women farmers in Punjab did not provide a frequency of use rating.

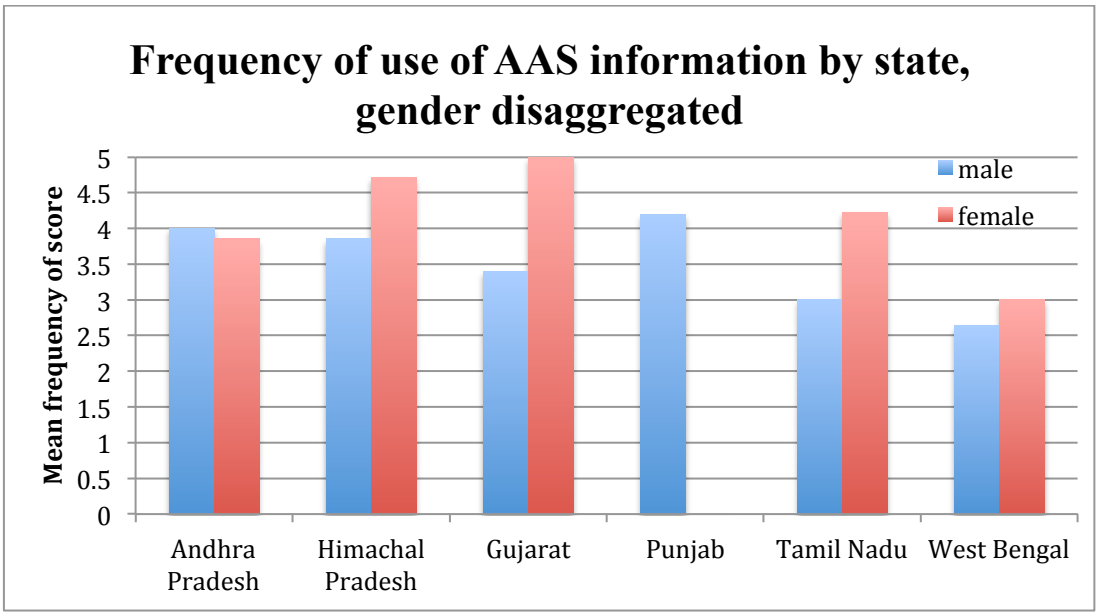


Figure 11. Frequency of use of AAS information by state, gender disaggregated.

Figure 12 demonstrates how often farmers indicated that they follow AAS advice, grouped by their responses as to how useful they find the advice. There appears to be a positive relationship to some degree between how often farmers follow the advice provided, and how likely they are to rate the information as useful.

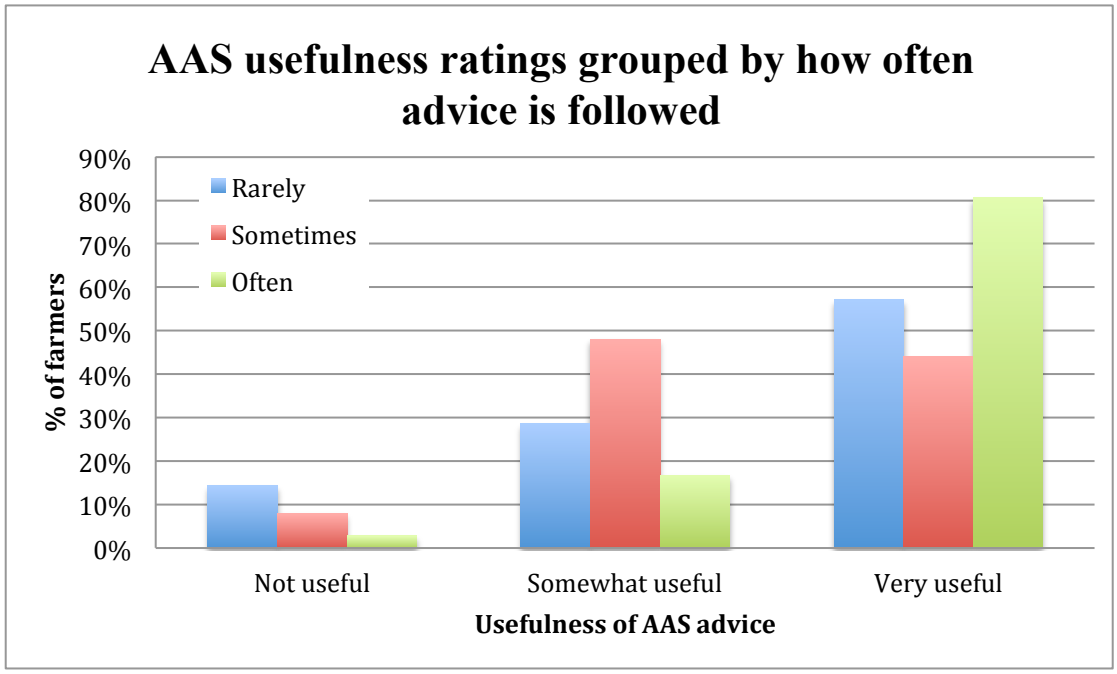


Figure 12. Usefulness of AAS grouped by how often advice is followed.

III. Trust and relevance

In individual interviews, farmers were asked several questions about trust in AAS information and their perceptions of its accuracy and relevance to their village. Farmers were asked, "do you trust the information given to you through AAS?" Responses were coded as do not trust=1, somewhat trust=3, and trust=5, with average scores taken for each state. Farmers were also asked "out of 10 forecasts, how many did you find accurate?" and average percentages taken for each state. Finally, farmers were asked "how relevant is AAS information to your village?" in reference to their perception of whether information is tailored sufficiently to the local context of a village to be useful for management of farm level operations. Responses were coded as not relevant=1, somewhat relevant=3, or relevant=5.

Trust in AAS was highest in Andhra Pradesh, Himachal Pradesh and Tamil Nadu, also the states where awareness of AAS is highest and usefulness was rated highest (figure 13).

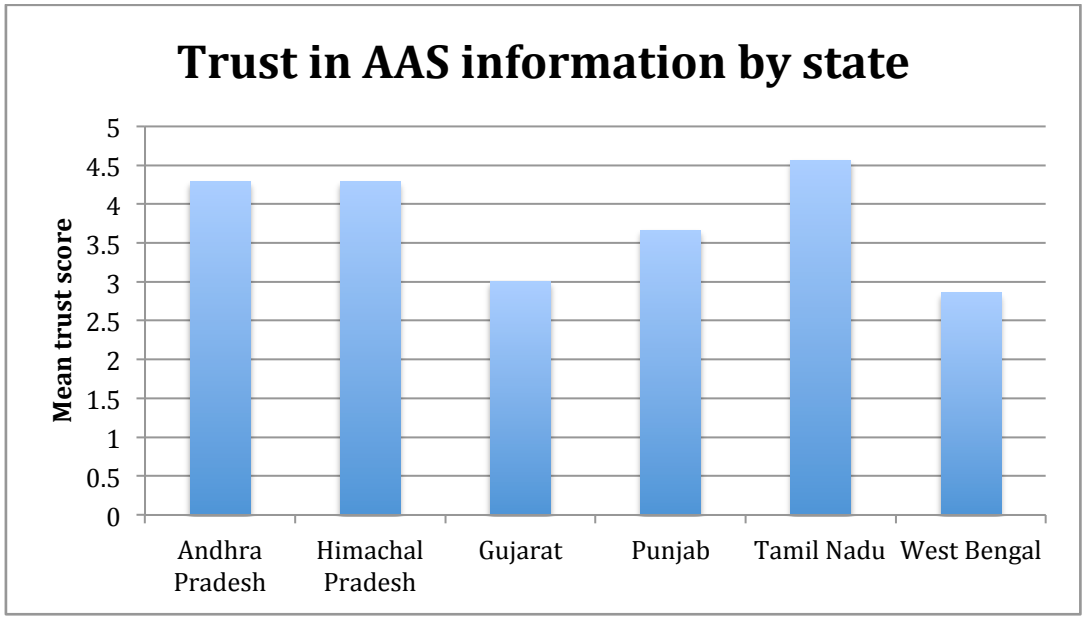


Figure 13. Trust in AAS information by state.

As with usefulness (figure 8), women farmers tended to indicate higher trust in AAS information than male farmers (figure 14). Women farmers in Punjab did not provide a response to the trust question.

Women farmers in Andhra Pradesh, Himachal Pradesh and Tamil Nadu displayed the highest levels of trust in AAS (figure 14). The surveyed villages in Andhra Pradesh and Himachal Pradesh also had the highest levels of women in agriculture, which may be an indication of the importance of social reinforcement of the use of and trust in AAS, as villages with higher rates of women in agriculture tend to show higher levels of awareness and trust of AAS information.

For male farmers, trust overall was highest in Tamil Nadu, Andhra Pradesh and Punjab, states where male farmers also had the highest awareness of AAS (figure 6 and figure 14).

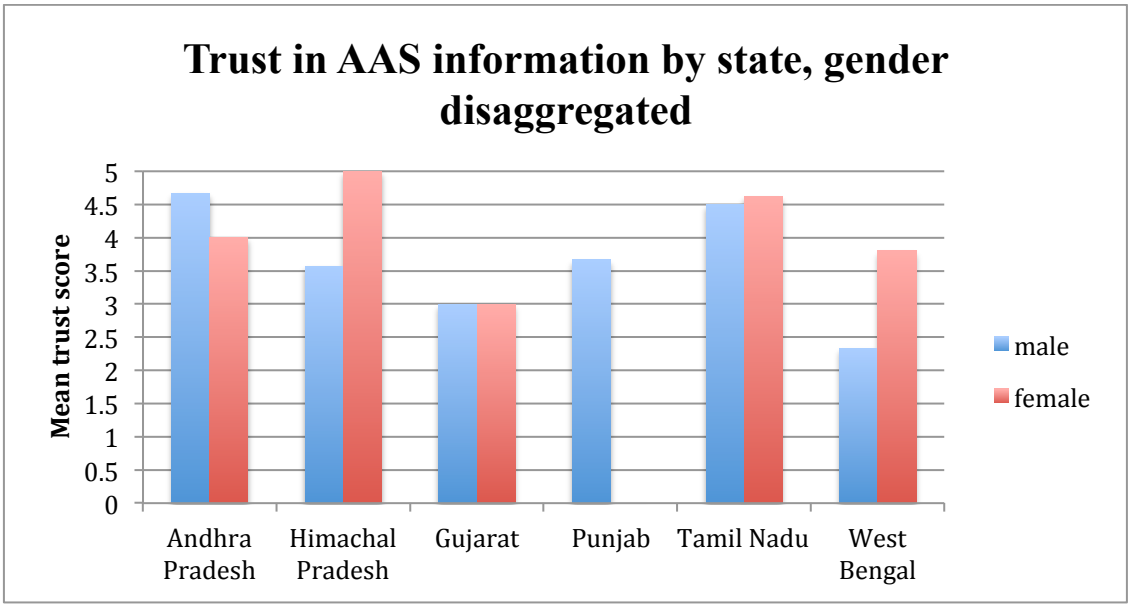


Figure 14. Trust in AAS information by state, gender disaggregated.

Farmers were asked, "out of 10 forecasts, how many did you find accurate?" An average of this percentage was taken for each state (figure 15). Figure 16 displays this information disaggregated by gender.

On average, farmers in Andhra Pradesh, Himachal Pradesh, Punjab and Tamil Nadu perceived AAS forecasts to be more accurate than farmers in Gujarat and West Bengal did.

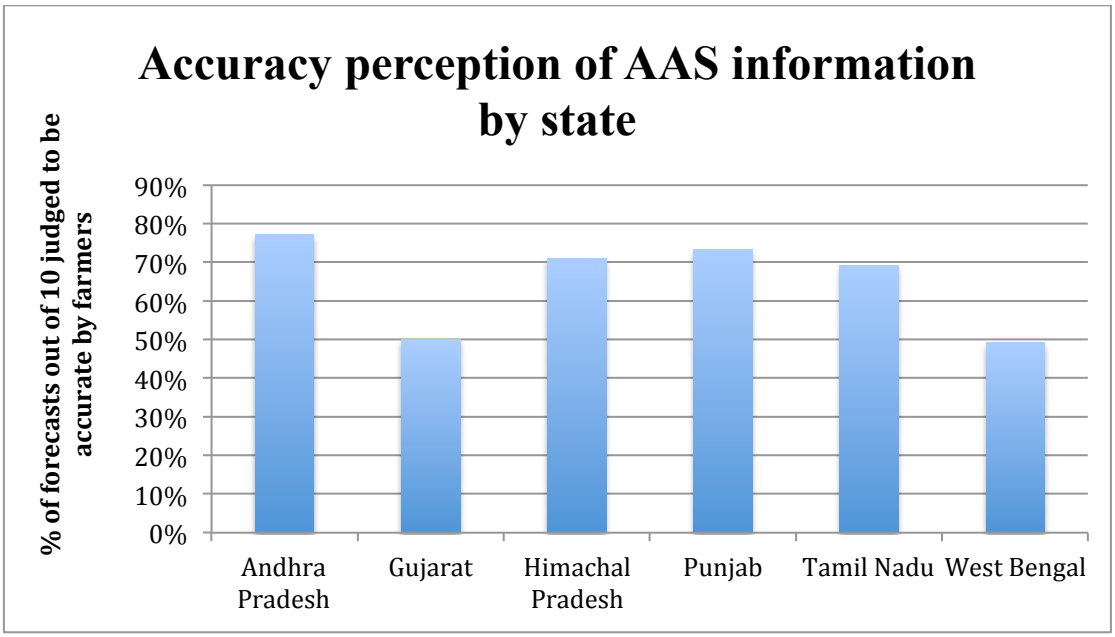


Figure 15. Accuracy perception of AAS information by state

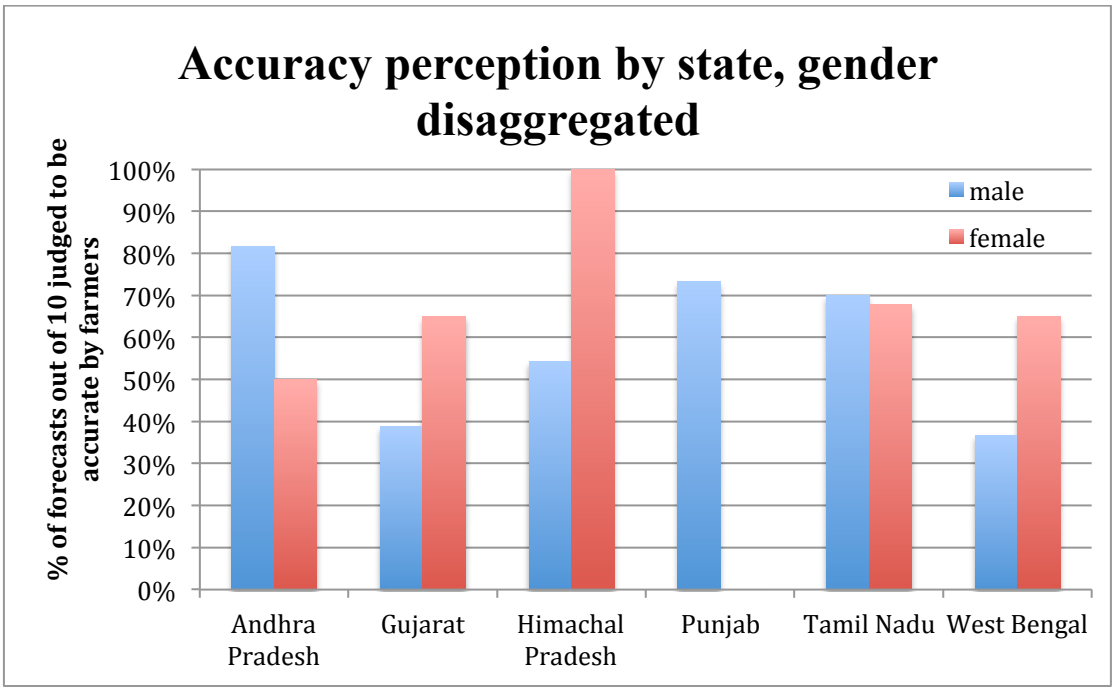


Figure 16. Accuracy perception of AAS information by state, gender disaggregated

Relevance refers to the perception that information is tailored sufficiently to the local context of a village to be useful for management of farm level operations. Farmers in Tamil Nadu, Himachal Pradesh, and Punjab found AAS information to be the most relevant to their decision-making (figure 17).

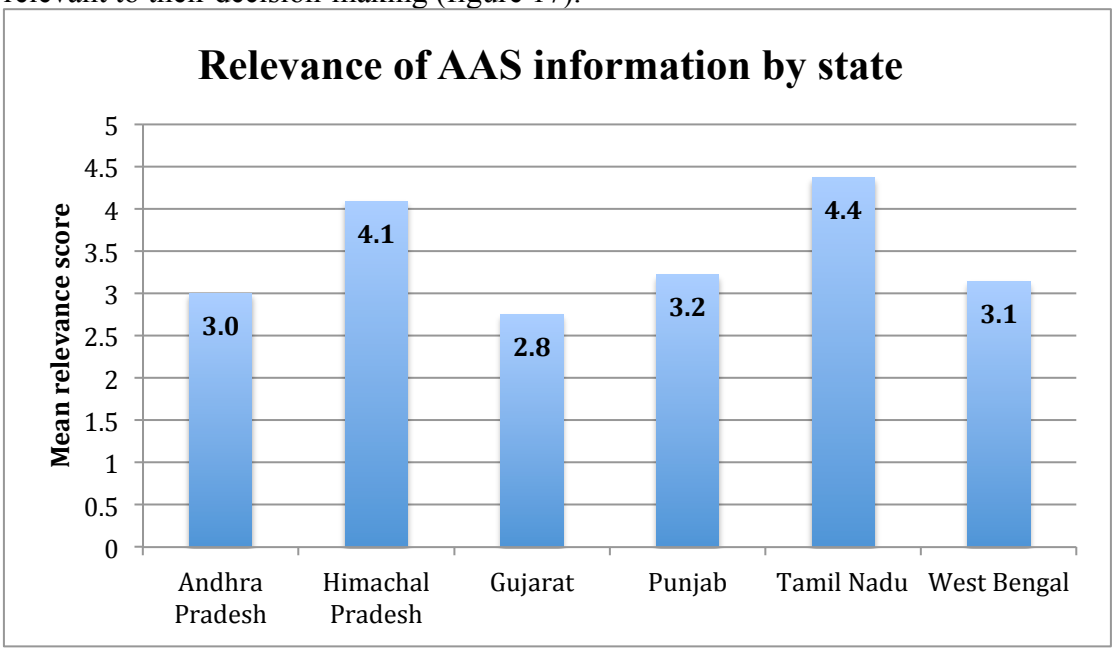


Figure 17. Farmer perception of relevance of AAS information by state

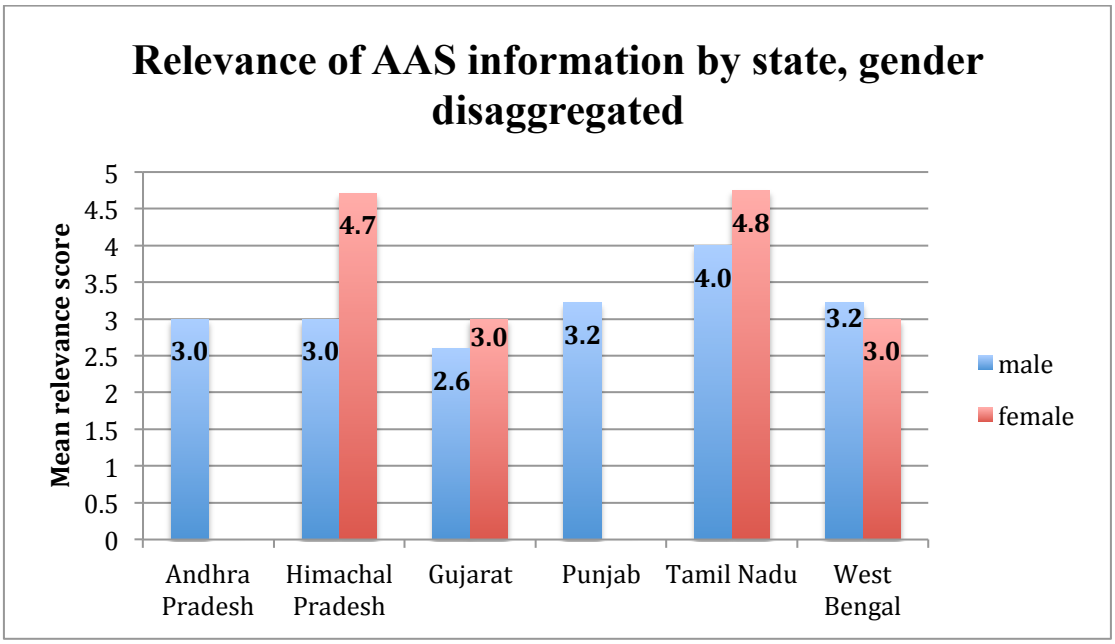


Figure 18. Farmer perception of relevance of AAS information by state, gender disaggregated

Perceptions about accuracy and relevance of AAS across all states varied depending upon a number of factors. While farmers in various villages remarked on the need for higher resolution forecasts, more accuracy in predictions, as well as longer lead-times, perceptions of accuracy and relevance seem to be related to how much AAS information is available to farmers and influences their decision-making. From the data, it is revealing that villages where accuracy and skill level perceptions of AAS were higher were also where awareness, usability and trust of AAS was high amongst male and female farmers (Andhra Pradesh, Himachal Pradesh, and Tamil Nadu).

This was particularly true in villages where farmers asserted that they received AAS information regularly and on time, there were fewer gaps in information, they trusted the information more and they were able to better interpret advisories and use it to inform their decision-making. Relevance was also rated highest in Himachal Pradesh and Tamil Nadu, but was not rated as highly in Andhra Pradesh as in Punjab and West Bengal.

Farmers had a number of suggestions for additional relevant information they would like to receive through AAS:

- Water management, especially during times of shortage
- New varieties of seeds; also information on why certain seeds failed and how to prevent it
- Wind speed to help decide time for spraying of pesticide, weedicide and fungicide
- Determining harvest time for specific crops
- Dealing with sudden frost in winter
- Information on market prices of produce
- Information on mechanization possibilities on the farm
- Crop related information related to protecting crops during sudden variations in temperature
- Information on better fertilizer mix
- Soil nutrient management strategies
- Choice of alternative crops during delays or breaks in rains.
- New pests expected in each season and suitable pesticides

- Organic farming. At the moment the advice is tailored to conventional chemical based farming and therefore some farmers want to know how to switch to organic farming. Those already on organic farming want more information tailored to it in the AAS.
- On new mechanization techniques to reduce cost of cultivation, new machines for harvesting and sowing seeds.
- Information related to cold storage facilities
- Help with dealing with wild animals, particularly wild boars that attack crops and farmers.
- Sharing of new research in agriculture

Communication channels

Across the six states, farmers in focus group discussion and individual interviews commonly mentioned the following channels through which they received AAS information:

- Farmer meetings with agro-meteorological scientists/extension officers from SAUs (or AMFUs) or related institutions like KVKs or research centers. These meetings and discussions are preferred when done in the villages, but some farmers also take the initiative to contact key personnel from these institutions for specific information.
- Through local NGOs working in the village on agricultural related issues who help disseminate the advisories.
- Farmers clubs
- AAS bulletins distributed in the village, displayed on notice boards in key locations in the village
- Kisan Melas (Farmer Fairs) organized in the village
- Media: newspapers, radio and television
- Voice messages and SMS
- Announcements over the microphone in the village
- Family members

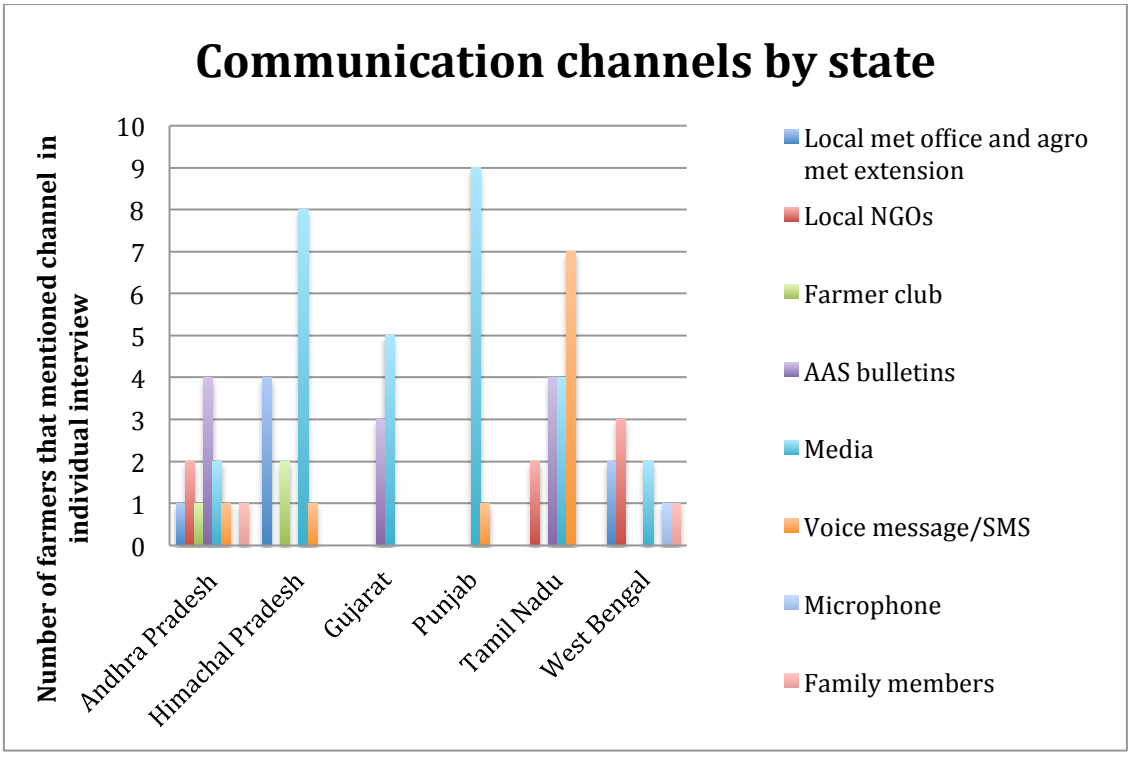


Figure 19. Communication channels by state.

In individual interviews, farmers provided information on the communication channels by which they access AAS information (figure 19). Notably, in regions with the highest levels of AAS awareness (Andhra Pradesh, Himachal Pradesh, and Tamil Nadu), overall a greater diversity of communications channels was recorded. This suggests that employing a range of communications channels to disseminate AAS information and meet a variety of preferred communication modes may be a more successful strategy that concentrating resources on a few channels.

Recommendations for improvements in communications channels included:

- Increase the reach of advisories provided through mobile phones (voice mails and SMS)
- A toll free number (call center) for agro-meteorological advice that farmers can call on for information and clarifications.
- Provide advisories through television channels in addition to the state-level forecasts currently relayed
- Flash news on all channels on important weather events
- Printed advisory bulletins displayed in all central points in the village accessible to all (temples, bulletin boards, shops, milk collection booths etc)
- Use of pictures in textual advisories to make them more comprehensible
- Specific FM radio station for weather based agro and livestock advisories
- Regular trainings and interactions in the village with scientists that all farmers can attend
- Specific trainings and discussions on AAS for women farmers in the village
- Organizing farmers into Kisan groups (Farmers' Group) to attend meetings with AMFUs and help disseminate vital information in the village.
- Larger farmer role in dissemination activities through the appointment of village level volunteers who could receive biweekly advisories from AMFUs and communicate them to the rest of the village.Use of less technical language in advisories for easy interpretation

Challenges in dissemination

On some occasions farmers divulged that extension officers from KVKs or SAUs tended to hold meetings and impart information to a few select farmers in a village, while a majority remained outside the information circuit (Bhanjal, Himachal Pradesh; Panglian and Mehma Sarja, Punjab; Chandamari and Prasadpur, West Bengal). This was also the case when information was based on membership to farmers' clubs (Baironpalli, Andhra Pradesh) or through a certain experimental project, where only those associated with such clubs or projects had easier access to the information.

In some cases, women farmers felt radio and TV were not enough since they never found time to listen/watch it and hence missed out on programs (Amtrar, Himachal Pradesh).

While SMS services and voice mails were popular, in some cases network problems have prevented them from having a big impact (Kannivadi, Tamil Nadu).

For farmers who are unable to read, AAS bulletins on display in the village were not useful. Farmers also mentioned that even when they knew how to read the information, they found it hard to comprehend it due to the dense technical language.

Summary of results

Awareness of the AAS program, perceptions of usefulness, accuracy and relevance and trust in AAS information varied across states and by the gender of respondents. Awareness was higher in Andhra Pradesh (94%), Tamil Nadu (80%) and Himachal Pradesh (79%), and lower in Gujarat (60%), Punjab (58%) and West Bengal (50%). Awareness of AAS was lower in states where women's participation in agriculture in the surveyed villages is lower (Gujarat, Punjab and West Bengal).

Overall, female farmers were less likely to be aware of AAS than male farmers (about 85% of men versus 55% of women). Women farmers tended to identify the program as having higher usefulness than male farmers, and showed higher trust in it. There was found to be somewhat of a positive relationship between how often farmers follow the advice provided, and how likely they are to rate the information as useful.

Membership in a farmers or women's group appeared to have a positive relationship with whether farmers were aware of AAS. However, concern was expressed by farmers that women and other marginalized groups were excluded from these groups, and multiple farmers recommended that care be taken to ensure that meetings with extension representatives and experts be accessible to all. Women's groups in particular appear to be a positive force in spreading awareness and creating a culture of AAS information use.

Accuracy perceptions were on average highest in Himachal Pradesh (71%), Tamil Nadu (69%), Andhra Pradesh (68%), and Punjab (68%).

In regions with the highest levels of AAS awareness (Andhra Pradesh, Himachal Pradesh, and Tamil Nadu), overall a greater diversity of communications channels was recorded.

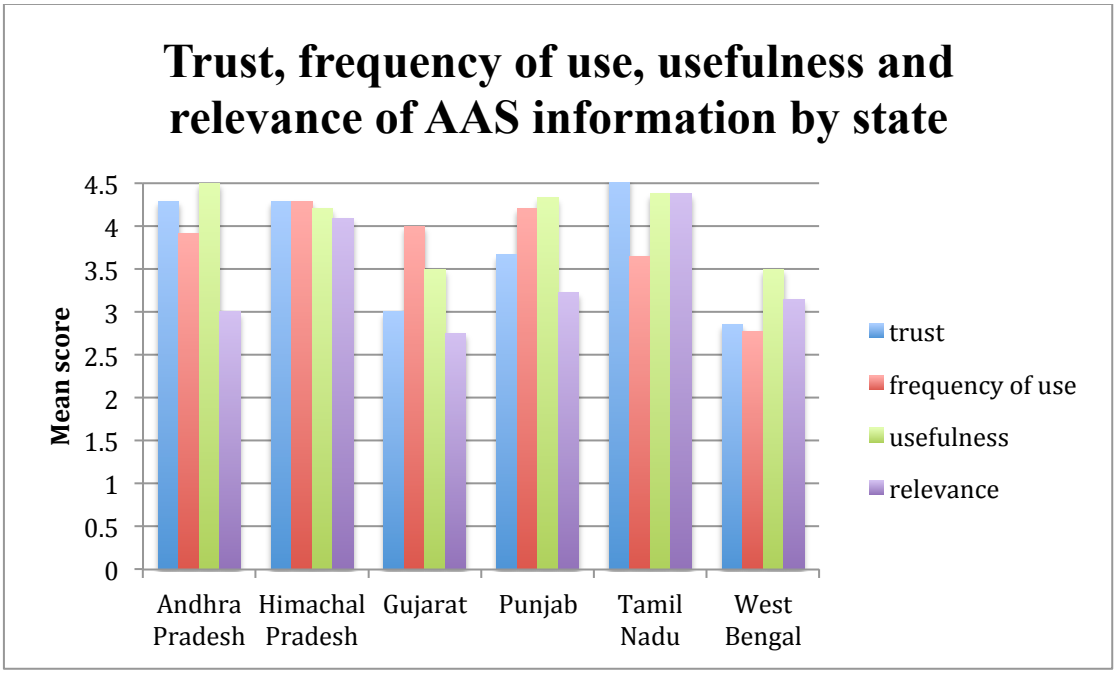


Figure 20. Trust, frequency of use, usefulness, and relevance of AAS information by state

Trust in AAS was highest in Andhra Pradesh (4.3), Himachal Pradesh (4.3) and Tamil Nadu (4.6), also the states where awareness of AAS is highest and usefulness was rated highest.

Relevance was highest in Tamil Nadu (4.4), Himachal Pradesh (4.1), and Punjab (3.2).

Discussion

The AAS program has successfully reached large numbers of farmers with agro-meteorological advisories relevant to their decision-making, communicating with farmers in multiple ways including personal contacts with extension services and other local agencies, media, farmers' clubs, announcements over microphones in the village, village bulletins, and voice messaging/SMS. Program implementation is carried out differently across the states surveyed, offering lessons in how different practices impacted issues of salience, access, legitimacy, and equity of AAS information provision and use. This section discusses results from individual interviews in the context of AAS practices in each state and farmer recommendations from individual and focus group discussions. Finally, it synthesizes good practice lessons likely to be relevant to scaling up agro-meteorological advisory programs in other contexts.

Salience

The program has sought to ensure salience of information to farmer needs and usability through local downscaling, improved resolution of rainfall forecasts, and value-addition to forecasts by agricultural experts to create agro-meteorological advisories. Discussions with farmers reinforced the importance of local downscaling and value addition to forecasts with locally relevant agricultural information. Even within a state, agro-climate differences can be high. This was evident between Palampur Agricultural University in Himachal Pradesh (knowledge hub of AAS advisory generation) and the remote low hill parts of Una districts (closest to Punjab in terms of agro-climate features) where surveyed Una district farmers did not find provided agro-meteorological advisories accurate at all nor salient to their local decision-making under a variable climate.

In addition, lower relevance ratings (except in the case of Andhra Pradesh) tended to coincide with areas of lower AAS awareness and use, potentially indicating an opportunity to increase AAS use by improving the scale and accuracy of advisories. Farmers in Andhra Pradesh and Punjab cited collaboration between AAS providers and local NGOs as an opportunity to make AAS information more useful to farmers by embedding it into local practice. In Punjab, it was noted that for smallholder farmers with farm sizes of less than an acre, agro-meteorological advisories are not of much relevance due to the small scale of their operations.

Access

With regards to access of AAS information, in regions with the highest levels of AAS awareness (Andhra Pradesh, Himachal Pradesh, and Tamil Nadu), overall a greater

diversity of communications channels was recorded. This suggests that employing a range of communications channels to disseminate AAS information and meet a variety of preferred communication modes may be a more successful strategy that concentrating resources on a few channels.

In Andhra Pradesh, broadcasting AAS advisories over a village loudspeaker and display of AAS bulletins in prominent places in the village were successful communications strategies. In Himachal Pradesh and Punjab, trainings and discussions in villages were the preferred dissemination channels, while in Tamil Nadu, SMS based dissemination and phone calls were preferred channels to reach farmers. For farmers who cannot read advisories, voice messages were preferred. In Tamil Nadu, the presence of a local agro-meteorological knowledge center (the M.S. Swaminathan Research Foundation) improved access and usability of AAS advisories by farmers.

In some locations such as Andhra Pradesh, membership in farmers' clubs (the main outlet for transmission of agro-meteorological advisories in this case) remains a barrier to women and other socially marginalized groups' access to the advisories and climate information. Other more widely reachable means of communication – such as displaying the bulletin in prominent places in the village and announcements over the microphone, as well as interventions by local NGO to make AAS program more useful for farmers – will have to be privileged.

Legitimacy

In terms of legitimacy, trust in AAS was highest in Andhra Pradesh, Himachal Pradesh and Tamil Nadu, also the states where awareness of AAS is highest and usefulness was rated highest. This could be an indication that a culture of advisory use is self-reinforcing and promotes trust in advisories, even if accuracy is not necessarily greater than in areas where advisories are used less frequently. This may point to a significant opportunity to increase uptake and use through expanding communication channels and farmer participation in the process of information dissemination.

In Himachal Pradesh, farmers noted that trainings and discussion in their villages are the preferred communications channels for AAS information. Farmers groups are another opportunity to increase legitimacy of information as farmers become involved in the process of communication. It was recommended that farmers be organized into groups to attend meetings with AMFUs, and assist in communication of advisories with the rest of the village. Farmers in Andhra Pradesh recommended a larger farmer role in dissemination activities, through appointment of village level volunteers or 'champion' farmers who could receive bi-weekly advisories from AMFUs and communicate them to the rest of the village.

Equity

In terms of equity, women overall have lower awareness of AAS than men do, indicating the importance of targeting women in communications efforts. When women farmers are fully engaged, the appropriation and use of AAS information is maximized (lesson from Amtrar village, Himachal Pradesh). The establishment of specific trainings and

discussions on AAS for women farmers in the villages was recommended, as were trainings and interactions with scientists that all farmers can attend. Membership in women's or farmers groups may be a positive factor in increasing awareness of AAS information, and extension services targeting existing local groups could be a strategy for increasing communication of AAS information. Care should be taken to ensure that targeted groups are inclusive of all with interest in joining.

Village discussions/trainings on agro-meteorological advisories are a good strategy to increase the reach of advisories. However, ensuring wide representation in discussions is critical. In West Bengal, women farmers noted that experts from the SAU came for discussions in the villages sometimes, but that more efforts could be made to include women in these meetings. In another example, in Punjab, richer and 'progressive' farmers received AAS information regularly and were able to benefit from it. They had better access to it due to their connections with AMFUs or extension officers and resources such as Internet access. In some cases they helped organize trainings in the village to disseminate information to others farmers; however, this was not always the case. Moreover, in case of special projects in a village, such as the 'Climate Change' project in Achalpur, Punjab, those associated with it were more likely to know about the advisories and benefit from them than those who were not part of the project, thus creating information asymmetries.

Farmers in West Bengal and Gujarat noted that wide community mobilization and inclusion of all farmers within the community (not only male farmers of high socio-economic status) is critical during village discussions by agricultural experts to ensure widespread appropriation and use of AAS advisories. This is a critical strategy to avoid a situation where the majority is left out and only those who are closely associated with the knowledge providers (agro-meteorological experts at the SAU, etc.) and those who are part of experimental projects receive most of the information from AAS and are in a position to use the information appropriately. It is recommended that local NGOs be leveraged as well to widely mobilize the community around use of agro-meteorological information.

In Himachal Pradesh, gender differences in the types of communications channels preferred were observed. While male farmers in two villages identified radio and television as good channels to reach them, women farmers expressed their inability to listen to radio or watch television during the day due to lack of time and engagement with other household and field related activities. In designing climate services projects, care should be taken to identify gender-specific preferences for communications channels appropriate for daily schedules and tasks.

Lessons for scaling up

Key challenge	***Lessons for scaling up***
Salience**:** tailoring content, scale, format and lead-time to farm-level decision-making	• Local downscaling, improved resolution of rainfall forecasts, and value-addition is paramount to ensure salience to local farmer needs and usability by farmers. • For smallholder farmers with less than an

	acre of land, AAS advisories are not of much relevance due to the small scale of operations.
Access: providing timely access to remote rural communities with marginal infrastructure	• Broadcast AAS advisories over a microphone at the village level • Display AAS bulletins in prominent places in the village • Presence of a local agro-meteorological knowledge centre/hub improved access and usability of AAS advisories • Smallholder farmers can be successfully reached with agro-meteorological information using a diversity of communication channels (agricultural extension, presence at farmer fairs, local knowledge centre/hub, face-to-face village meetings and training by agricultural experts, SMS and voice messages, etc)
Legitimacy: ensuring that farmers own climate services, and shape their design and delivery	• Collaboration with local NGOs or projects to promote the use of advisories serves to increase reach and uptake of agro-meteorological advisories by embedding it in local practice. • When there is sustained interaction between farmers and agro-meteorologists and agricultural scientists, higher use of advisories ensues. • Larger farmer role is recommended through appointment of a designated agro-meteorological contact point at the village level to communicate with AMFU and disseminate advisories to the village. • The use of 'progressive' farmers to organize trainings and disseminate information to other farmers is an effective strategy. • Appointment of local farmers from villages to manage and record data from manual weather stations in the village goes a long way in making the process of information collection and dissemination more inclusive and open. It also increases

	discussions amongst farmers and spreads information through word of mouth.
Equity: ensuring that women, poor and socially marginalized groups are served	• Trainings and discussions in villages with agricultural experts are the preferred form of communication, ensuring that all farmers can attend. Wide community mobilization and inclusion of all farmers within the community (not only male farmers of high socio-economic status) is critical during village discussion to promote widespread uptake and use of AAS advisories. • When women farmers are fully engaged, uptake and use of AAS advisories is maximized. • Women groups play a positive role in gathering agro-meteorological information from agro-meteorologists and agricultural scientists and disseminating it via word of mouth. • Care should be taken to identify gender-specific preferences for communications channels appropriate for daily schedules and tasks.

Conclusion/recommendations

This evaluation uncovered a number of effective practices for equitably reaching farmers with relevant and timely agro-meteorological information. The intent was to provide lessons that can be transferred to other locations facing similar challenges in supporting farmers with climate information services in a variable and changing climate, and used to guide investment in climate/agro-meteorological advisory services elsewhere in the world.

Key recommendations for scaling up include:

- A key lesson is that when women are fully engaged, the appropriation and use of agro-meteorological advisories is maximized.
- The use of existing social groups and networks to spread awareness and create a culture of advisory use appears to be a transferable lesson.
- Advisories need to be locally salient for farmers to use and benefit from them. Investment in local downscaling capacity and value-addition is paramount to ensure local salience and usability.

- Trainings and discussions in villages are a superior dissemination channel. When there is sustained interaction between farmers, agro-meteorologists and agricultural scientists, high use of advisories ensues.
- Information is not enough: farmers should also have access to accompanying knowledge and technology to empower farmers to use advisories, such as high quality seeds.
- Use of an NGO or local project to promote the use of advisories services to increase the reach and uptake of advisories, and to embed its use into local practice.
- Smallholder farmers can be successfully reached with advisories using a diversity of locally appropriate communication channels (extension, local knowledge center, face-to-face village meetings and trainings by agricultural experts, SMS and voice messages, etc).
- Presence of a local agro-meteorological knowledge center improves access and usability of advisories.
- SMS based dissemination and phone calls are effective channels to reach farmers. For those who cannot read advisories, voice messages on the phone are preferred.
- Care should be taken to identify gender-specific preferences for communications channels appropriate for daily schedules and tasks.

Appendix 1: Glossary

Block level: an administrative division in India. A block is a sub-division of a district.

Kharif: monsoon crop in the Indian sub-continent. Usually sown with the beginning of the first rains in July, during the southwest monsoon season. Rice is the main *kharif* crop.

Kisan call center: call centers hosted by the Department of Agricultural and Cooperation, Government of India to respond to agriculture related inquiries.

Kisan Mela: farmer fair

Krishi Vigyan Kendra: agricultural science extension centers in India.

Panchayats: village governing body in India.

Progressive farmer: typically wealthier and better educated relative to the majority of farmers, and use newer farmer technologies and practices. They may provide advice and information on farming practices to other farmers.

Rabi: winter crop in the Indian subcontinent, grown mid-November to April. Wheat is the main *rabi* crop.

Sarpanch: elected head of the panchayat, the village governing body in India.

Appendix 2: Farmer recommendations for AAS improvement

State	Additional information sought through AAS	Additional needs
Andhra Pradesh	• On alternate crop choices, especially during shortage or delay or rains • On organic cultivation	• More training: more village-level trainings for both male and female farmers is required to help with better interpretation and use of advisories • Picture messages: bulletins will be easier to interpret if textual information is elaborated with pictures to improve understanding on kinds of pests etc.
Himachal Pradesh	• On water management, especially during times of shortage • Access to good quality seeds	• Advisories through cell phones (voice mails and text messages) • Provide advisories through television in addition to state level forecasts currently relayed • Printed advisory bulletins displayed in all central points in the village
Punjab	• Information on new varieties of seeds; also on why certain seeds failed and how to prevent it • Wind speed to help decide time for spraying of pesticide, weedicide and fungicide • Harvest time for wheat • What to do during sudden frost in winter • Information on market prices • Information on mechanization possibilities on the farm • Timely and accurate rainfall forecasts	• Display textual copies of advisories in prominent locations in the village such as the Gurudwara (Sikh temple). Common areas also ensure information is evenly disseminated and not restricted to few factions or privileged sections. • Specific trainings and meetings for women farmers in the village • Advisories through SMS and voice mails • 24/7 TV Channel exclusively on agriculture • Organize farmers into Kisan groups (Farmers' Group) on a voluntary basis to help disseminate vital information in the village. • Appoint village level volunteers who could receive biweekly advisories from the AMFU and communicate them to the rest of the village.
West Bengal	• Crop related information – for	• Detailed weather forecasts on TV at

	example, advance advisories on how to protect cauliflower crop during higher than average temperatures in winter. • Information on new techniques to reduce cost of cultivation, new methods of cultivation and technology, seed varieties, better fertilizer mix, suitable pesticides, and unknown diseases • Soil nutrient management strategies • Choice of alternative crops during monsoon and winter season	least 2 -3 times a day. • Door to door information through an appointed volunteer in the village • Newspapers • More face-to-face meetings and discussions in the village with agricultural experts that all farmers could attend • A toll free number for agro-meteorological advice. • Advisories to be displayed on notice boards in key locations in the village.
Tamil Nadu	• Improved resolution: information is sufficient to manage crop-based activities but the resolution needs to be improved for the forecasts, particularly rainfall forecasts. • Pest management: information on new pests expected in each season. More trainings on pest management • Information on organic farming. At the moment the advice is tailored to conventional chemical based farming and therefore some farmers do not find it useful. • On new mechanization techniques: in the past farmers grew ragi, wheat, and other cereals. Now they don't, because of labor shortage. Famers want to find out about machines for harvesting and for sowing seeds. • Information related to marketing, cold storage facilities and self help group trainings	• TV channels need to have fixed channels and timings to relay advisories and other information related to agriculture. Flash news on all channels on important weather events is necessary. • For those who cannot read advisories, voice messages on the phone are preferred. • Mobile phone application for AAS should be started. • Larger role of farmers in dissemination activities through voluntary involvement and enlistment • Specific FM radio station for weather based agro and livestock advisories • Call center where farmers could call for additional information and assistance
Gujarat	• Higher resolution forecasts,	• More village level trainings with

	particularly rainfall • Information on alternate crops, particularly during drought years or poor rains • Information on market price of produce • Help with dealing with wild animals, particularly wild boars that attack crops and farmers • Sharing of new research in agriculture, especially recommendations in new technology and equipment	farmers • Detailed advisories on local TV channels • AAS through mobile phones • Special trainings for women in villages

Farmer recommendations synthesis

Additional information sought through AAS	Suggestions on communication channels
• Water management, especially during times of shortage • New varieties of seeds; also on why certain seeds failed and how to prevent it • Wind speed to help decide time for spraying of pesticide, weedicide and fungicide • Determining harvest time for specific crops • Dealing with sudden frost in winter • Information on market prices of produce • Information on mechanization possibilities on the farm • Crop related information related to protecting crop during sudden variations in temperature • Information on better fertilizer mix • Soil nutrient management strategies • Choice of alternative crops during delays or breaks in rains • Information on new pests expected in each season and suitable pesticides • Information on organic farming. At the moment the advice is tailored to conventional chemical based farming and therefore some farmers want to know how to switch to organic farming. Those already on organic farming want more information tailored to it in the AAS. • On new mechanization techniques to reduce cost of cultivation, new machines for harvesting and sowing seeds	• Advisories through cell phones (voice mails and text messages) • Elaborate advisories through television channels in addition to state level forecasts currently relayed • Flash news on all channels on important weather events • Printed advisory bulletins displayed in all central points in the village accessible to all (temples, bulletin boards, shops, milk collection booths etc) • Specific trainings and discussions on AAS for women farmers in the village • Organizing farmers into Kisan groups (Farmers' Group) to attend meetings with AMFUs and help disseminate vital information in the village • Larger farmer role in dissemination activities through appointment of village level volunteers who could receive biweekly advisories from AMFUs and communicate them to the rest of the village • Regular trainings and interactions in the village with scientists that all farmers can attend • A toll free number (call center) for agro-meteorological advice that farmers can call on for information and clarifications • Use of pictures in textual advisories to

• Information related to cold storage facilities • Help with dealing with wild animals, particularly wild boars that attack crops and farmers • Sharing of new research in agriculture	make them more comprehensible • Use of less technical language in advisories for easy interpretation • Mobile phone application for AAS related information • Specific FM radio station for weather based agro and livestock advisories

Appendix 3: Documented stories of AAS use by farmers

Andhra Pradesh

Male farmer:

> *"I have less land. I used to apply DAP fertilizer every 30 days. Then I started listening to the forecasts and advisories, which said that it should be applied every 15-20 days. Since then, I have been able to increase yields in cotton by 4 quintals/acre.*

Male farmer:

> *"In vegetables, the advisories informed us to use vermicompost. I did so, and was able to increase yields by 5-6 bags (50 kgs. per bag). This started 4 years back."*

Female farmer:

> *"Earlier we used to spray fertilizers all over and a lot used to get wasted. We knew that, but still we did it since it was the easiest thing to do. But we learnt from the advisories that by spraying, not only is fertilizer wasted, but also yield is less. It recommended crop based application of fertilizers where quantity of fertilizer is less, but yield is more. Another thing is, fertilizer spraying could be done only by men, because the equipment used for spraying was heavy. With crop based application on the other hand, women can do it too, so I find it beneficial."*

Female farmer:

> *"Three years ago, I found out from a weekly advisory that rain was forecast and transplantation of paddy was recommended. I followed the advice and reaped a good crop. Farmers who did not follow the recommendation, delayed transplantation by 15-20 days and had lesser yields."*

Himachal Pradesh

Male farmer:

> *"Three years ago, I found out from a weekly advisory that rain was forecast and transplantation of paddy was recommended. I followed the advice and reaped a good crop. Farmers who did not follow the recommendation were delayed transplantation by 15-20 days and had lesser yields"*

Male farmer:

> *"Two years ago, the advisory recommended delaying harvesting of wheat crop based on heavy rainfall forecast. I did so and saved my crop. If I had*

harvested, then heavy rains would have destroyed the harvested grains left in the field"

Female farmer:

"Through the meetings with agricultural experts I learnt how to protect my cucumber crops. I got an apparatus which traps the flies that sit on the plant and destroy it. I have been using it for 5 months now and it has been very helpful in preventing fly attacks"

Female farmer:

"I got to know about vermicomposting through the advisories. I started using it on my onion crop and found the yield to be higher and the quality of onions also improved."

Female farmer:

"My cabbage crop used to get infected with diseases. I used to spray pesticides but to no avail. I learnt from trainings that I should spray the pesticides at evening, instead of afternoon and then they become much more effective."

Punjab

Male farmer:

"Agrometeorologists came for a meeting in a nearby village. They informed us about a big rainfall event in 2009 in 2 days. I had earlier delayed nitrogen fertilizer application for wheat. When I heard about the forecast, I immediately hired labor and applied the fertilizer. That was very helpful in keeping my crops healthy."

Male farmer:

"I learnt about new cotton seeds through the advisories. I tried them and harvested a good crop with it."

West Bengal

Male farmer:

"I find rainfall forecast useful in deciding time of sowing of Aman rice. Rainfall data helps in irrigation operation."

Male farmer:

"Yes, Til and groundnut production have increased a lot since they've been using the advice."

Tamil Nadu

Male farmer:

"I use the wind speed and direction forecast to inform pesticide spray and to provide structural support for crops. I also use rainfall forecasts to determine when to harvest."

Male farmer:

"The advisories are useful for livestock management. I learnt that we should allow the animals to graze immediately after rainfall. I also rely on it for treating diseases in livestock."

Male farmer:

"If rains are forecast then I postpone irrigation and that saves labour costs associated with it. Rainfall forecasts also help me decide on weeding and fertilizer application."

Female farmer:

"I have changed weeding operations based on AAS information. I also decide on harvesting operations now by referring to the bulletin."

Gujarat

Male farmer:

"Once rains were forecast, but I did not trust the advisory and still decided to harvest. It rained and my harvest was destroyed. Now if I know its going to rain, I harvest early."

Male farmer:

"Last year, my neighbouring farmer put something in his fields that resulted in a virus that started affecting my crop too. I took it to the Cotton Research Institute who recommended a certain type of medicine which helped to get rid of the virus."

Female farmer:

"Advisories on fertilizer application and pesticide application are very useful to me."

Appendix 4: Methods

India Agro-meteorological Advisory Service (AAS) Case Study

Independent Study of the AAS Program from a Farmer Perspective

GUIDE FOR FOCUS GROUP

(For information and checklist)

I am from a team from CCAFS that is here to learn more about the development challenges you face. If you agree, I would like to ask you questions about your livelihoods, your agricultural practices, and the resources you have to address development challenges in your community. This information will be used in a larger study of development challenges across India and Mali, and will help to prioritize future development programs.

While I will record all of your answers accurately, I will need your personal consent. Any information you provide to me will be confidential, and will not be shared with other members of this community or with other Communities. If you have any questions about this project, I am happy to answer them.

Remember some rules of conduct, courtesy, and wisdom to lead the focus group.
Go to the peasants and do not expect them to come find you sitting waiting for them.
Discuss where to hold the focus group and if everyone is comfortable.
Remember the purpose of the focus group and insist that it is to have a perception of a group and not a single individual. Give a voice to the voiceless.

General

1. Introduce the investigating team
2. Thank the group for its availability and also the time they are willing to spend in the group. Indicate that the discussion will focus on agricultural issues and other ongoing activities in the village, but that will be deepened during this session.
3. Ask the group of farmers to attend.

Conduct of the focus group

This list of questions is to begin discussions with the group. These are open questions in a non-sequential order. There is no order in the administration of guide questions. Some questions may find answers to other questions. We can go back and a question to another, the key is to get to extract information about the climate and weather information (which must guide all threads). Always try to approach / ask, referring to the previous question and / or the response.

THIS IS A GUIDE, NOT A SEQUENCE. YOU DO NOT HAVE TO ASK ALL QUESTIONS IN A CHRONOLOGICAL ORDER

FG Questionnaire # (State/District/#-M or F):	
Village Name:	
Field Team Member:	
Date:	

Q.1: Seasonal Calendar of Activities in the Village (10-15 min)

What are the main activities you practice during the year (rank by order of importance)

Rank	***Livelihoods***	***Seasonality:***											
		Jan	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
	Agriculture												
	*Livestock**												

Q.2: Crops Cultivated (10 min)

We come to understand that many people in your community are farmers. Can you tell us what are the main crops that farmers cultivate in this community, ranked by order of importance, why you cultivate this crop (for what purpose) and the constraints to cultivating this crop?

Rank	*Crop Name*	*Cultivated for what purpose* ***[1-7]***	*Constraints*
1			
2			
3			

Use [1]: 100% self consumption (subsistence crop); [2]: 75% self consumption and 25% sold
[3]: 50% self consumption and 50% sold; [4]: 25% self consumption and 75% sold;
[5]: 100% sold [6]: forage [7]: Other (Specify)

Q.3: Cropping Systems (10 min)

What are the main cropping systems practiced by farmers in your community?

Cropping systems	Crops cultivated	Why system	Crop Varieties	Fertilizer use ?	Irrigation?	Any changes in

	(Identify for each system)	chosen ?	*Local*	*Introd*	(chem. or organic?)		cropping system over last 30yrs ?
Monoculture							
Inter cropping							
Crop Rotation							
Other ? - Horticulture - Agroforestry - _____							

* If Livestock identified as a major livelihood, ask Q. 3.1:

3.1: <u>LIVESTOCK</u> (10 min)

We observed stray animals in the village. What types of animals do farmers raise in your community? Can you tell us what role/utility this livestock rearing holds for you?

Types of animals	Herding mode	Role/Utility: Livestock for what purpose ? ***[1-6]*** *[1]: Milk* *[2]: Savings (cover emergency expenses of the household)* *[3]: Prestige* *[4]: fattening (meat)* *[5]: Draught power / farming support* *[6]Other (specify)*	Any change in the herding mode ?

<u>Q.4: Main Constraints Encountered</u> (20 min)

What are by order of importance (negative) the main constraints to agriculture and livestock you face?

Agriculture

Constraint	Rank	*Frequency % (#respondents who gave rank/total #FGD respondents)*	When do you face it ?	How does it make your life harder ?	How do you mitigate this constraint ?

Livestock: What are the constraints you face in the management of livestock?

Constraint	Rank	*Frequency % (#respondents who gave rank/total #FGD respondents)*	When do you face it ?	How does it make your life harder ?	How do you mitigate this constraint ?

RESEARCH PROGRAM ON
Climate Change, Agriculture and Food Security

CGIAR

CCAFS

The CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) is a strategic initiative of CGIAR and the Earth System Science Partnership (ESSP), led by the International Center for Tropical Agriculture (CIAT). CCAFS is the world's most comprehensive global research program to examine and address the critical interactions between climate change, agriculture and food security.

For more information, visit www.ccafs.cgiar.org

Titles in this Working Paper series aim to disseminate interim climate change, agriculture and food security research and practices and stimulate feedback from the scientific community.

CIAT
Centro Internacional de Agricultura Tropical
International Center for Tropical Agriculture
Consultative Group on International Agricultural Research

futureearth

ICRISAT
Science with a human face