Agro-Met Services and Farmer Responsiveness to Advisories: Implications for Climate Smart Agriculture

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Abstract
Agro-met services delivered through SMS by Watershed Organization Trust (WOTR) provides crop and locale-specific agro-advisories based on weather forecasts and the particular crop growth stage in order to reduce risks and improve agriculture productivity despite local climatic variations. The objective of the

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chapter is to understand the nature and importance of different components of WOTR advisory system and the response of farmers to the agro-met advisory services.

An important aspect for developing a farmer-responsive agro-advisory system is the willingness of diverse stakeholders to collaborate (farmers, NGOs, Research institutions, Government institutions, private organizations) and converging of respective strengths. It was found that the content of advisories needs to be relevant to the location and to the specific crop to make an advisory system demand driven that is based on farmers' needs.

Keywords

Agro-advisory system · Farmer response · Onion and Pearl millet

Context

Birner et al. (2009) defined "agricultural advisory services are defined as the entire set of organizations that support and facilitate people engaged in agricultural production to solve problems and to obtain information, skills, and technologies to improve their livelihoods and well-being."

Farmers and other rural actors can benefit from numerous types of advisory services defined as much by their content (technical, economic, social, and environmental) as by the way they are provided (disseminating information and techniques, reinforcing the learning process, or accompanying actors) (SanneChipeta 2006).

There have been many initiatives to provide weather-based crop advisories in India. The National Centre for Medium Range Weather Forecasting (NCMRWF) under the Ministry of Earth Sciences (MoES), Government of India, in collaboration with India Meteorological Department (IMD), Indian Council of Agricultural Research, and State Agricultural Universities had been providing Agrometeorological Advisory Services (AAS) to the farming community based on location-specific medium-range weather forecast to the districts under different agro-climatic zones (now called Integrated Agrometeorological Advisory Service) (Maini and Rathore 2011).

There is a large interest and takeoff of similar private and public programs on advisory systems in India (Mittal et al. 2010), and it is important to understand the impact of these interventions. Policies to improve access to ICT in rural areas need to focus as much on content and education as infrastructure. Local content creation needs to be linked to institutional innovations to provide farmer-responsive extension services (Anderson 2007).

The present study examines the case of agro-met services delivered through SMS by Watershed Organization Trust (WOTR) in Sangamner block located in Ahmednagar district of Maharashtra. WOTR's knowledge-embedded service to farmers provides crop and locale-specific agro-advisories based on weather forecasts and the particular crop growth stage in order to reduce risks and improve agriculture productivity despite local climatic variations.

Objectives

The specific objectives of the chapter are to:

(i) Understand the nature and importance of different components of advisory system and their interactions in the context of WOTR's agro-met advisory system.
(ii) Identify the different knowledge systems available to and accessed by the farmers in the area.
(iii) Understand farmers response (adoption or non-adoption) to different types of agro-met advisories.

Conceptual Framework

We use the framework of advisory system used by Faure et al. (2011) (Fig. 1) to analyze the case of agro-met advisory system that was developed by Watershed Organisation Trust (WOTR), a not-for-profit organization. The framework by Faure et al. (2011) was adapted from Gadrey (1994) and Birner et al. (2009), which depicts the actors providing the advisory service, the interactions among them, and the factors influencing the service.

The operation of an advisory system is explained by interlinked components of governance, financing mechanisms, skills and qualifications of advisors and managers of service providers, and method by which advice is provided, which is characterized by the service relationship between the advisor and the farmer (Birner et al. 2009; Faure et al. 2011, 2016). According to Birner et al. (2009), quality of advisory services is indicated by the "(i) accuracy and relevance of the content of the advice, (ii) timeliness and outreach of the advice, (iii) quality of the partnerships established and the feedback effects created, and (iv) efficiency of service delivery and other economic performance indicators."

The present study mainly focuses on the *service relationship* between advisor and farmer. Service relationship was divided into technical relationship (content of the service, the tools used to provide the service) and contractual relationship (organization of work, price of service, planning of advisory activities) (Faure et al. 2011). In the context of WOTR agro-met advisory system, it is of relevance to understand the response of the farmer, who is the final beneficiary or client of the advisory system, which in turn has implications on the content of advisory, outreach, and the effectiveness of the service delivery system.

WOTR Agro-Met Set up

The integrated agro-meteorology service evolved by WOTR consists of four components that are interlinked as follows: (i) weather awareness, local weather data acquisition, and short range weather forecasts; (ii) crafting of agro-advisories,

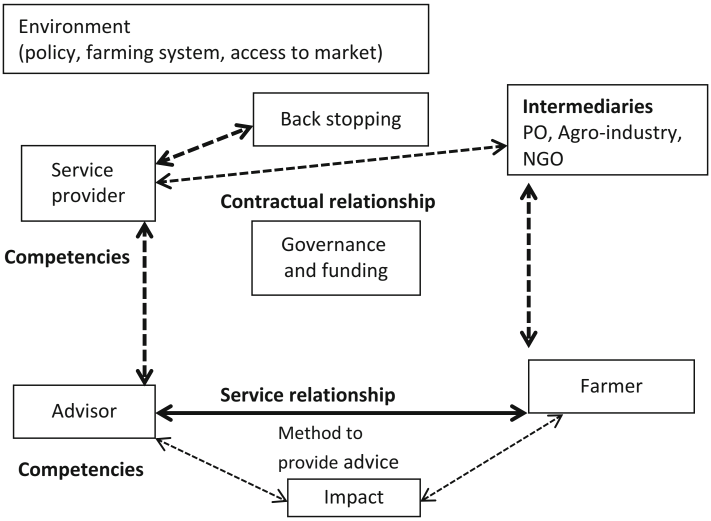

Fig. 1 Advisory system used by Faure et al. (2011).

dissemination, and feedback gathering; (iii) an automated content management system (ACMS) for agro-meteorological advisory generation and dissemination; and (iv) on-site capacity building, knowledge and technology transfer, and engagement with local institutions (Lobo et al. 2017).

WOTR, in collaboration with the India Meteorological Department (IMD), has installed 103 Automated Weather Stations (AWS) in Jalna, Ahmednagar, Aurangabad, Pune, Nashik, Dhule, and Nandurbar districts of Maharashtra. Altogether, they make for a high density grid ranging 3–5 km between the weather stations, the reason being to provide a sufficiently dense network of high quality data points to enable the IMD to better calibrate their weather models, given the diversity of topographies and agro-climatic ecologies present in the project district. Of these, 92 AWSs are telemetrically linked to WOTR's servers and send on an hourly basis, weather information round-the-clock. This data is subject to quality control at WOTR and then forwarded to the IMD. IMD sends WOTR daily, 3-day weather forecasts for respective villages.

Based on these short-term (3-day) local weather forecasts, agricultural experts from WOTR prepare agro-advisories with the help of crop-weather calendars which have been prepared with inputs from the Central Research Institute for Dryland Agriculture (CRIDA) and two state agricultural universities (the Mahatma Phule Agriculture University (MPKV) at Rahuri and the Vasantrao Naik Marathwada Agriculture University (VNMAU) at Parbhani) with whom WOTR has a knowledge-sharing collaboration. These advisories that are crop and locale-specific include integrated nutrient-water-pest-and diseases management recommendations that stress organic and environmentally sustainable interventions. These advisories are issued in the local language at least twice a week in the summer months and more frequently during the agricultural season, as required, thus alerting farmers and giving them enough time to implement suggested measures. The advisories are disseminated through SMSs to mobile phones, wallpapers that are put up at prominent places in the project villages, and by word-of-mouth.

Components of WOTR Advisory System and Interactions Between Key Actors

Contractual Relationships: Actors and Governance Arrangements

WOTR has been engaging with rural communities and farmers since nearly 25 years now. In the early year of this millennium, it became evident that agriculture, especially rainfed farming systems, was in distress. Climate variability was beginning to affect crop productivity and weather-induced losses began increasing; adverse market conditions and declining soil health resulted in low returns and increasing costs of cultivation. This led WOTR to launch an initiative to offer a combo of services that included timely weather forecasts, weather responsive crop management advisories, information on prevailing market prices of key crops, as well as on-farm extension and technical services.

With a view to developing an approach that can be scaled up in a cost-effective manner and contribute to improve the country's efforts in the field of applied agrometeorology, WOTR entered into a collaborative partnership with key developmental, scientific, and academic institutions, namely, the India Meteorological Department (IMD), the Central Research Institute for Dryland Agriculture (CRIDA), the Mahatma Phule Agriculture University (MPKV), and the Vasantrao Naik Marathwada Agriculture University (VNMAU) (Table 1). The specific objective of this initiative is to provide farmers locale- and crop-specific weather-based crop management and assist them in using this information for agricultural decision-making. This effort was financially and technically supported by the Swiss Agency for Development and Cooperation (SDC) and the National Bank for Agriculture and Rural Development (NABARD).

The advantage of such an arrangement involving stakeholders working across scales (from the local, national to the international), having complementary strengths and working towards a common objective, is that it makes possible a pooling and sharing of valuable resources and expertise across domains and institutional boundaries and facilitates mutual learning, cogeneration of practical knowledge and technology transfer. More importantly, such a partnership opens up possibilities to channel insights and experiences from the ground to decision and policy makers which can contribute to improving the quality and effectiveness of the agrometeorological services provided by state and national entities.

Even though the collaborative partnerships between the various institutions were within a formal contractual framework, the trust (developed over a period of

Table 1 Key actors in the WOTR agro-advisory system, roles and relationships

Actor	Type of organization	Roles	Type of relationships (Actor linkages with key facilitator – WOTR)
Watershed organisation trust (WOTR)	Nongovernment organization	Conceptualized and facilitated the entire agro-met advisory system – Design and framework of the advisory system; community mobilization, awareness, generating, establishing AWSs and providing weather data to IMD for processing, crafting advisories, delivery of advisories and services to farmers; feedback from end users	Key facilitator
India meteorological department (IMD), Ministry of Earth Sciences, government of India	Central government	Establish transmission linkages between WOTR, the AWSs, and IMD; expertise in analyzing meteorological data and providing short-term weather forecast for respective villages; hand-holding support for management of AWS (maintenance, calibration); training of WOTR personnel on applied meteorology	Trust, service, contractual – Memorandum of understanding
Mahatma PhuleAgriculture university (MPKV), Rahuri	Agriculture university	Support to developing crop-weather calendars and crop management practices	Trust, service, contractual – Memorandum of understanding
Vasantrao Naik Marathwada agriculture university (VNMKV), Parbhani	Agriculture university	Support to developing crop-weather calendars and crop management practices	Trust, service, contractual – Memorandum of understanding
Central research Institute for Dryland Agriculture (CRIDA), Indian Council of Agricultural Research (ICAR)	Research	Provide inputs on cropping/production systems management; contingency crop planning	Trust, service, contractual – Memorandum of understanding

(*continued*)

Table 1 (continued)

Actor	Type of organization	Roles	Type of relationships (Actor linkages with key facilitator – WOTR)
AWS supplier	Private company	Supply of automated weather stations; first-level training on installation and operations/maintenance	Business
Network service provider	Private company	Bulk SMS services	Business
Farmers	End users	Users of advisories	Service, trust

Source: Authors field notes.

interaction and personal relationships) and service motivation were a common binding force for the collaboration (Table 1).

At the farmer level, the relationship of WOTR is still based on service and trust (social capital developed over a period of interactions with farmers) with no formal contractual relationship. Over a period of time, from point of financial sustainability of the advisory system, it is also important to transition into business contracts, which could also ensure quality advisories and accountability.

Technical Relationships

Capacity Building, Structuring Advisories

The content of crop- and location-specific advisories was prepared in a knowledge-sharing collaborative mode under contractual arrangements between WOTR, state agricultural universities, and central research institute (as summarized in Table 1). But it is equally important to develop awareness among the farmers about the advisory system and develop local human capital at the village level for improved adoption of advisories sent to them.

Agro-Met trainings were conducted in all villages to enable communities to understand the purpose and utility of the weather stations and how to protect and maintain them. Weekly visits of "para-agriculture workers" (*Wasundhara-Sevak*) often accompanied by WOTR subject matter specialist) are made to the villages to discuss about the automatic weather station and various aspects of its uses. This helped to get community become inquisitive and keen to opt for the new initiative.

Agricultural professionals provided extension, technology, and training support at the farm and village level, established "demonstration plots," undertake Farmer Field Schools and engaged with farmers' groups, local governance institutions, and government departments (Lobo et al. 2017). To ensure community participation and engagement on this component, exposure visits were arranged to nearby villages which already had experience of using the Agro-Met Advisory services. Farmers met other groups of farmers and sought their feedback.

Tools Used for Advisory Dissemination

Advisories were disseminated through mobile telecommunication networks (via SMSs) directly to individual farmers, by announcements over the village public address system (loudspeakers), and weekly posters that are put up at prominent places in some villages and on walls/blackboards (Lobo et al. 2017).

Feedback Mechanism in Place to Monitor

In order to develop effective advisories, there is need to get farmers' feedback about their utility, impact, and how they have applied them, if at all. WOTR has put in place a system for regular feedback collection which involves collection of on-field data and farmer's observations. For a particular season, three farmers per key crop were identified in selected villages. Feedback against the key advisories was collected from these selected farmers in a prescribed register on a 15 days interval basis by para agronomist, which is then reviewed by an agronomist, who is in-charge of a cluster of villages. This validated data is then entered into software developed by WOTR and uploaded into the system. This software helps collate, assess, and analyses the feedback received from the farmers.

The agro-met advisory feedback system is necessary to assess the impact of the disseminated agro-advisories and to understand the problems faced by farmers in implementing them. The feedback system also helps to update WOTR's knowledge bank; refine or modify advisories generally prescribed for specific problems; generate better targeted and effective crop management practices; and better understand the challenges faced by farmers and how they respond to and adapt to climate-induced risks and extreme events.

Advisors

The advisors included a team of qualified subject matter specialists from WOTR and Agriculture Universities and "para-agronomists." The subject-matter specialists were agriculture graduates and postgraduates who trained the para-agronomists and farmers through Farmer Field Schools and on-field demonstrations.

The para-agronomists were local literate rural youth with education up to diploma or higher secondary school education. They were trained along with selected farmers on various crop management practices, importance of agro-advisory system, and also the process of feedback on the advisories.

These advisors are the key connecting link in the advisory system that combines contractual relationships and technical relationships. They play a two-way role: that of influencing the farmer's adoption of the different crop advisories sent through SMS and at the same time gathering feedback regarding farmer's informational needs and developing or refining content of advices that meet the farmer requirements.

Uptake of Agro-Advisories by the Farmers: Implications for Improving Service Relationship

A short feedback survey of the farmers in Sangamner block of Ahmednagar district was undertaken to understand how farmers perceive the advisories at different crop growth stages and their action (follow-up or not following up) on the advisories.

Sangamner block of Ahmednagar district comes under the Western Maharashtra Scarcity Zone. This area suffers from the twin problems of low productivity and high instability as a result of inadequate and unpredictable rainfall. The average annual rainfall is less than 500 mm and ranges from 350 mm to 450 mm. High temperatures and high wind velocity result in high potential evaporation values leading to moisture deficit. In Sangamner, kharif is an important cropping season where pearl millet, pulses, groundnut, maize, soybean, and tomato are major crops. Onion in this region is predominantly grown in shallow to medium type of soil during both kharif (June–September) and rabi seasons (October–February).

The feedback on WOTR advisories was taken from 120 randomly selected farmers receiving SMS in Kharif (rainy) season of 2014–2015. Farmer interviews were conducted through structured questionnaires to collect information on farmers' response to the advisories on various crop management practices (adoption or non-adoption).

Descriptive statistics cross classification tables and measures of association based on chi-square statistics and Cramer V were used to understand differences in adoption of advisories. The rank-based quotient (RBQ) was used to understand farmer's preferences regarding the modes of communication for getting agro-met information.

Profile of the Sample Farmers in the Area

Most of the farmers were small and medium farmers (average land ownership of 1.2 h) with some basic education (mean education of about 10 years) (Table 2).

Major Crops Grown by the Sample Farmers

The major crops in the kharif (rainy) season are onion (103 plots) and pearl millet (70 plots) with an average cultivated plot area of 0.53 and 0.51 acres, respectively (Table 3).

The average price of onion in Ahmednagar district (in 2015) was Rs. 25 per kg, which is higher than that of pearl millet (Rs. 16 per kg). This is also one reason for farmers' preference to cultivate onion.

Table 2 Characteristics of sample farmers in the area

	Mean (N = 120)	Minimum	Maximum	Standard deviation
Family size (no.)	4.5	4.0	11.0	1.6
Age of household head (Years)	41.6	24	66	10.6
Education of household head (Years)	9.6	0	17	3.1
Total land owned (Hectares)	1.2	0.1	6.4	0.9
Total number of large ruminants	2	0.0	19.0	2.3
Annual household income (USD[a])	1741	309	5868	999

Source: Field survey data
[a]One USD is equal to 68 INR (2018)

Table 3 Crops grown in Kharif 2014–2015 (rainy season) among the sample households

Crop	No. of plots	Mean (Ha)
Pearl millet	70	0.51
Sorghum	2	0.50
Onion	103	0.53
Groundnut	10	0.42
Tomato	6	0.28
Marigold	1	0.40
Green peas	2	0.30

Source: Field survey data

Major Climate Risks as Perceived by Farmers

Late onset of monsoon and dry spells were perceived as the major climate risks by 100% and 89% of the respondents, respectively. Majority also considered other risks associated with agriculture such as diseases and pests (Table 4).

Sources of Information Accessed by Farmers in the Study Area

The traditional ICTs included TV, radio, newspapers, other farmers, government agricultural extension services, traders, input dealers, seed companies, and relatives. These have been an important tool since past several decades to disseminate scientific and technical agricultural knowledge to farmers and also leading to improved adoption of technologies (Mittal and Mamta 2012).

Majority of the sample farmers (about 88% of the respondents) indicated that SMS service from WOTR was one of the major sources of crop advisories. Agricultural information through television was the second most important source of information (as indicated by 72.5% of the sample farmers). Other progressive

Table 4 Major risks as perceived by farmers

Risk	No. of farmers	Percent
Climate risks		
Late onset of monsoon	120	100.0
Dry spells	107	89.2
Unseasonal precipitation	33	27.5
Other agriculture related risks		
Diseases	112	93.3
Pests	112	93.3

Source: Field survey data

Table 5 Major sources of information (n = 120)

	No. of farmers	% of total sample farmers
TV	87	72.5
Radio	22	18.3
Agricultural extension officer	51	42.5
Kisan call center	35	29.2
Progressive farmers	66	55.0
SMS WOTR	106	88.3
SMS government	17	14.2

Source: Field survey data

Table 6 Farmers preferences regarding modes of communications

	Mean rank	RBQ	Rank
SMS through mobile	1.2	94	I
TV program	2.5	62	II
Wallpaper	3.1	48	III
Newspaper	3.2	46	IV

Source: Field survey data

farmers were also considered as important sources of information (by about 55% of farmers) (Table 5).

The sample farmers were asked to rank their preferences regarding the modes of communication for getting information on weather and crop management practices.

It was found that SMS through mobile phone was ranked first followed by television programs, which was ranked second (Table 6). Gowda and Dixit (2015) found that farmers with higher education level showed better comprehension of advisories, acted upon the advisories more promptly and shared the information with fellow farmers more often than those with lower education level.

There are also other web-based services such as iKisan, an online informational resource for farmers by private entity, Nagarjuna Fertilizers and Chemicals Ltd. (NFCL) (Meera Shaik et al. 2004). In the state of Maharashtra, the Department of

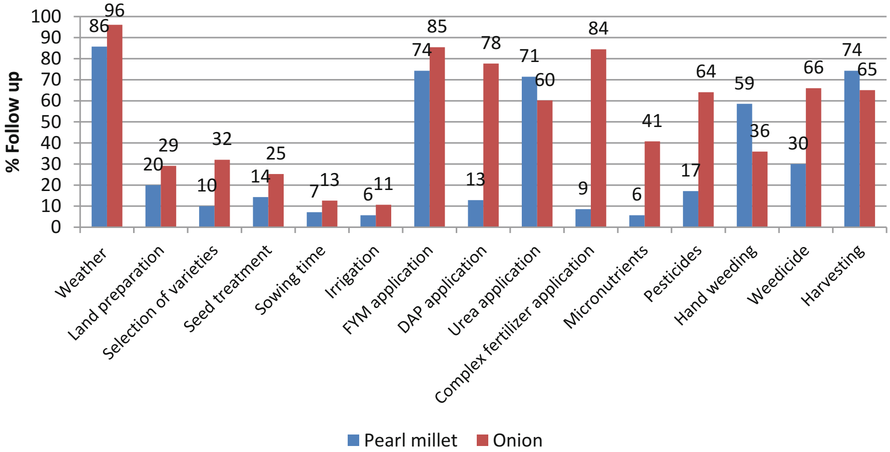

Fig. 2 Positive follow-up on the crop advisories in case of pearl millet onion crops.

Agriculture, Government of Maharashtra, provides wide range of agricultural information and services through its web portal. Other such advisory services include "Kisan Call Centres (KCCs)," an initiative of Ministry of Agriculture & Cooperation and Farmers welfare, Government of India.

Response of Farmer's to WOTR Agro-Met Advisory Information

The total number of plots under cultivation among the 120 sample farmers was 195 in the rainy season (kharif) of 2014–2015. Out of these, 70 plots were under pearl millet and 103 plots were under onion. The type of advisories sent to the farmers included location-specific and crop-specific information on weather, land preparation, seed varieties, seed treatment, sowing time, irrigation, FYM application, DAP application, urea application, complex fertilizers, micronutrient application, pesticides, hand weeding, weedicides, and harvesting. Farmers may choose parts rather than the whole package of practices. So, many farmers adopt pieces of the package rather the entire package (Al-Karablieh et al. 2009). This was noticed in the respondent farmers' in the area. Not all farmers followed up on all the advisories. Some crop advisories received greater positive responses in terms of adoption as compared to others (Fig. 2). This also varied with the type of crop, in this case: pearl millet and onion.

Weather Advisories

The weather advisories included a 3-day forecast of rainfall, temperature, wind speed, and humidity. The aim was to help the farmers to plan intercultural operations such as weeding, fertilizer application, pest and disease management, and

Table 7 Relationship between type of crops (pearl millet or onion) and follow-up on advisories (crop management practice-wise)

Crop type	Pearl millet (Total no. of plots = 70)		Onion (Total no. of plots = 103)				
Management practice	Follow-up	Not followed	Follow-up	Not followed	Chi Square	P-value	Cramers V
Weather	60	10	99	4	6.06[a]	0.01	0.18
Land preparation	14	56	30	73	1.83	0.17	0.10
Seed	14	56	33	70	3.05	0.08	0.13
Selection of varieties	7	63	33	70	11.39[a]	0.00	0.25
Seed treatment	10	60	26	76	3.52	0.06	0.14
Sowing time	5	65	13	90	1.36	0.24	0.08
Irrigation	4	66	11	92	1.30	0.25	0.08
FYM application	52	18	88	15	3.36	0.06	0.14
DAP application	9	61	80	23	70.08[a]	0.00	0.63
Urea application	50	20	62	41	2.30	0.13	0.11
Complex fertilizer application	6	64	87	16	96.56[a]	0.00	0.74
Micronutrients	4	66	42	61	26.25[a]	0.00	0.39
Pesticides	12	58	66	37	37.08[a]	0.00	0.46
Hand weeding	41	29	37	66	8.63[a]	0.00	0.22
Weedicide	21	49	68	35	21.64[a]	0.00	0.34
Harvesting	52	18	67	39	1.65	0.19	0.10

Source: Authors calculation based on field survey data
[a]Significant at 1% probability level

harvesting. It was found that weather-related advisories were followed up in the case of both pearl millet (86% of plots) and onion crops (96% of plots) (Fig. 2). Chi-square test was used to test if there was any association between the type of crop grown and the follow-up action on weather advisories (Table 7). The chi-square test indicated significant association at 1% significant level.

It was noticed that farmers were not flexible to change their crop preference. For example, short duration crop was recommended instead of onion due to dry spells. But the farmers ended up resowing the same crop repeatedly instead of sowing an alternative crop (pearl millet, pulses – green gram, black gram, and cowpea).

Seed

The advisories on seed advisories included seed treatment and time of sowing. The follow-up was low in both pearl millet and onion crops. In the case of pearl millet, farmers were advised to treat the seed with bio-fertilizers to improve germination percentage. For onions, advisory was for the seedlings to be treated with fungicides and pesticides. Since the seeds were pretreated at the time of purchase itself in both the major crops, namely, pearl millet and onion, there was no necessity to follow-up on the advisory.

Based on the 3-day weather forecast, farmers were advised on appropriate sowing times. Most often, farmers persisted with their normal sowing dates and resisted changing sowing dates. This could be because of village to village variation in onset of monsoon and type of soils. Farmers having clay soils go for sowing even with low rainfall as these soils have higher field capacity and thereby have ability to retain water for a longer time (volumetric soil moisture content remaining at field capacity is about 45–50%). Conversely, farmers with sandy soils wait for adequate rainfall due to lower field capacity before they start sowing. Farmers having access to irrigation tend to grow their crops on normal date of sowing.

Even though the follow-up on recommended specific variety was low (in 10% of plots in case of pearl millet and 32% of plots in onion), chi-square test indicated significant association (at 1% level) between the crop type and follow-up on advisory (refer to Table 7). One reason for farmers unable to follow-up on recommended seed variety was that these varieties were not easily available to farmers in adequate quantity in the market. Thereby, the farmers opted for other varieties in the market from private companies.

Irrigation

The advisory for irrigation was based on the phenological growth stage of the crop and rainfall forecast (during prolonged dry spells). For pear millet, the critical stages for irrigation were tillering, flowering, and grain formation. In onion, the critical stages included seedling stage, vegetative, bulb formation, and development stages. There was very low follow-up on the irrigation advisories in both types of crops. Farmers were irrigating as per the prevailing local conditions using their respective experiences. Type of soil again plays an important role in the farmer's decision on timing of irrigation. Sandy soils have lower water retention capacity and require more frequent irrigations during dry spells as compared to clayey soils. Another reason could be that farmers have water sharing arrangements with neighboring farmers possessing groundwater source such as tube well. Sometimes 8–10 farmers share the same irrigation source in which case it could take about 12–15 days for a farmer to get his turn to irrigate and hence the irrigation advisory timing does not match with the situation.

Farm Yard Manure (FYM) Application

There was high follow-up on advisories regarding application of FYM in 74% and 85% of the plots belonging to pearl millet and onion crops, respectively. However, there was no significant association between the type of crops and follow-up since farmers adopted the recommendations irrespective of type of crop. The advice on FYM Application is given at the time of land preparation such that FYM is incorporated into the soil before last harrowing so that volatization losses of ammonia are reduced.

Fertilizer Application

Fertilizers applied included urea, DAP, complex fertilizers, and micronutrients. The advisories for urea application were sent at the time of transplantation, 30 days and 60 days after transplantation in the case of onion. For pearl millet, the advisories for urea application were sent at the time of sowing and 35 days after sowing.

The follow-up on urea advisory was in 71% and 60% of plots for pearl millet and onion crops, respectively. Urea is one of the major sources of nitrogen fertilizer and easily available in the market. Chi-square test indicated no significant association between the type of crop and adoption of advisories.

The advisories for DAP/complex fertilizer application was at the time of transplantation in the case of onion and for pearl millet, it was at the time of sowing as basal dose. In the case of DAP and complex fertilizers, the adoption was high in onion (in almost 78% and 84% of plots, respectively) as compared to pearl millet (in about 13% and 9% plots, respectively). Accordingly, the chi-square test indicated significant association (at 1% level) between the type of crop and adoption of the advisory (Table 7). The Cramer V, a measure to compare the strength of association between any two cross-classification tables, was 0.63 and 0.74 in the case of DAP and complex fertilizers, respectively indicating strong associations between crop type and adoption of advisories. Adoption of DAP and complex fertilizer advisory was higher in onion crop since nutrient requirement is more in onion as compared to pearl millet. Farmers also invested more in onions due to higher expected returns. Some farmers could not purchase DAP due to nonavailability during peak demand period and instead applied complex fertilizers such as 19:19:19 and 10:26:26.

For micronutrient advisories, even though adoption of advisory was on lower side in both types of crops, it was relatively high in onion crop (in 41% of plots) as compared to pearl millet (6% of plots). Chi-square test indicated a significant association between adoption of advisory and type of crop. In general, adoption of advisories on micronutrients might be less due to relatively poor awareness about the importance and role of micronutrients among the farmers. Some progressive farmers followed the advisory due to awareness created by agriculture service center sand private dealers.

Pesticide Application

Onion crop is infested by major pests like thrips, aphids, onion fly, etc. while pearl millet is infested by stem borer and blister beetle. The adoption of advisory was high in case of onion (almost in 64% of plots) as compared to pearl millet (in only 17% of plots). This could be due to higher pest occurrence in onion as well as higher economic importance of the crop as compared to pearl millet. The chi-square test indicated significant association (at 1% level) between the type of crop and adoption of advisory. The Cramers V was 0.46 indicating reasonably strong relationship between the two variables.

Weeding

Advisories on weeding included hand weeding and use of weedicides. Adoption of advisories on hand weeding was more in case of pearl millet (in 59% of plots) as compared to onion crop (36% of plots). The chi-square test indicated significant association (at 1% level). In case of advisories on application of weedicides, the adoption of advisories was high in case of onion crop (in 66% of plots) as compared to pearl millet (in only 30% of plots). This indicates that farmers are willing to spend more on onion crop, which fetches higher returns. There was a significant association between the adoption of advisory and crop type. Onion is very succulent and close growing crop, which makes it susceptible to damage during hand weeding operations, which in turn increase infestation of pest and disease.

Harvesting

The follow-up on advisories was high in both pearl millet and onion crops in 74% of plots and 65% of plots, respectively. This was mainly by way of taking precautionary measures during light rains. Farmers harvested the crops before the event of rainfall and thereby avoided losses. Farmers could avoid risk of loss from pest incidence and reduced quality of grain in pearl millet and rotting in onion. Also it becomes difficult to harvest onion once rains occur. There was no significant association between type of crop and adoption of advisory. At the time of harvesting, losses due to unseasonal rainfall is very high and also affect the quality of produce. Sometimes farmers lose their whole produce/income within 1 h due to unseasonal rainfall. Therefore, adoption of advisories at the time of harvest stage of crop was higher in both types of crops.

Therefore, as indicated by Chandra Babu et al. (2012), it is important for extension programs to consider tailoring the delivery of agricultural information to the different information search behaviors of farmers. The quality of information, timeliness of information, and trustworthiness of information are the three important aspects that have to be delivered to the farmers to meet their needs and expectations (Mittal and Tripathi 2009).

The results also corroborate with observation of Weiss et al. (2000) that even though information needed for diverse groups of end users growing the same crops maybe similar, the differences in implementation of the information occur due to differences in human and financial resources available, and methods of information dissemination. Mittal and Mamta (2012) found that although farmers indicated that they would like more information delivered to them via mobile, they were not proactively seeking it out.

Conclusions: Implications for Making Advisory Systems Demand Driven

Setting up an advisory system that is location specific and responsive to individual famers needs, involves interactions between diverse actors (farmers, NGOs, Research institutions, Government institutions, private organizations). One of the key factors for developing such a system is willingness of diverse institutions to collaborate and convergence of respective strengths. Even though formal contracts provide framework for working together, it is also important to develop trust and accountability among the different actors for smooth delivery of services as well as the ability to innovate and respond to changes on the ground.

It also requires certain amount of resources to improve capacities, especially those of advisors, both subject-matter specialists and local para-agronomists, who directly engage with the farmers (client) and form the critical link in the advisory system.

In the context of uptake/follow-up of advisories by the farmers, there were differences depending on the type of crop grown. In the present case, the major kharif crops for which advisories were sent were pearl millet and onion. Weather advisories had good uptake irrespective of the type of crop. Among the advisories pertaining to fertilizer application, there was high follow-up in case of advisories for application of DAP and complex fertilizers in case of onion and less in pearl millet. In general, farmers tend to follow on advisories more in high-return crops (such as onion) as compared to cereal crops such as pearl millet.

Some of the advisories were not adopted irrespective of the type of crop such as irrigation scheduling. In such cases, content of advisories can be upgraded by taking into account the location or plot specific characteristics (such as soil characteristics, water availability, etc.) and thereby increasing the rate of adoption of advisories.

Sometime other issues such as poor mobile connectivity (quality and coverage) and low literacy levels affect the uptake of advisories. It is important to recognize that farmers generally adopt new technologies and practices when these are built on their knowledge and skill sets and demonstrate usefulness of specific technologies. Extreme weather conditions (such as drought) could also negatively affect the demand for advisories. Crop failures would directly impact on the number of farmers following up on the advisories. Such risks have to be taken into account, especially in cases where agro-advisory services are chargeable. Some farmers are willing to pay if the information is customized to their specific soil, crop, and weather conditions.

The above findings can help in refining the content of specific advisories and thereby making the system demand driven based on farmer's needs. This would help in increasing the effectiveness of the advisory system. Such feedback would also help in making the whole agro-advisory system sensitive and responsive to changes and requirements on the ground.

Cross-References

- ► Climate Change Adaptation Through Science-Farmer-Policy Dialogue in Mali
- ► Climate Smart Adaptations in the African Tropics: Scaling Weather Information for Decision Support Outcomes in Nigeria Savannahs
- ► Educating Farmers in Rural Areas on Climate Change Adaptation for Sustainability in Nigeria

- ► Enhancing Resilience of Livelihoods and Production Systems to Climate Variability and Other Related Risks in Africa
- ► Scaling Up Climate-Smart Agricultural (CSA) Solutions for Smallholder Cereals and Livestock Farmers in Zambia

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