Article

Role of Mobile Phone-enabled Climate Information Services in Gender-inclusive Agriculture

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Abstract

The mobile phone-enabled information delivery mechanism has the potential to reduce the knowledge gap between large and small farmers, and also across gender by creating awareness about new technologies and best practices. This article focuses on how access to information through the mobile phone makes women feel empowered if they are receptive to the information they receive. It also seeks to find out the type of information most valuable to women. This was done by analyzing the listening behavior of farmers, both men and women, to information provided by mobile phones. This study was undertaken in the selected villages in two states of India—Haryana and Bihar. The findings of the study show that information delivered through mobile phones under this pilot project contributed towards reducing information asymmetry among farmers, in general, and between women and men farmers. The listening rate of women farmers was equivalent to that of men farmers. Participating farmers reported that precise and timely weather-based agro-advisory messages helped them in taking informed decisions about input use, thus leading to savings on irrigation and reducing the cost of other inputs such as pesticides and fertilizers.

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Women farmers also said that agro-advisory messaging helped them make more efficient use of inputs by increasing their knowledge about climate-smart technologies.

Keywords

India, mobile phones, information, gender empowerment, climate-smart technologies, weather-based agro-advisories

Introduction

Indian agriculture has suffered from low growth and productivity in the last two decades, which has been attributed to major challenges such as insufficient physical infrastructure, inadequate availability of inputs such as seed, fertilizers, and agro-related services in rural areas, and poor access of farmers to information about modern technologies and best practices (Evenson, Pray, & Rosegrant, 1999; Fan, Hazell, & Thorat, 1999; Kumar & Rosegrant, 1994; Mittal & Kumar, 2000; Singh, 2002). Several studies, recently conducted in South Asia and Africa, have shown the transformative potential of modern information and communication technologies (ICTs) in agriculture. Among these, mobile phones have demonstrated their suitability to address the issue of the existing information asymmetry (Ali & Kumar, 2010; De Silva, Ratnadiwakara, & Zainudeen, 2010; Fafchamps & Minten, 2012; Mittal, 2012; Mittal, Gandhi, & Tripathi, 2010; Mittal & Mehar, 2013, 2016; Muto & Yamano, 2009). Mobile-enabled information has the potential to play an important role in improving the adoption of modern technologies, inputs, and best practices (Anderson & Feder, 2007; Bhatnagar, 2008). The increasing penetration of mobile networks and handsets, and the recent introduction of a number of mobile-enabled information services in rural India presents an opportunity to make useful information more widely available (Fischer, Byerlee, & Edmeades, 2009; Mittal, 2012; Mittal & Mehar, 2013, 2016).

The overall goal of using mobile phone-enabled information delivery mechanisms is to promote inclusive growth by reducing the knowledge gap between both large and small farmers and across gender by creating awareness about the latest technologies and best practices, besides facilitating two-way communication (Mittal & Mehar, 2012). Usually the agricultural sector, and, in particular, the farmer, is highly vulnerable to risks as a result of the high variability in climatic conditions and market

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uncertainties. The farmer's exposure to the risk and uncertainty is often aggravated by lack of information about weather, inputs, farm management practices, or market prices, which adversely impacts crop production and income (Mittal, 2012, Mittal & Mehar, 2012). Delivery of the latest agriculture-related information is expected to result in (a) an increase in productivity through informed decision making on crop choice, seed varieties, inputs, agronomic practices and plant protection, (b) a reduction in the production costs through the adoption of better/quality inputs and technologies and better management practices, and (c) improved incomes resulting from reduced costs and better price realization for the produce. The process of adoption of mobile-based information delivery systems has been slow and many of the models are still at an early stage of development. The sustainability of these models is also in question as most are still funded externally, and farmers are not paying the cost of receiving information.

The problem of the lack of information is even more pertinent among women engaged directly or indirectly in agriculture. Besides facing socio-cultural barriers, women farmers have lower levels of literacy, limited access to assets, and information as compared to their male counterparts, leading to a gender gap (Action Aid, 2011; FAO, 2011; Mehar, Mittal & Prasad 2016). Sharma (2009) reports that mobile phone ownership in India is largely limited to the earning members of the household or to the head of the household. But now, mobile phones are increasingly being accessed by women as well, even if they might not own them. Field experience (Tandon, 2009) clearly suggests that women are not only keen to get information, they are swift to apply what they learn and display an admirable degree of pragmatism when it comes to securing assets, natural resources, capital, and markets for the livelihoods of their communities.

It is against this backdrop that this paper focuses on the receptivity of women to the information they receive through mobiles and how this access to new knowledge has led them to feel empowered. It is too early to state that this empowerment has been converted into actions whose impact can be quantified, but there is evidence that women farmers want information, and they feel empowered through it. Women empowerment in the context of this paper is measured in terms of increased access to information and their ability to utilize it for agricultural activity. Thus, this study focuses on how women farmers vis-à-vis men farmers adopt or accept information that they receive, the kind of information they value, and what it potentially means for their empowerment, which, at present, is largely measured in terms of behavioral change. It is done by

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analyzing the trends in the listening behavior of farmers to the information provided through mobile phones. In this analysis, we focus on the number of farmers interested in listening to the information provided by ICT, and also their preference for specific information related to agriculture. Another focus of this analysis is to identify and understand the gender-specific preferences for information.

This paper specifically focuses on two aspects—utilization of information by women in agriculture, and its usability over time.

Data and Methodology

The Intervention

(M)obile Solutions is an ICT-based climate and agro-services project, which is a part of the Climate Smart Village model by Kisan Sanchar (disseminating partner) and IFFCO Kisan Sanchar Limited (IKSL), the content partner. The aim of this intervention is to improve the adoption of climate-smart agriculture practices, such as conservation agriculture (CA) practices, and to increase awareness about climate risk management among farmers. The project aims to document the perception of farmers about the increasingly erratic weather events and rising temperatures and to find out whether the information they receive helps in their overall behavior change toward adapting to climate change and the uptake of climate-smart practices. The project sends voice and text (SMS) messages in Hindi or in a local language to the mobile phones of the farmers twice a week. Messages include weather forecasts and recommended actions that farmers could take, as well as information on pests and remedies, seed varieties, and climate-smart technologies such as conservation agriculture. Additional messages provide information about climate change and its effects on agriculture. The pilot project is designed in such a way that farmers can also call a helpline to ask questions. It allows them to get the information they need and also contribute to the content of future messages.

Data

The data set used in this paper was collected during the pilot study of this intervention. Two types of information were collected and collated to understand changes in the perception of the farmers to the wheat-maize cropping systems, with a focus on women farmers. The first type was

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gathered from electronic listening reports of individual farmers to voice messages transmitted to them under the pilot project. The second set of data was based on the manual feedback collected from farmers, which aimed to quantify actions taken by farmers on the basis of the information received. We also collected information about the benefits that the farmers observed after using the information.

This dataset is based on households in the villages of the Karnal district of Haryana and the Vaishali district of Bihar. The villages covered in the study include Anjanthali, Garhijattan, Sawant, and Sandhir in Karnal, and Dabaich, Laksminarayanpur, Mukundpur, and Rajapakar in Vaishali. This dataset represents the period between September 2013 and May 2014 during which farmers listened to the information provided through voice messages. A total of 1,100 farmers participated in the project. Of them, 510 were asked at random to provide feedback on the usability and effectiveness of the information provided. The feedback was based on the data collected between November 2013 and January 2014. Women participants in this study were either the heads of households or members of male-headed households. Since they were receiving information on their mobile phones independently, the purpose of the project was also to create awareness and understanding of modern technologies so that women participants could be empowered to take active participation in household decision-making processes related to agriculture. A total of 58 percent of the sample farm households cultivated maize and were mainly concentrated in Vaishali, with a few maize growing households in Karnal.

The methodology followed in this study consisted of collection and analysis of electronically recorded listening data on each message by each farmer. The average listening rate was the average time (in seconds) a farmer spent on listening to a message. The average listening rate was used as an indicator in this analysis because it measured the duration for which the farmers listened to a message when they had the option of disconnecting the phone. Thus, the listening rate was taken as an indicator of farmers' interest in the information they were receiving. It was assumed that if the farmer chose to listen to a certain type of information or to listen for a longer period, then s/he was getting valuable information or was interested in knowing more about the information being disseminated.

Based on this, we analyzed trends by the types of messages and monthly data across gender to understand the listening behavior of the farmers. The data were analyzed for the mean length of time spent listening to each message. Around 345 messages were disseminated during the period under study. The duration of messages ranged between 45 seconds and 90 seconds, and the average length of the messages was

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58 seconds. The electronically generated dataset was supported by a feedback survey to understand which information was valued the most by farmers, the action taken on messages received/listened to by farmers, and the benefits farmers realized after utilizing the information. The questionnaire was prepared according to the type of voice messages sent to the farmers, and the information disseminated on weather, seed and related seeding practices, insect and pest management, livestock, CA technologies, and other farming and agriculture-related knowledge. The questionnaire was intended to determine the preferences of farmers regarding the type of information which was beneficial to them as well as the farmers were asked to elicit suggestions to improve the message services. Both open-ended and closed-ended questions were formulated to collect a range of responses from the farmers.

For the analysis of the dataset, responses to the closed-ended questions were analyzed by using a simple statistical method of determining average responses to a particular question. The responses to the open-ended questions were grouped and coded, and simple statistical methods were used to determine the types of messages preferred by the farmers, why they were preferred, and how they had proven to be beneficial. A total of 7.1 percent of the respondents to the feedback survey in Karnal and 16.1 percent of the respondents in Vaishali were women. In the electronic survey, 8.1 percent respondents were women from Karnal and 18.2 percent were women from Vaishali. The average age of the farmers in the sample households was 41.9 years while the average age of women in the surveyed households was 36 years. Among the eight villages under study, there was no women participation from Sawant village in Karnal. Out of the 510 households surveyed, 258 produced maize in addition to wheat. In Haryana, only 10.8 percent of the households under study cultivated maize, whereas the number for Bihar was around 89.5 percent.

Results and Discussion

Gender Listening Rates at State and Village Level

Women have a limited access to agricultural information and knowledge in the rural areas. Some people believe that they do not need access to such information as they are not the key decision-makers in the field. But Munyna, (2000) has shown that if women are not fully informed about technologies, market information, and other agriculture-related aspects, the overall agricultural development is negatively affected.

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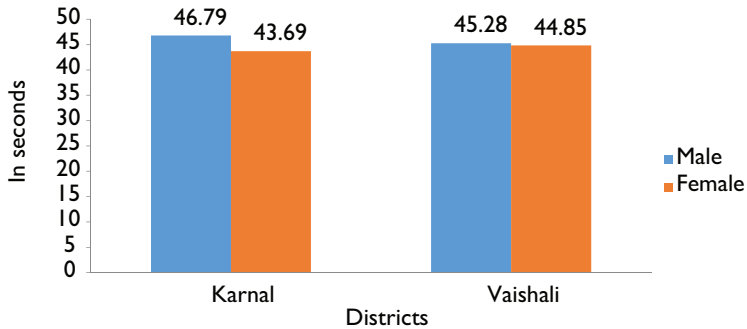

Figure 1. Gender-wise Mean Duration of Message Listened to by Farmers in both the Districts

Source: Authors calculations using the primary survey data.

Thus, while tracking message listening rates[1] it was interesting to note that women farmers, on an average, listened to the messages for as long as the men farmers (Figure 1). It can be taken as the first indication that they found the information useful or that they were interested in listening to the information as much as their male counterparts. It was further investigated through a survey in which 98.6 percent of the women found the information useful. Interestingly, the difference in listening time between men and women farmers was smaller for Vaishali as compared to Karnal, but overall the difference was marginal.

This trend was true even at the village level (Figure 2). The only major exception was the Sawant village in Karnal where no women participated. In the other three villages in Karnal, the difference between the listening behavior of men and women was marginal.

In the Vaishali district, with the exception of Rajapakar village, the women participating in the pilot project demonstrated a higher mean rate of listening to the messages than the men farmers. Thus, it was clear that women farmers were listening to agro-related information and the project dissemination services had successfully reached them.

Message Listening Rate by Type of Information

It is important to understand the types of information prioritized by the farmers/listeners. From the feedback surveys conducted prior to the intervention, we obtained data on which information was valued the

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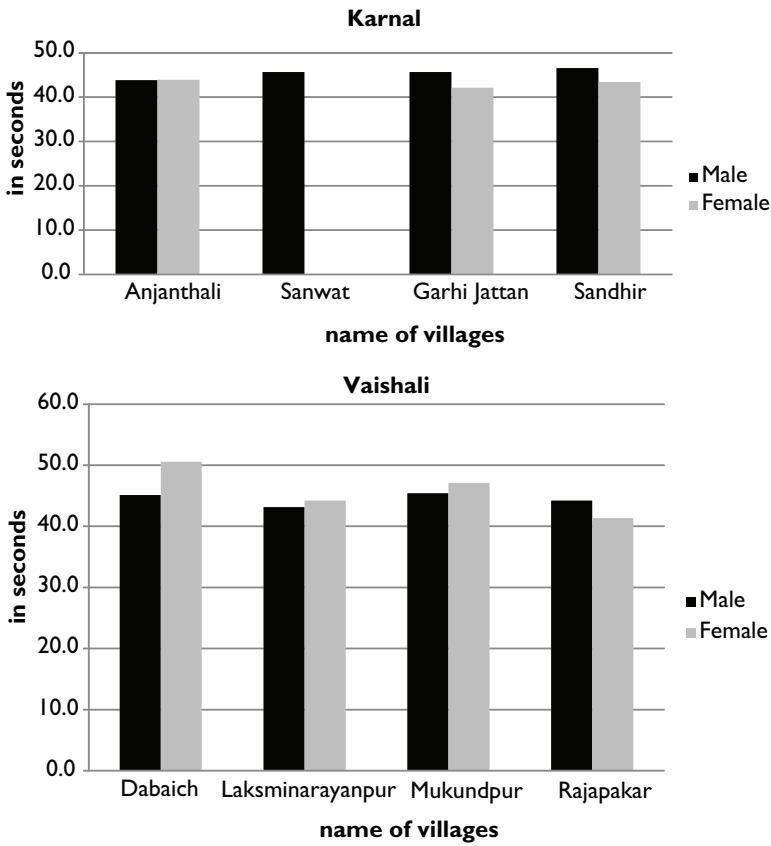

Figure 2. Gender-wise Mean Duration of Messages Listened to by Farmers by Villages

Source: Authors calculations using the primary survey data.

most by farmers. Table 1 presents the results. Some differences exist between the farmers' pre-intervention perceptions as presented in Table 1 and the results in Figure 3. For example, information on conservation agriculture and post-harvest management was not included in the priority list of farmers, but the listening rate to this type of information was high across both the districts. Figure 4 presents the actual listening rates according to types of information.

Weather-related information was found to be the most relevant to all the farmers, regardless of gender, in both the districts. It was followed by

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Table 1. The Information that the Farmers Valued the Most (in Percent)

Type of Information	Karnal Men	Vaishali Men	Karnal Women	Vaishali Women
Weather	64.3	50.0	95.8	38.5
Seeds	10.7	9.3	–	–
Nutrient management	14.3	0.5	–	–
Pest management	3.6	20.2	–	30.8
Post harvest management	–	15.5	–	–
CA technologies	3.6	–	4.2	–
Livestock	3.6	–	–	–

Source: Authors calculations using the primary survey data.
Note: Blanks indicate that the information did not fall in their priority list.

the information about nutrient management and seeds, which was considered significant, mainly, by men in Karnal, and information about pest management and post-harvest management, which was valued by men in Vaishali. Information on pest management was also of key importance to women in Vaishali. Farmers said that correct weather forecast helped them plan their irrigation and input use, and was, therefore, the most important piece of information for them. Farmers in Vaishali voiced that pest infestation caused the maximum losses to their wheat and maize crop, so information on pest management was vital for reducing their crop losses. More farmers in Vaishali are engaged in maize production as compared to farmers in Haryana, which explains why they also valued information on post-harvest management of maize. However, women farmers in Vaishali did not list post-harvest management information as important.

It was interesting to note that even when exposed to the information that farmers had not specified as being important during the pre-project survey, both male and female farmers listened to the information for an almost similar duration as the information they considered significant (Figure 3). The mean duration, in seconds, of listening to a message on seed information for women farmers in both the districts was as high as that of men farmers, although they had not ranked it high in terms of information important to them during the pre-project feedback survey.

Figure 3 again highlights that the women farmers exhibited almost same interest as men farmers in both the districts when it came to listening to various types of information. In Karnal, the highest mean duration of messages listened to by women farmers was related to

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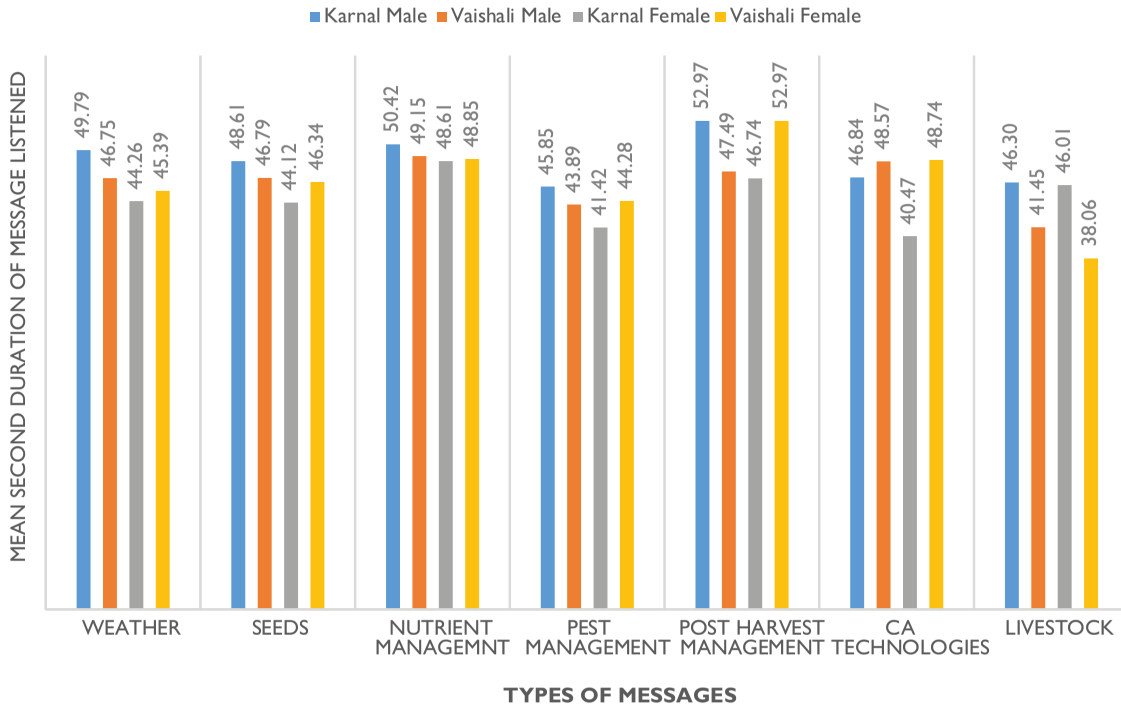

Figure 3. Gender-wise Mean Duration of Messages Listened to by Farmers

Source: Authors calculations using the primary survey data.

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nutrient management (48 seconds) and CA technologies (40 seconds), although women are usually not directly involved in either of these two fields, which are largely controlled by male family members. Not much difference was found in the listening behaviors of men and women in most of the other categories as well, indicating that men and women farmers share similar preferences when it comes to information. However, some differences were observed in the listening behavior of the two when it came to information related to post-harvest management and CA technologies. These two fields of knowledge commanded a higher mean listening rate from men farmers than from women farmers (Figure 3).

In the case of Vaishali, the highest mean listening rates for women farmers were related to post-harvest management, nutrient management, and CA technologies. The lowest mean listening rates of women farmers were observed in information related to livestock (38 seconds). Considering that it is generally assumed that women primarily handle livestock management, it would indicate that they did not find much utility in the information provided about livestock as they already had sufficient knowledge about it. It raises the question whether the utility of information declines with prior knowledge of information or with the continuous flow of information, or if the content of the message is simply not relevant.

This analysis also implies that farmers themselves might not always be able to prioritize their information needs—they might be seeking only the information they are aware of. New information about technologies, varieties, inputs, etc., was included, which farmers were not aware of until they were exposed to it through the advisory services. It is because of this increase in awareness level that their interest in these technologies increased. Thus, information is also an enabling factor towards the adoption of new technologies. It also signifies that agro-advisory services should not only be demand-led but should expose farmers to the new information as well.

Message Listening Rate Overtime

In order to test the assumption that the utility of information declines over time, we analyzed the monthly trends of listening rates over time to see whether there were diminishing returns on the information received by the farmers and whether it was true across gender. Information and demand are dynamic and, as in the case of other goods, there are diminishing returns to the utility of information as well (Mittal, 2012; Mittal &

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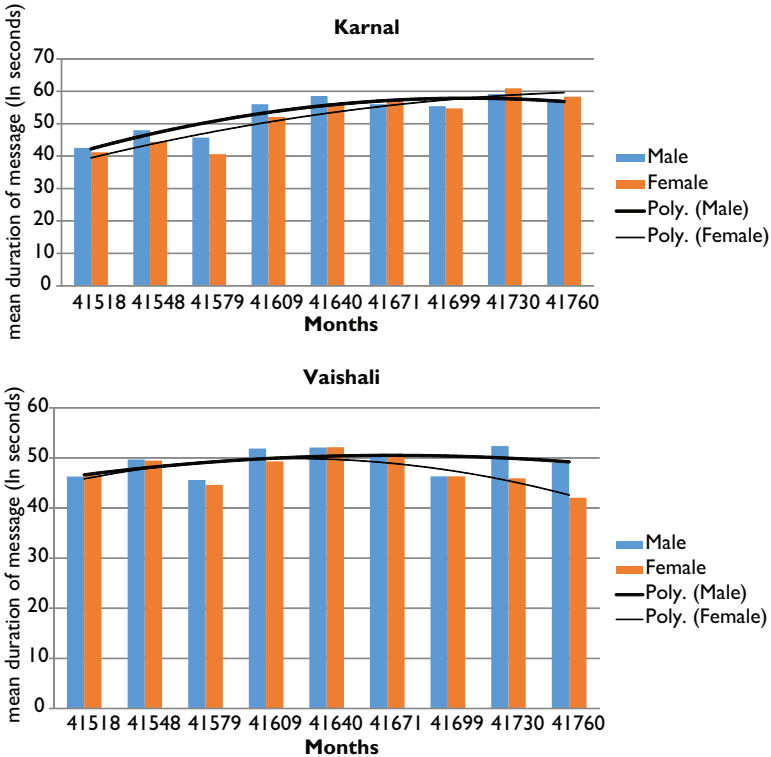

Figure 4. Gender-wise Mean Duration of Message Listened Across Different Months

Source: Authors calculations using the primary survey data.

Mehar 2016). Monthly trends are presented in Figure 4 for Karnal and Vaishali, respectively.

It can be interpreted from Figure 4 that the mean duration of messages listened to by women farmers in Karnal showed a positive trend. Similarly, the mean percentage of total messages listened to by women farmers also increased over time. It indicates that women farmers responded well to the messages and their interest in mobile-based information increased over time. It can also be interpreted that, quite likely, there was a large information asymmetry among women farmers in Karnal, and therefore, their interest in mobile-based information increased over time while that of men remained almost the same. While over time the mean listening rate for men declined a bit, it was still positive.

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The trends in Vaishali were different from those in Karnal. Initially the mean duration of messages listened to by women farmers increased till January 2014 after which it started decreasing. It indicates that it is quite likely that women farmers in Vaishali initially showed interest in agro-related information, but as they were actively involved in agriculture and were experienced hands, this information had less utility for them over time. It also indicates that the information gap among women farmers in Vaishali was comparatively lesser than that among women farmers in Karnal.

We cannot firmly conclude that there is a declining marginal utility of information. It may also be because of the feedback loop in the pilot study from the farmers to the information service providers, which helped the information agro-advisory services to constantly customize their content to meet the dynamic needs of the farmers in the study. Thus, the marginal reduction assumption does not hold as information changed with their changing needs and they continued to draw utility from the information provided. These results need to be further validated using more information category details to see the trends per message.

Action Taken on the Messages

In the above sections, we analyzed the information received by women and men farmers and accordingly assessed their information needs and behavior toward that information. We interacted with a sample of these households through feedback surveys in the form of a structured questionnaire and also through focus group discussions to understand which actions, if any, were taken by these farmers. About 92.9 percent of men farmers from Karnal and 77.3 percent of men farmers from Vaishali reported that they had taken specific actions after receiving precise information. Although the listening rate of women in Haryana was quite good, they had limited ability to take action due to their low involvement in agriculture. In Bihar, 83.3 percent of women farmers who were engaged in farming reported having taken action on the information they received.[2]

The cost of obtaining information is usually very high for the women farmers (Lastarria-Cornhiel, 2008). In such a scenario, providing agro-related information through mobiles can be beneficial as it significantly reduces the cost of information. It can also increase production, which is reflected in the increased profits. The fact that women farmers are listening to agro-related information shows the potential of ICTs to provide information to them, thereby proving to be a tool for their empowerment in the long term.

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Table 2. The Most Prominent Actions Reported by Farmers after Receiving Messages

Action Taken	Men	Women
Weather information utilized to plan irrigation and input use	Yes	No
Land preparation with new technologies like zero tillage	Yes	No
Using recommended varieties of seed (varietal diversification)	Yes	No
Nutrient management	Yes	Yes
Weed management	Yes	Yes
Pest management	Yes	Yes
Conservation agriculture	Yes	No

Source: Authors calculations using the primary survey data.

Table 2 sums up the most significant actions that farmers said they had taken after being connected with the agro-advisory mobile service. Not all of these actions were taken by women because of their limited direct involvement, but it was observed that women farmers mainly took steps related to nutrients and weed and pest management. This information was new to them, and they found it valuable enough to apply to their daily farming activities.

The benefits that farmers gained by taking action on the messages received through agro-advisory services are presented in Table 3. In a short time period of eight months, it is not possible to see tangible benefits in terms of change in productivity or adoption of technologies, but it shows that both men and women farmers valued the information received through the agro-advisory services. During the feedback survey phase, not all the farmers were able to appropriately quantify the benefits of the information received and actions taken as a result. But they highlighted the types of benefits seen (Table 3).

A total of 70 percent of women farmers felt that agro advisories had helped them to increase their knowledge about farming practices, including information about modern technologies and best practices. They attributed the increase in yields to the utilization of new information they had been able to access through mobiles. At least 48.1 percent of the women farmers felt that the information helped them to reduce the costs with efficient input management, and 55.6 percent of the women respondents felt that the information provided to them helped them in reducing

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Table 3. Benefits Realized by Farmers with Increased Access to Reliable and Timely Information

	As Responded by Percent of Farmers	
Realized Benefits	Men	Women
Know more about farming practices	79.7	70.4
Experienced better yields	63.6	70.4
Reduced cost on inputs	64.1	48.1
More aware about the right input use	49.4	29.6
More aware about technologies	50.6	51.9
Has helped to reduce losses	72.7	55.6
Better weather information for action	76.2	77.8

Source: Authors calculations using the primary survey data.

losses. They cited the latter in the context of losses suffered due to erratic rainfall by other farmers in the village who were not connected to this service.

Weather forecasts proved to be the most valuable information for them as these enabled them to take informed decisions. The example cited involved information about unusual, erratic and excess rainfall in the Rabi season of 2013–2014, which not only helped them reduce the number of irrigations but also saved the wheat crop. Prior information on the likelihood of a bad monsoon season in western India prompted them to diversify their cropping system toward maize or use the direct-seeded rice (DSR) technology. More detailed investigations and impact assessment studies are required to confirm these initial results.

Conclusion and Way Forward

The study suggests that information delivered through mobile phones helps to reduce the information gap between farmers and has the potential to enhance productivity. Realizing the full potential of this technology, however, will require significant improvement in the supporting infrastructure as well as in capacity building, particularly, for small farmers, so that they can use this information more effectively. Farmer groups have become more aware of these technologies and value the information on weather delivered to them. Women farmers value these

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services, show interest in knowing about new technologies, and feel empowered with the information delivered to them. They have also become more aware of climate smart technologies. There is still a long way to go before women can convert this information into action in parts of the country where they have limited involvement in agriculture. But women in the male-headed households also feel that their participation in family agriculture has improved with the increased flow of information. Farmers have gratefully acknowledged that precise and timely weather based agro-advisories have allowed them to take informed decisions about the use of inputs during the sowing season based on which they have saved on irrigation as well as on the cost of pesticides and herbicides. Overall, the average listening rate of women through voice calls was as good as that of their male counterparts. The feedback forms collected from women farmers showed that the information they listened to helped to increase their knowledge about climate-smart technologies and the efficient use of inputs and encouraged their participation in decision making that made them sensitive towards climate change.

Notes

1. Mean duration of message is described as the mean of the total duration of different messages listened to by the farmers over time.
2. Access to resources is also an enabling factor to take action, but the data collected in this study do not permit us to analyze this aspect.

References

Action Aid. (2011). *What women farmers need: A blue print for action*. Retrieved April 11, 2016 from http://www.actionaid.org/sites/files/actionaid/the_blue_print_for_women_farmers.pdf

Ali, J., & Kumar, S. (2010). Information and communication technology (ICTs) and farmer's decision-making across the agricultural supply chain. *International Journal of Information Management*, *31*(2), 149–159.

Anderson, J. R., & Feder, G. (2007). Agricultural extension. In R. Evenson, & P. Pingali (Eds), *Handbook of Agricultural Economics* (vol. 3, pp. 2344–2367). Washington, DC: Agriculture and Rural Development Department, World Bank. doi:10.1016/S1574- 0072(06)03044-1

Bhatnagar, S. (2008). *Benefits from rural ICT applications in India: Reducing transaction costs and enhancing transparency?* LIRNEasia presentation at Public Lecture on ICT in Agriculture, Colombo, Sri Lanka. Retrieved April 11, 2016 from http://www.lirneasia.net/wp-content/uploads/2008/03/bhatnagar_transaction-costs-and-icts.pdf

De Silva, H., Ratnadiwakara, D., & Zainudeen, A. (2010). *Social influence in mobile phone adoption: Evidence from the bottom of pyramid in emerging Asia*.

Downloaded from gtd.sagepub.com at MEJORAMIENTO DE MAIZ Y TRIGO on May 17, 2016

LIRNEasia. Retrieved April 11, 2016 from www.lirneasia.net/wp-content/uploads/2010/03/DE-SILVA-TBOP3_03_1.5.pdf

Evenson, R. E., Pray, C., & Rosegrant, M. W. (1999). *Agricultural research and productivity growth in India* (IFPRI Research Report No. 109). Washington, DC: International Food Policy Research Institute.

Fafchamps, M., & Minten, B. (2012). Impact of SMS-based agricultural information on Indian farmers. *World Bank Economic Review*, *26*(3), 383–414. doi: 10.1093/wber/lhr056

Fan, S., Hazell, P., & Thorat, S. (1999). *Linkages between government spending, growth, and poverty in rural India* (IFPRI Research Report No. 110). Washington, DC: International Food Policy Research Institute.

Fischer R. A., Byerlee, D., & Edmeades, G. O. (2009, June 24–26). *Can technology deliver on the yield challenge to 2050?* Prepared for UN & FAO expert meeting on "How to feed the world in 2050," Rome.

Food and Agriculture Organization of the United Nations, FAO. (2011). *The state of food and agriculture 2010–2011: Women in agriculture: Closing the gender gap for development*. Rome: Author.

Kumar, P., & Rosegrant, M. W. (1994). Productivity and sources of growth for rice in India. *Economic and Political Weekly*, *29*(52), A183–A188.

Lastarria-Cornhiel, S. (2008). Women's Effective Rights To Land. Retrieved April 11, 2016 from http://www.socwomen.org/wpcontent/uploads/2010/05/SWS_FactSheet_WomenLand_29Mar2013.pdf

Mehar, M., Mittal, S. & Prasad, N. (2016). Farmers coping strategies for climate shock: Is it differentiated by gender? *Journal of Rural Studies*, *44*(April), 123–131. doi: 10.1016/j.jrurstud.2016.01.001

Mittal, S. (2012). *Modern ICT for agricultural development and risk management in smallholder agriculture in India* (Working Paper No. 3). Mexico, D.F.: CIMMYT.

Mittal, S., Gandhi, S., & Tripathi, G. (2010). *Socio-economic impact of mobile phone on Indian agriculture* (Working Paper No. 246). New Delhi: International Council for Research on International Economic Relations.

Mittal, S., & Kumar, P. (2000). Literacy, technology adoption, factor demand and productivity: An econometric analysis. *Indian Journal of Agricultural Economics*, *55*(3), 490–499.

Mittal, S., & Mehar, M. (2012). How mobile phones contribute to the growth of small farmers? Evidence from India. *Quarterly Journal of International Agriculture*, *51*(3), 227–224. Retrieved April 11, 2016 from http://ageconsearch.umn.edu/bitstream/155478/2/2_Mittal.pdf

Mittal, S., & Mehar, M. (2013). Delivering agro-advisories through mobile phones—reality check? *Agricultural Extension in South Asia Blog*. Retrieved April 11, 2016 from http://www.aesa-gfras.net/images/Surabhi.pdf

Mittal, S., & Mehar, M. (2016). Socio-economic factors affecting adoption of modern information and communication technology by farmers in India: Analysis using multivariate probit model. *The Journal of Agricultural*

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Education and Extension, 22(2), 199–212. doi:10.1080/1389224X.2014.997255.

Munyna, H. (2000). Application ICTs in Africa's agricultural sector: A gender perspective. In E. M. Rathgeber & E. O. Adera (Eds.), *Gender and the information revolution in Africa* (pp. 85–124). Canada: International Development Research Centre.

Muto, M., & Yamano, T. (2009). The impact of mobile phone coverage expansion on market participation: Panel data evidence from Uganda. *World Development*, *37*(1), 1887–1896.

Sharma, S. (2009). *Rural India calling*. USID Foundation. Retrieved April 11, 2016 from www.usidfoundation.org/usid2009/callforpapers/papers/Paper-P-00024.pdf

Singh, P. (2002). *Agricultural policy-vision 2020*. Planning Commission. Retrieved April 11, 2016 from planningcommission.nic.in/reports/genrep/bkpap2020/24_bg2020.pdf

Tandon, N. (2009). *Issues and challenges of climate change for women farmers in the Caribbean: The potential of ICTs*. The Natural Resource Management Network Retrieved April 11, 2016 from http://www.comminit.com/natural-resource/content/issues-and-challenges-climate-change-women-farmers-caribbean-potential-icts

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