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Effectiveness of mobile agri-advisory service extension model: Evidence from Direct2Farm program in India

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ABSTRACT

This study examines the effectiveness of mobile as a novel approach for providing targeted and equitable agri-advisory services to farmers at scale. A cross-sectional survey of farmers registered on CABI's Direct2Farm (D2F) user database was undertaken using a combination of telephone interviews, household survey and focus group discussions covering six states in India. Results indicate that majority of farmers receive information from various sources, notably fellow farmers (73%) and government extension (58%). Mobile service was ranked 5th as a source of information out of seven identified. Nonetheless, there was evidence that CABI-D2F mobile services reached a large number of farmers in a short time compared to what could be achieved by traditional extension approaches, and the services significantly influenced farmers to take up new agricultural practices ($p < 0.01$). At least 40% of the initial 400,000 registered farmers became active users of the service, regarding it as a valuable and credible source of agricultural information. Small-scale farmers, women, and elderly people were less likely to use mobile service with preference for traditional extension approaches. This digital divide may be attributed to low literacy levels, and/or ownership or control of mobile phones. Results raise two issues; firstly how mobile services can be designed to best fit differences in gender and social realities; and secondly, how mobile services can be effectively monitored to ensure messages are being received by targeted users.

1. Background

The renewed prominence of agriculture on the development agenda has reawakened interest in agricultural extension and advisory services. Increased attention on extension is expressed through the Global Forum for Rural Advisory Services (GFRAS). Agricultural extension and advisory services facilitate the transfer of knowledge, information, improved technologies and practices to farmers, farmer organizations and value chain and market actors (Christoplos, 2010). Research evidence has shown positive effects of extension access on farmer knowledge, adoption, productivity, and economic returns for farmers (Birkhaeuser, Evenson, & Feder, 1991). Return on investment in agricultural advisory services is estimated at 58% (Alston, Chan-Kang, Marra, Pardey, & Wyatt, 2000; Dercon, Gilligan, Hoddinott, & Woldehanna, 2009). Evaluation of specific extension programs such as Farmer Field Schools (FFSs), has shown positive impacts on the environment and health (Praneetvatakul & Waibel, 2006).

The traditional agricultural extension is done face-to-face, through an extension officer visiting a farmer, a group of farmers or conducting farmer field schools (Stringfellow, Coulter, Lucey, McKone, & Hussain, 1997); this has primarily been government-led. However despite its relatively long history and widespread adoption, significant challenges in providing extension services still exist including; insufficient funds for supporting public extension, limited involvement of rural farmers and populations in extension processes, and lack of research and appropriate extension methods. This limits coverage of extension services, particularly across rural regions, and adapting technological packages to community-specific contexts (IFPRI–WorldBank, 2010).

An array of innovative practices has been developed to fill this gap in extension and advisory service delivery. Approaches that have been used include village-based intermediaries, farmer-to-farmer extension, farmer field schools or farmer field days, aimed at reaching as many

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farmers as possible with extension messages. The key difference with traditional extension approaches is the emphasis on participatory learning and action, with more tailor-made services, including facilitation of access to financial services and access to markets. However, the high cost associated with face-to-face extension constrain effective delivery of the service to the farmers, who are often widely distributed (FAO, 2014).

Information and Communication Technology (ICT) enabled services have been increasingly advocated by extension practitioners as an alternative to conventional face-to-face extension approaches. They range from radio programs using add-on features, to television shows, mobile technology services, and the internet. ICTs are considered low cost and have the ability to deliver timely, relevant, and actionable information to farmers even in remote locations and to diverse populations. ICT-based solutions are also viewed as an enabling tool for extension service delivery targeting poor rural farmers especially women (Manfre & Nordehn, 2013). Information provided via ICTs is becoming more varied, ranging from specific technologies, market access, price information, weather information and early warning of drought, floods, and diseases. This allows farmers to make more informed decisions on what to grow and how to improve their agricultural practices. The growth of mobile phone ownership among the rural population of developing countries further presents an opportunity to deliver the much needed agricultural services to smallholder farmers using mobile-enabled extension messaging.

Although many extension and advisory service providers are using "e-extension" and mass media approaches to improve their outreach to farmers and farmers' access to information, most of these initiatives are at early pilot stages and limited empirical evidence is available on the effectiveness of ICTs in extension (Davis & Addom, 2000). Further, debate has occurred about the appropriateness of these ICT approaches, specifically their effectiveness in stimulating learning and adoption of agricultural practices. This paper presents the results of an effectiveness assessment of the Direct2Farm (D2F) service, a CABI-led project that used mobile agri-advisory service extension model in India. Effectiveness was measured in different dimensions: farmer awareness of new practices, knowledge acquisition and retention, uptake of new technologies, and knowledge sharing. Proxy measures and anecdotal evidence were used to measure technology uptake and behavior change, based on farmers self-reporting during the study.

2. Agri-advisory services in India and Direct2Farm campaign

The Government of India, like most governments in the developing world, operates a system of agricultural extension to spread information on new agricultural practices and technologies. The extension system works through a large workforce of public extension agents. However, dispersed rural populations, monitoring difficulties and lack of accountability limit the efficacy of traditional extension systems in India (Shawn & Fernando, 2012). Lack of financial resources to recruit adequate extension personnel, as well as retaining staff deployed to rural areas are other challenges facing agricultural extension in India. During the project team's field visit to Haryana, we were informed that a considerable number of extension posts were vacant. A countrywide study on extension service access in India shows that only 5.7% of farmers reported receiving information about modern agricultural technologies from public extension agents (Glendenning, Babu, & Asenso-Okyere, 2010).

CABI has been involved in using mobile technology to support farming in India since 2008. In 2014, CABI started to scale up - Direct2Farm (D2F) - in six states of Haryana, Uttar Pradesh, Madya Pradesh, Rajasthan, Bihar, and Jharkhand, in order to investigate further the potential for mobile-based agri-advisory services. The aim of the mobile agri-advisory services was to complement and extend the reach of existing extension efforts, thus further empowering farmers to solve their everyday farming problems and increase productivity. The D2F service is a content repository containing agricultural fact sheets and short advisory voice and text messages for a range of crops and livestock. This repository is used (and can be used in future) to feed short, credible SMS and voice content to mobile Value Added Services (VAS) Providers and Mobile Network Operators (MNOs) in India, which can be delivered directly to smallholder farmers via their mobile phones. Content is developed and translated into local languages by CABI content team and validated by the Subject Matter Expert (SME) before being fed into the content management system.

In July 2014, a cohort of 400,000 farmers was recruited to the CABI-D2F scale up service, from the six scale-up states. Details of their farming practices and location were collected as part of the registration process. The service began distributing free text and "voice" messages in January 2015 to the registered members. Messages were sent out at critical points in the farming calendar as 'campaigns', which focused on particular aspects of crop production, plant protection, agro-met advisory and livestock husbandry. By the end of 2015, CABI-D2F completed 714 campaigns which collectively distributed 9.5 million tailored voice messages and close to 6 million text messages (Table 1). The messages were targeted, based on farmers' location, language, choice of crops, livestock and farming practices. The proportion of voice messages sent out disaggregated by content is shown in Fig. 1. The content of text messages was aligned to the voice messages.

Table 1
Overview CABI-D2F message distribution in 2015.

Month	Number of messages	
	Voice	SMS[‡]
January	66,896	367,014
February	3,94,014	1,226,773
March	540,161	1,571,211
April	361,359	1,917,450
May	510,886	669,038
June	778,648	162,725
July	866,838	0
August	320,530	0
September	26,289	0
October	737,453	0
November	2,621,510	0
December	2,626,493	0
Total	9,551,080	5,914,211

[‡] The program considered text messaging less interactive and opted to stop SMS in favour of voice messaging, halfway the project.

3. Methodology

3.1. Study population and samples

We used mixed method approach that utilized both quantitative and

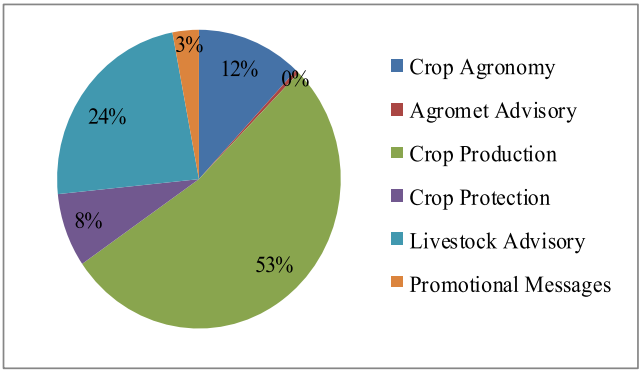

Fig. 1. Proportion of voice message sent out during 2015, disaggregated by message content.

Table 2
Sample size by state and village.

State	Telephone interviews		Community visits	
	Sample	% of sample	District (villages)	Respondents
Haryana	1250	60.6	Bhiwani (Dhangar), Sonipat (Bichpari)	31 households, 6 FGDs (38 participants)
Uttar Pradesh (UP)	578	28.0	Bareilly (Bhoji Pura), Hardoi (Madrawan)	30 households, 8 FGDs (59 participants)
Bihar	77	3.7	Muzaffanpur (Bahdinpur), Vaishali (Amnipur)	36 households, 8 FGDs (52 participants)
Jharkhand	40	1.9	–	–
Rajasthan	108	5.2	–	–
Madya Pradesh (MP)	9	0.4	–	–
Total	2062	100.0		

qualitative data collection methods. The study population comprised farmers from the CABI-D2F Registered User Database of 400,000, from which a representative sample was obtained. Data for the study were collected in two waves; November 2015 – February 2016, and August – September 2016. We used telephone interviews, Focus Group Discussions (FGDs) and face-to-face interviews for data collection.

The sample for telephone interviews was determined following (Israel, 1992) method for sample determination. We obtained a sample of 1067 farmers from the population, which we increased to 2062 to mitigate a predicted 20%–25% non-response rate. Table 2 shows the distribution of this sample by state. The telephone survey questionnaire explored the socio-demographic profile of each respondent, their experience with CABI-D2F, information seeking and sharing behavior, and feedback on the mobile service. Additionally, questions enquired how information was used, any reported behavioral changes, and users' perceptions of the service. We embedded validity checks during the telephone interviews to reduce bias related to the timing of the interviews (see protocol in Appendix 1).

Further, we conducted community visits to six randomly selected communities (across 3 States). We considered communities that had at least 50 respondents to the telephone survey. During community visits, we explored users' experiences of CABI-D2F and mobile info-services in general, barriers to using the service, and willingness to pay for future services, and information exchange at the community level, as well as non-users' perceptions of the D2F service. During community visits, we directly interviewed 97 households and conducted 22 FGDs (see Table 2). The community interviews used an adapted version of the telephone survey questionnaire.

3.2. Analytical framework

The primary objective of an extension approach is to influence farmer learning in such a way that it influences positive change in farming practices and application of technologies. Cai and Abbott (2013) show farmer learning as a process involving awareness, knowledge acquisition and retention, knowledge evaluation, knowledge use and adaptation, and knowledge sharing. Karubanga, Kibwika, Okry, and Sseguya (2016) used the same framework to assess farmer learning and innovation through an integration of video-mediated and face-to-face extension approaches in Uganda. Lukuyu, Place, Franzel, and Kiptot (2012) considered farmer satisfaction with information, learning, and transfer of learning in assessing the effectiveness of volunteer farmers. Other scholars have used various indicators to measure the effectiveness of extension approaches in different countries (Amudavi et al., 2009; Hellin & Dixon, 2008). In this study, we measured the effectiveness of D2F mobile agri-advisory services using four proxy measures; i) awareness ii) knowledge acquisition, iii) uptake of new technologies; and iv) knowledge sharing.

- Awareness was measured by the number of farmers reached by information on new practices and technologies through D2F.
- Knowledge acquisition was measured by farmers' reporting of understanding of information, and their perception of information relevance, timeliness, and reliability.
- Uptake of new technologies was measured by the number of new practices and technologies farmers applied after receiving messages, a measure of the proportion of knowledge put into use in relation to what they learned through received messages.
- Knowledge sharing was measured by the proportion of farmers who indicated to have shared information with other farmers within their community, and their willingness to share information they receive, an indicator of trust in the information source and content received.

3.3. Model specification

This study aims to demonstrate how successful (or not) D2F messages were at influencing participants to learn and take up new technologies or practices. It is noted, however, that farmers' decision to take up or adopt new practices would be conditional on receiving appropriate information and whether such information was clear and understandable. This is in addition to other socio-economic and environmental factors that affect farmers' adoption decisions. Given our interest in simultaneously modeling the determinants of learning and technology uptake, this suggests the specification of Heckman's sample selection model (Heckman, 1976). This model facilitates controlling of sample selection biases that could otherwise arise from the existence of unobservable variables that determine both the discrete and continuous choices pertaining to technology adoption. The model considers that observations are ordered into two regimes, the first stage referred as the selection model and the second stage as the outcome model. In this context, these regimes are defined by whether a farmer understood the information received on their mobile phone (selection) and whether the farmer took action (outcome). The probit model for sample selection assumes the existence of a relationship between the selection and outcome models given by equation (1) and (2):

$$Y_1 = b' X + U_1 \quad (1)$$

$$Y_2 = g' Z + U_2 \quad (2)$$

where, Y_1 and Y_2 are latent variables indicating knowledge acquisition and uptake of new agricultural practices respectively; X is a k-vector of regressors, Z is an m-vector of repressors; b' and g' are vectors of associated parameter estimates; U_1 and U_2 are error terms and are jointly normally distributed, independently of X and Z with zero expectations. The independent variable Y_1 is only observed if $Y_2 > 0$. Thus the actual dependent variable Y is (Eq. (3)):

$$Y = Y_1 \quad \text{if } Y_2 > 0 \text{ and Y is missing if } Y_2 \leqslant 0 \quad (3)$$

The first stage is estimated using probit maximum likelihood method, while the second stage is estimated using OLS regression. This model has been used by other researchers studying the two-step procedure for analyzing technology adoption for example; Kaliba, Verkuijl, and Mwangi (2000) and William and Stan (2003).

For model specification, the dependent variables were: knowledge

acquisition (selection) and uptake of new practices (outcome). The outcome variable was measured in terms of farmers taking up any one of the practices promoted by D2F. Uptake was dichotomized, whereby if a farmer reported to have taken action was 1 or 0 otherwise. Knowledge acquisition was measured in terms of farmers' understanding messages received. Knowledge acquisition was categorical where farmers indicated the extent to which they understood the information. In this case, only those who reported having fully understood the message were coded as 1 and 0 otherwise. Based on prior studies (Fu & Akter, 2012; Ricker-Gilbert, Norton, Alwang, Miah, & Feder, 2008; Shawn & Fernando, 2012) a set of independent variables were included in the model that were hypothesised to affect the level of understanding of messages and subsequently the ability of the farmers to take action or adopt recommended practices. These included: age of farmer, household size, education level, gender, farming experience and land ownership. Dummy variables for the location were included to better understand if there were location-specific factors that could have affected the dependent variable. We also included variables for type of dissemination method (Voice, SMS, Dial Back and Service Call); to better understand the role of various mobile approaches in facilitating learning and technology adoption. Table 3 shows the distribution of study variables and respondent characteristics.

3.4. Data analysis

Qualitative data gathered through FGDs were analyzed using content analysis. This helped to group responses according to themes in order to extract information related to the major objectives of the study. Survey data were analyzed using the STATA 12 statistical package. Descriptive and inferential statistics were used such as chi-square and t-tests. These analyses helped ascertain the level of significance of learning across various delivery mechanisms, gender and farm categories.

4. Results

4.1. Socio-demographic characteristics of respondents

The majority of survey respondents were male (96%) with an average age of 41 years (ref. Table 3). Women accounted for 4% of the population within the telephone survey sample, which is broadly comparable to 5% within the CABI-D2F User Database. The average family size was 7.2 reaching as high as 20 members per household. Literacy rates were quite high for the region with 42% of sampled farmers reporting that they had completed secondary education, and only 14% describing themselves as illiterate.

The majority (52%) of the telephone survey population had been farming for 16+ years, with recent farmers, 5yrs or less making up only 13% of the total sample. Geographic variations aside, farmers grew a number of crops with wheat, vegetable, and paddy rice as the most common crops. Other crops included; Jowar, mustard, sugarcane, and fodder. Livestock ownership was represented in small proportions with households owning on average 1.7 livestock units. Buffalo and cattle were the most commonly owned livestock among all farmers, with 78% of the total population owning at least one buffalo and 45% owning at least a cow.

Average land ownership was 3.4 ha. When the sample was further disaggregated according to landholding, respondents were fairly equally distributed across four landholding categories – marginal, small, small-medium and medium, except large farmers who accounted for a small percentage (5%) (cf Table 4). We adopted the landholding size categories used by the Ministry of Agriculture, Government of India, for the National Agricultural Census (http://agcensus.nic.in). Among the women farmers, 55% were either marginal or small-scale farmer, as compared to 29% of the men who fell into this category. Among the marginal farmers, 90% did not have their own land but instead had rented land. For the other categories, all farmers have their own land and no renting was reported.

Table 3
Descriptive statistics of respondents.

Variable	Description	Mean	Std. Dev	Min	Max
Dependent variables					
Uptake	Farmer taking up one of more new practices as a result of information received on phone = 1 if yes	0.73	0.39	0	1
Farmer knowledge	Farmer reported fully understanding message received on mobile phone = 1 if yes	0.786	0.41	0	1
Independent variables					
Gender	Sex of respondent; male = 1	0.96	0.20	0	1
Age	Chronological age in years	41.47	13.85	15	92
Family size	Total number of HH members	7.31	3.65	1	20
Edu_None	Respondent has no formal education = 1 (control)	0.14	0.35	0	1
Primary	=1 if highest education is primary	0.24	0.43	0	1
Secondary	=1 if highest education is secondary	0.42	0.49	0	1
Tertiary	=1 if highest education is tertiary	0.20	0.40	0	1
Mob_info[‡]	Received information on mobile = 1 if yes	0.54	0.50	0	1
SMS	Farmer received text message = 1 if yes	0.73	0.44	0	1
Voice	Farmer received voice message = 1 if yes	0.30	0.46	0	1
Dial back	Farmer used dial back service = 1 if yes	0.07	0.25	0	1
Service call	Farmer used service call = 1 if yes	0.56	0.50	0	1
Farm size	Farmed land in hectares	3.39	4.06	0.16	58.3
Land owned	=1 if farmer owned the land they farmed	0.92	0.27	0	1
Farming years	Number of years farming	20.13	13.09	1	70
Livestock	Livestock units[†]	1.66	1.70	0	31
Farmer group	=1 if member to farmer organization	0.05	0.21	0	1
Labour con.	Labour constraint = farm size / family size	0.49	0.66	0	8.8
Haryana	State in India; =1 if yes	0.61	0.49	0	1
UP	State in India; =1 if yes	0.28	0.45	0	1
Jharkhand	State in India; =1 if yes	0.02	0.14	0	1
Bihar	State in India; =1 if yes	0.04	0.19	0	1
Rajasthan	State in India; =1 if yes	0.05	0.22	0	1
MP	State in India; =1 if yes (control)	0.00	0.07	0	1

[†] Livestock Units are livestock numbers converted to a common unit. Conversion factors used were: cattle = 0.5, sheep = 0.1, goats = 0.1, pigs = 0.2, chicken = 0.01, camel = 0.75 (FAO, 2005).

[‡] Farmer received information on mobile phone irrespective of source.

Table 4
Farmers receiving information by source and farmer category.

Variable	Sample size (n)	% of sample	% of farmers receiving information†						
			Fellow farmers	Gov't Dpt.	Service provider	Helpline	NGO	Media	Mobile
Information seeking									
Yes	1,241	60	73	58	46	27	9	6	18
Age category (years)									
15–29	450	22	70	56	40	31	6	8	22
30–39	477	23	73	57	47	29	7	5	18
40–49	522	25	74	54	46	23	11	6	18
50–59	321	16	74	61	49	26	7	2	14
≥60	292	14	76	66	50	29	12	6	16
Chi2(4)			1.926	7.779	5.182	5.161	7.834	7.302	6.205
Pr			0.749	0.096	0.269	0.271	0.098	0.121	0.184
Gender									
Male	1975	96	73	57	46	28	9	6	19
Female	87	4	63	79	58	16	8	3	3
Chi2(1)			2.000	7.101	2.259	2.624	0.032	0.640	6.300
Pr			0.157	0.008	0.133	0.105	0.858	0.424	0.012
Farmer category									
Marginal	432	21	38	36	25	15	7	3	9
Small	408	20	45	37	30	18	5	4	9
Small-medium	498	24	46	36	28	20	5	5	13
Medium	434	21	48	33	29	13	5	3	14
Large	108	5	46	35	26	19	5	5	13
Chi2(4)			4.222	10.223	0.796	10.367	5.370	8.666	9.144
Pr			0.518	0.069	0.977	0.065	0.372	0.123	0.103

† computed based on sample size under each category.

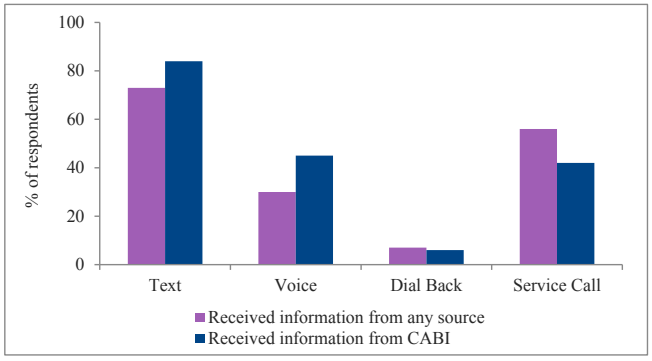

Fig. 2. Format of the most recent messages received by respondents to the telephone survey (total sample size = 1086).

4.2. Farmer information seeking behavior

Farmers were asked where they obtained information on agriculture and livestock farming. The assessment took into consideration how information is acquired by farmers – either actively (e.g. consulting a fellow farmer, an Agricultural Dealer, or calling an expert) or passively (e.g. listening to the radio, watching TV or receiving a message on their mobile phone). At least 60% of farmers indicated that they had received agricultural advice in the last 12 months. Fellow farmers were the most important source of information for the majority of farmers (73%), closely followed by Government extension services (58%) and agricultural service points (46%), such as an agricultural dealer (Table 4). Mobile services accounted for 18% of responses, giving them an overall ranking of 5 out of 7 sources considered.

Information sources used by farmers were varied by age category, gender, and land holding. Elderly farmers were more likely to seek information from government compared to other age groups, as were women when compared with men. Use of mobile services is sometimes considered to be more common with young people (15–39 years), though the difference was not statistically significant in our study when compared with older farmers, though preferences differed. Men, on the other hand, were more likely to use helpline and mobile phones for information compared to women. Marginal and small-scale farmers were more likely to seek information from government compared to small-medium and large farmers who were more likely to use helpline, media, and mobile.

4.3. Effectiveness of D2F mobile agri-advisory service

4.3.1. Awareness creation

CABI D2F service analytics revealed that a core of around 40% (of 400,000 registered users) had become active users of the service. Similarly, 53% of the telephone survey respondents confirmed that they had received information on their mobile phones (from any source), of which over half of them (587 respondents out of 1088) specified CABI-D2F. Other sources of mobile information mentioned by farmers were; government, local agricultural university, NGOs, commercial agribusinesses, helpline and telephone operators. The majority of farmers (73%) could recall receiving text messages, while 56% mentioned service call (Fig. 2). Only 30% and 45% of respondents mentioned receiving voice messages from all sources and CABI-D2F respectively. It is conceivable that farmers could have missed voice messages, because of circumstance thus the low recollection, but are able to recall the text messages since they are kept on the phone.

Information received through mobile phone covered various agricultural practices. The largest proportion of respondents (25%) mentioned that they received information on the timing of farm activities such as sowing, weeding, and harvesting (Fig. 3). Farmers also mentioned receiving information on the type of crop to sow (22%), irrigation (15%) and nature of soil and treatment (14%).

4.3.2. Knowledge acquisition

Through the telephone survey, and community visits, the study gathered qualitative insights of farmer perceptions of information relevance, timeliness, and reliability. Overall, 94% of farmers reported being able to understand the messages they received from CABI-D2F compared to 90% of respondents reporting on other messages (Fig. 4). An important finding was that, except for voice messages which were

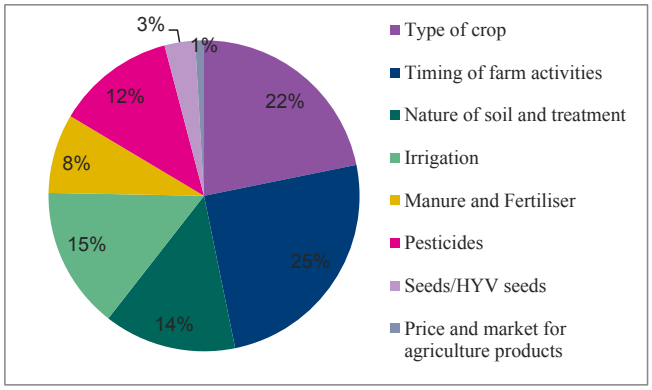

Fig. 3. Information received by farmers through mobile phone.

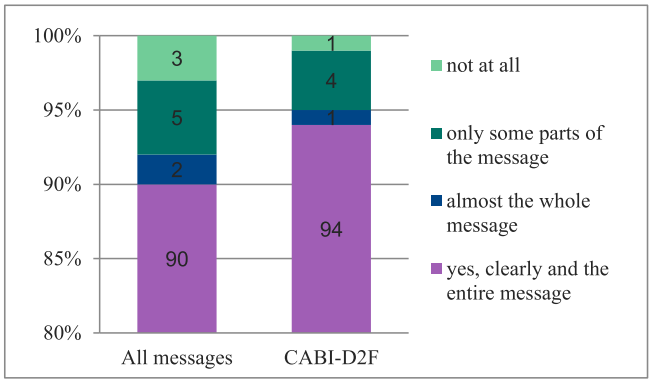

Fig. 4. Proportion of farmers who reported understanding messages sent by CABI-D2F compared to all messages they received (sample size = 1028).

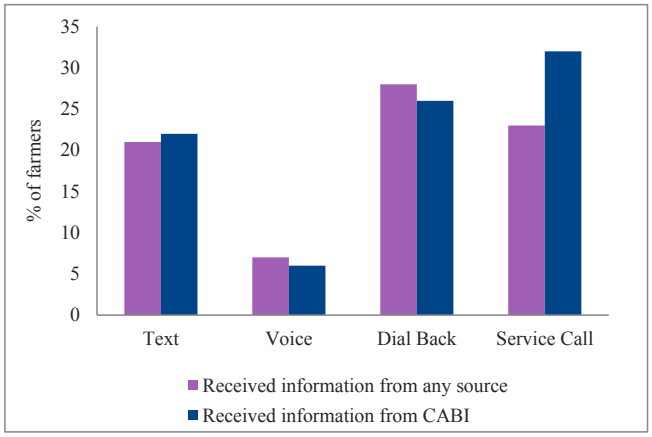

Fig. 5. Respondents to the telephone survey who reported not fully understanding messages disaggregated by their format (total sample size = 1086).

reported to be very clear, about a quarter of the farmers overall were not able to fully understand the messages they were receiving (Fig. 5). However, during FGDs farmers reported a preference for text messages. Farmers mentioned that the messages could easily be saved for later, or message re-confirmed with others, often a family member, or local agricultural dealer. Text messages were also shown to the local Government extension worker, to reconfirm the advice being given. Farmers considered service calls and voice messages less favourable because they may not always arrive at a convenient time for them to take the call, and if the reception was poor, the opportunity was lost. This further explains why 48% of the voice messages were recorded as not listened to the end by recipients (service analytics).

In terms of age and gender, older respondents were the more likely to report having difficulty understanding the messages due to the language used in the message and of not being able to hear clearly enough the voice messages, which is imaginable. Similarly, women reported the language used in the messages as the principal barrier to understanding messages in the first instance.

4.3.3. Uptake of new practices

Overall, 76% of the respondents reported taking action in association with information received, out of those who confirmed receiving information on their mobile phones. Of those who identified CABI-D2F service as the source, 79% reported acting on the information, which was a higher proportion than those taking action overall (76%) (Table 5). Farmers who did not take action reported various reasons. Mostly, farmers indicated that the information was not received in time to allow for farm decisions to be made. Farmers also indicated that advice received was contradictory to traditional practices, or information was not applicable to crops they grew.

The most commonly mentioned actions taken by farmers were; irrigating farms according to the weather report received, timely harvesting, and use of pesticides/insecticides (Fig. 6). The low uptake of practices such as the use of high yielding varieties, soil testing, livestock checkup and fertilizer, may also be reflected by the earlier mentioned challenges particularly unavailability or high cost.

4.3.4. Information sharing

CABI-D2F users were more likely to share information coming through the service (90%) than mobile service users overall (86%). This difference was statistically significant ($z = 2.57$; $p < 0.05$). Of those who shared CABI-D2F information, 86% reported that the person they had shared it with, had reported it was useful. Farmers indicated that they were convinced about the accuracy of the information, the main reason they shared with others. Smallholder farmers felt their knowledge had been increased and marginal farmers reported gaining yield benefits. Women were the most keen to continue to receive information but did not express an opinion on the quality of the service. Understanding farmers' propensity to share CABI-D2F messages and recommend the service provides a useful insight into the potential for the service to 'reach' far beyond direct service users over time.

Results further indicate that farmers were more likely to recommend CABI-D2F to their peers than any other service, with farmers being significantly more likely ($z = 2.54$; $p < 0.05$) in future. Respondents gave a range of (free text) answers as to why they were more likely to share information. The reasons can be broadly grouped into three; (i) benefits they gained or perceived future benefits, (ii) service accuracy and trustworthiness, and (iii) continuing to receive such messages could do no harm.

4.4. Determinants of technology uptake and the role of mobile agri-advisory services

We estimated factors affecting uptake of new practices with a particular interest in the role of mobile phone services, as a proxy measure for the effectiveness of the delivery method. However, uptake of new practices is conditional on understanding the message given (knowledge). It is argued that farmers who understood the messages and responded (or did not respond) share some common characteristics, which assist in better understanding the reasons underlying their response (or failure to respond) as captured by the Heckman probit model (Table 6).

The nature of message - text, and voice, showed significant positive effects on the level of understanding of the messages. This is line with farmers' perceptions that text and voice messages were easier to understand compared to dial back or service call. Besides the technical challenges of accessing voice messages, we also note that the latter two mobile options were not actively marketed during the project and therefore their utilization was minimal. For example, only 7% of

Table 5
Proportion of farmers who took action and reasons for non-action.

Response		Frequency	%
Received information on mobile phone (yes)		1088	53
	CABI-D2F only	587	54
Taken action (yes)		830	76
	CABI-D2F only	464	76
Reasons for no action (CABI D2F)†			
	Advice not received on time	30	25
	Advice contradictory to traditional practices	24	20
	Information not applicable to what we grow	14	12
	Recommended products not available locally	13	11
	Didn't understand the messages at all	13	11
	Suggested products were not cost effective	11	9
	Suggested products/services not affordable	11	9
	Doesn't do farming anymore	2	2

† Percent is calculated based on total responses, not the number of farmers not taking action.

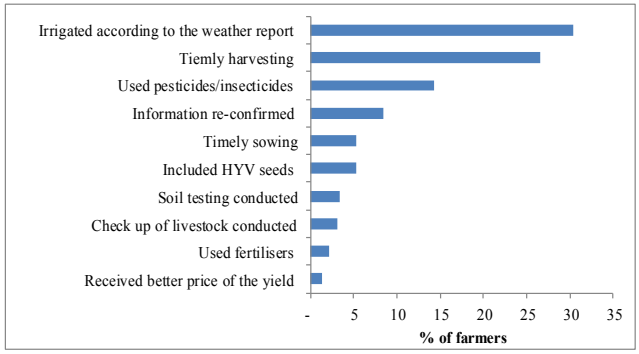

Fig. 6. Proportion of users who reported acting, or not, in response to information received on their mobile phone (total sample of 1088 responses).

Table 6
Results from the Selection and outcome equations of the Heckman model of farmer taking action on information received on mobile phone.

Variables	Uptake of new practices (outcome model)		Farmer knowledge (selection model)	
	Coef.	Std. Err.	Coef.	Std. Err.
Gender	0.036	0.060	0.286	0.400
Age	−0.000*	0.001	−0.001**	0.005
Family size	0.002	0.004	0.032	0.021
Primary	−0.013	0.038	−0.479*	0.286
Secondary	0.032	0.034	−0.332	0.268
Tertiary	0.028	0.037	−0.141	0.299
SMS			0.258**	0.156
Voice			0.889***	0.223
Dial back			−0.284	0.267
Service call			0.218	0.185
Mob_info	0.082***	0.021		
Farming years	0.000	0.001		
Farm size	0.001*	0.005		
Land owned	0.464**	0.401		
Farmer group	−0.017	0.050		
Livestock	0.003	0.040		
Labour con.	−0.018**	0.032		
Haryana	−0.071	0.355	−4.288	0.585
Utta Pradesh	−0.115	0.219	−4.365	0.614
Jharkhand	−0.111	0.232	−4.485	0.731
Bihar	−0.046	0.229	−4.450	0.817
Rajasthan	−0.049	0.223	−4.262	0.680
Constant	0.860**	0.366	4.877	
Number of obs	730			
Censored observations	63	Uncensored observations		667
Rho	1.000	Waldi Chi2 (16)		26.18
Prob > Chi2	0.016			

Statistical significant at the 0.01 (***), 0.05 (**), 0.1 (*) level of probability.

farmers reported using CABI-D2F Toll-Free IVR dial back service.

Age of respondent showed a significant negative effect on both the probability of understanding phone messages and taking action on messages received. This implies that older farmers were less likely to take action based on messages received on the mobile phone, largely for failure to understand the messages but also possibly the messages did not address their expectations. This can be supported by qualitative evidence where some farmers indicated that the advice they had received contradicted their traditional practices. This was more commonly mentioned by older farmers and women compared to their counterparts. Prior results also indicate that older farmers had the lowest preference for information on mobile phones, attributed to less familiarity with emerging trends in technology and services hitherto.

Educational attainment affected the level of understanding of the messages but not utilization of information received. Results show an inverse correlation between the probability of understanding messages and a higher level of education, in contrast to a positive correlation with action taken.

5. Discussion

The study demonstrated that D2F mobile extension service achieved a rapid and broad reach of agricultural information to farmers, across geographies and farmer categories. Other studies have also demonstrated the capability of mobile extension to reach previously excluded farmers at a very low marginal cost (Mbo'o-Tchouawou & Colverson, 2014; Ricker-Gilbert et al., 2008; Shawn & Fernando, 2012). Besides, a large proportion of farmers (40% of the registered users) were active in receiving and responding to the service messages. This proportion is high in comparison to traditional extension (through training and visit) where an extension agent can on average reach 10–20 households a day. Besides, performance quotas lead extension agents to target the easiest to reach farmers (usually the same farmers), leaving out those that are in remote areas or marginal farmers.

Farmer access to information through mobile phone was varied by age, gender and farmer category. This digital divide reflects the prevalent social realities in access to extension, which have been in part attributed to differences in literacy, socio-cultural factors, ownership or control of mobile phones, and technological skills (Mbo'o-Tchouawou & Colverson, 2014). These differences, in particular, education attainment, sex, and age of respondent, to a great extent affected the level of understanding of the messages received. This flags some potential challenges in equitably reaching farmers, in particular women, elderly and resource-constrained farmers with mobile extension delivery mechanisms.

There was evidence that farmers were willing to take action and adopt new practices based on the information they received through mobile services. However, due to the number of other service providers

and people's difficulties in recalling the exact origin of messages, it is still problematic to definitively associate reports of action with a specific service, although the telephone survey provided a somewhat more nuanced picture. Those who identified CABI-D2F service as the source of information had a higher likelihood of taking action compared to those reporting on all messages. This could be due to perceptions of the quality, relevance, and timeliness of the information they received from CABI. This could be because, unlike market competitors, CABI-D2F developed and distributed targeted messages based on authoritative knowledge of defined farming systems.

Parallel to other studies on access to agricultural extension in Africa, this study also shows a great reliance of farmers on farmer-to-farmer exchange for agricultural information (Drafor, 2016; Kiptot & Franzel, 2015). Farmer-to-farmer exchange and information sharing is a good proxy for its perceived value. It is also an indicator of how far information is likely to spread within any given farming community, giving an estimate of the potential 'reach' for the service in broad terms, although this would need further and more detailed investigation.

6. Conclusions

The study has shown that D2F service was effective in reaching a large number of farmers in different geographies. Results, however, show significant differences in access to mobile information by age, gender and farmer type, which implies the need to target the right users of information, given the observed technological divide and social realities. Despite the digital divide, results confirm that once messages reached service users, there was good evidence of the service being effective and well received, leading to users implementing the new evidence-based farming practice. The mobile service is clearly more than capable of providing timely, relevant and accessible advice and is valued by those who have engaged with it, but there is need to make it more interactive and embed clear monitoring system to ensure the messages reach the intended audience. Farmers' propensity to share CABI-D2F messages and recommend the service provides a useful insight into the potential for the service to 'reach' far beyond direct service users given enough time. However, farmers expressed a preference for text messages over voice messages, because they could consult technical persons if the messages were not clear.

Conflict of interest

None declared.

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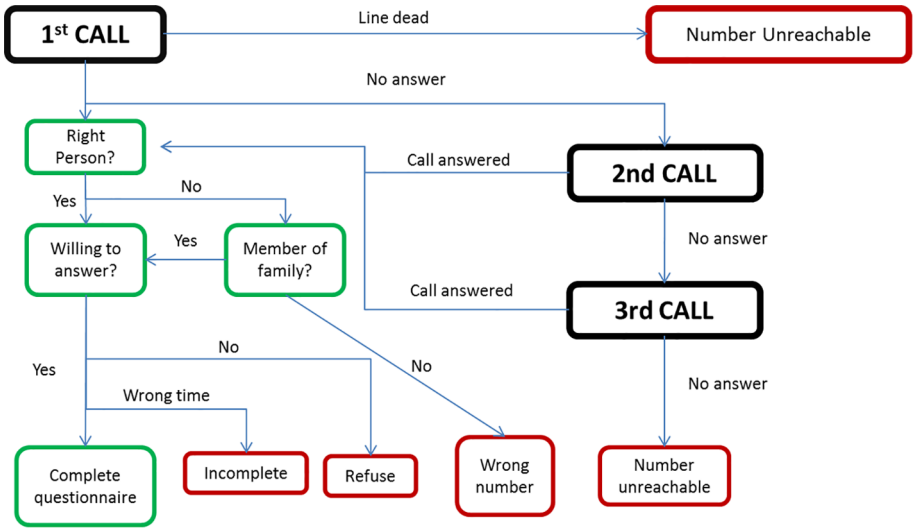
Appendix 1:. Protocol for telephone survey



Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.wdp.2019.02.007.

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