Using Data for Development: Evidence from a Phone System for Agricultural Advice*

Torsten Figueiredo Walter† Michael Kremer‡ Ofir Reich§ Zhengyun Sun¶
Sam van Herwaarden‖ Habtamu Yesigat**

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Abstract

We study the performance of a governmental phone-based agricultural extension system in a developing country which provides agricultural advice to farmers via interactive voice response (IVR). Through the analysis of administrative data generated by the system, we identify potential for system improvements. Based on this, we develop specific interventions to increase system performance and test these in randomized control trials. We find that small changes in the design of the interactive voice response system can have substantial effects on the amount of agricultural advice accessed by farmers.

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†Division of Social Science, New York University (AD). Email: t.f.walter@nyu.edu.
‡Department of Economics, Harvard University and NBER. Email: mkremer@fas.harvard.edu.
§Google. Email: e.scribbler@gmail.com.
¶Department of Economics, Harvard University. Email: zsun@g.harvard.edu
‖Precision Agriculture for Development. Email: svanherwaarden@precisionag.org.
**Precision Agriculture for Development. Email: hyesigat@precisionag.org.

1 Introduction

Government failure is typically conceived as the result of rent seeking activities by public officials. However, government failure can also arise passively. Public officials may not have the skills or the incentives to efficiently employ public resources in the pursuit of government objectives (Bandiera et al. 2009). In this paper, we put forward the hypothesis that passive government failure in low-income countries is an important barrier to development.

In recent decades, technological progress has led to the rise of data systems for management, and international organizations and other donor organizations have supported the introduction of these systems across governments in low- and middle-income countries.[1] As a result, governments commonly operate Education Management Information Systems, Health Management Information Systems, and many other data systems for management nowadays. These data systems are widely used to monitor aggregate performance and produce statistical reports. However, there is little feedback from the collected administrative data to the design of public service delivery systems. In other words, the opportunity to understand and improve these systems through analysis and evaluation of existing data goes largely unexploited, despite likely high returns.[2]

This paper accompanies the introduction of systematic analysis and impact evaluation to a public service delivery system in a developing country and examines its potential for system optimization. More specifically, it develops interventions to increase the performance of a governmental phone-based agricultural extension system based on analysis of administrative data and subsequently tests these in randomized control trials. Results show that small changes in the design of the phone system can have substantial effects on the amount of agricultural advice accessed by farmers. However, not all interventions succeed at increasing information access for farmers. Ultimately, the introduction of data analysis and impact evaluation leads to improved service delivery through the implementation of successful interventions and discarding of unsuccessful ones.

The phone-based agricultural extension system at the center of this paper is an interactive voice response (IVR) system that allows farmers to access pre-recorded agricultural advice messages. through menu selection (e.g. "For information on post harvest and processing, press 5."). Analysis of the call logs generated by the system reveals that a substantial share of farmers seeks advice through the system, but also uncovers significant potential for system improvements. Within the first three years since the initiation of the system, 2.7 million callers are recorded - corresponding to up to 40% of the target population. However, many users do not manage to access agricultural advice, but hang up before reaching this stage in the IVR menu. In their first call, a mere 37% of users succeed in accessing any advice. Our analysis identifies sections of the IVR menu where attrition is especially high and we develop interventions to reduce this, guided by both quantitative

[1] For example, the World Bank carried out 361 projects with education management information systems activities between 1998 and 2017. See http://datatopics.worldbank.org/education/wQueries/qemis for details.

[2] On a scale of 4, World Bank SABER rates utilization of Education Management Information Systems for decision-making as 1 ("latent") or 2 ("emerging") in 10 out of 10 low- and middle-income countries.

evidence from the call logs and qualitative information collected through focus groups, in-depth interviews, and a telephone survey. Subsequently, these interventions are tested in randomized control trials. In total, the impact of four system changes is evaluated in this paper.

Two out of the four interventions we test have a significantly positive effect on content accessed, while the other two do not. The most successful intervention removes a lengthy registration process users normally have to go through on their first call and provides access to agricultural advice without user registration instead. This leads to an increase in agricultural advice accessed by 18%. At the same time, we find that the cost of restraining from collecting user information through registration is low because the registration information provided by users is largely inaccurate, and as a result, it does not serve for targeting messages to farmers as intended. The other successful intervention removes a user prompt to save a selected crop to their profile. As a consequence, content accessed increases by 5.8%. At the same time, crop choice remains observable to the IVR platform provider through call logs, thus there is no associated loss of information. The two interventions that do not lead to an increase in content accessed introduce changes to the language menu, one adding pauses between the language options being read out, the other featuring an automatic menu replay if a user has not selected an option after ten seconds.

After impact evaluation, successful interventions are implemented or refined through further experiments. Unsuccessful interventions are discarded. This suggests that prior to the introduction of systematic data analysis and impact evaluation, system improvements were not foregone due to a lack of political will to implement them, but rather due to capacity constraints in identifying improvements. In other words, in the context at hand public service delivery appears to have been constrained by passive rather than active government failure. As a result, this paper more generally raises the question how important passive government failure is as a barrier to development.

The remainder of this paper is structured as follows. Section 2 provides background information on the IVR system for agricultural advice. Section 3 describes the data we work with. Section 4 presents descriptive evidence motivating our subsequent experimentation with specific system changes. Section 5 documents the randomized control trials we carry out and summarizes their results. Section 6 discusses these and Section 7 concludes.

2 Background

Our partner organization in government was established in 2010. It is a public agency with the aim to support transformation of smallholder agriculture into a productive and fast growing sector. As such, it conducts studies to identify systemic bottlenecks and priorities in the sector and recommends solutions. In addition, it implements pilot interventions that aim to support the transformation process. Among these interventions is the Interactive Voice Response (IVR) System for Agricultural Advice. This system can be accessed through a toll-free phone number and

is available nation-wide in five languages.[3] Apart from the knowledge of the language, the only other requirement for interacting with the system is a working phone with functioning keys.

The potential reach of the IVR system is large. According to nationally representative data from the most recent Demographic Health Survey (DHS), 60% of households have at least one member working in agriculture, and more than half of these households own a mobile phone. With 93% of these in turn speaking one of the languages served by the system, a back-of-the-envelope calculation suggests that 29% of households nationwide - corresponding to more than 31 million lives - could be affected by agricultural advice provided through the system. And this number is likely to increase further as mobile phone ownership continues to grow.

The extent to which agricultural advice provided by the IVR system could improve yields is uncertain. However, the IVR system covers all major grain and vegetable crops, accounting for more than 80% of agricultural land use in the country, and differences between actual average yields and potential yields are known to be large (Getnet et al. 2016, Van Ittersum et al. 2016, Van Loon et al. 2018).[4] Moreover, evidence from India and Kenya shows that agricultural advice provided through telephone systems can lead to changes in farmer behavior (Cole et al. 2019, Fabregas et al. 2019) and increases in yield (Casaburi et al. 2014, Cole and Fernando 2016). Hence, it is plausible that agricultural advice provided by the IVR system could have a significant impact on yields and thus livelihoods of farmers. The magnitude of these effects, however, will depend on the design of the IVR system and the advice itself.

The IVR system functions as follows. Upon calling into the system, users listen to a brief welcome message. Thereafter, first time users go through a set of questions to select their language and create a user profile before they get to the main menu. Profile registration is comprised of caller type specification (farmer, model farmer, extension worker, etc.), location (region, zone, district) and gender entry as well as the provision of information on land size. The registration process is conducted in two steps. In their first call, users are asked to specify their caller type, region and zone. In their second call, their district, gender and land size are elicited.[5] Detailed flow charts of the overall call process and the registration menu in particular are provided in Figures A.1, A.2 and A.3. Registration is followed by the top menu where users choose between content on rain-fed and irrigated crops, and are subsequently taken to the corresponding sub-menus (Figures A.4 and A.5). In each of these sub-menus, they then choose the activity they are interested in (e.g. planting, crop protection, harvesting) and specify a crop. Finally, before listening to content, they are given the option to save their crop choice to their profile. After the content has been played, they can either choose to replay the message they have listened to, or select another crop, or return to the top menu. At any point in time they can also terminate the call by hanging up.

[3] Until July 2017, the IVR system was only available in three most common languages.

[4] The crops covered are barley, maize, sorghum, teff, wheat, sesame, beans, chick peas, common (haricot) beans, lentils, rice, cotton, potatoes, carrots, onions, garlic, tomatoes, peppers and cabbage. The land use figure was obtained from the Central Statistical Office.

[5] If users do not complete the first part of registration on their first call, registration will restart on the second call where it left off on the first call. Users will then complete the first part of registration and move on to the second part on their third call.

The content is developed and verified by agronomists. However, it is not customized to farmers based on their characteristics (e.g. location). Moreover, the language tends to be rather technical and often several scenarios are covered. The following is an example of a content message:

> "Currently, two sources of nutrients are recommended: Urea (46% N) and NPS Ammonium Sulfo Phosphate (19% N + 38P2O5+ 7S). The recommendations for nutrient levels vary from place to place and additionally depend on the amount of rainfall. In areas with a long history of cultivation and rainfall above 800mm during the crop season, the optimum level of fertilizer application is most likely in the range of 200 to 300 kg/ha of Urea (92-138 kg of N/ha) and 100 kg/ha of NPS. However, if farmers find these levels to be high and difficult to afford, then 150 kg/ha of Urea and 100 kg/ha of NPS can be applied with the understanding that grain yield will be somewhat reduced but still attractive provided these inputs are applied efficiently. In areas for which no specific fertilizer recommendations are available, 100kg/ha of NPS and 100kg/ha of Urea can be applied."

3 Data

This paper makes use of two data sources. First and foremost, we use call logs from the IVR system to examine how IVR users navigate through the IVR menu. Additionally, we collect complementary data on user characteristics through a telephone survey. Both of the data sources are described below.

3.1 Call logs

During a call to the IVR system, the system records how the user navigates through the IVR menu by saving every navigation step as a separate event. Figure 1 provides an illustration. We use the call logs to generate different variables of interest. For example, we count the number of content items listened to in each call, or we measure user retention as the number of subsequent calls within a given window time. Details on the variables used in the analyses are provided in the corresponding subsections that present the descriptive analysis of the IVR system and each of the experiments. Similarly, the data samples used in each of the analyses are specified in these later subsections.

3.2 Telephone survey

We complement the data from the call logs with a telephone survey. In the telephone survey, we elicit information on farming practices and IVR system usage from a representative sample of system users.

We randomly sample 1,403 users that have selected farmer or model farmer as their caller type from the population of all farmers registered in the system who have called at least once in last five months.[6] Sampling is stratified by both language and IVR system usage, binned based on the number of unique content items accessed in their most active year, as detailed in Table A.1.[7]

The survey is composed of two main sections. The first one is centered on farming practices, covering topics such as ploughing, planting, fertilizer and pesticide use. The second section asks about farmers' interaction with the system and their perception thereof. Additionally, we collected basic demographic information including location, language, education and digital literacy. See Appendix Section A.1 for the complete survey instrument.

4 Motivational evidence

The total number of distinct system users recorded before the beginning of data analysis and experimentation was 2.7 million.[8] Assuming all users were from different households, we can compute an upper bound of the total share of farmer households that had interacted with the system, so far. Based on an estimate of a total of 6.9 million farmer households that own a mobile phone and speak one of the languages served by the system,[9] this amounts to nearly 40%. Hence, even if not all users were from different households, a substantial share of the target population had interacted with the system by the time we started experimentation.

To understand the experience of users with the system, we analyze user call logs. For this purpose, we draw a random sample of 50,000 users from all users that had called into the system by the end of July 2017 and extract their entire call logs up to that point. Then we focus on all users that made their first call between January 2016 and May 2017.[10] The final sample for analysis contains 17,378 users who made 123,123 calls.

Our analysis reveals that many users do not advance very far in the IVR menu. As figure 2 shows, in their first call, 16% of users do not even select a language, only 48% complete the first part of registration and a mere 37% listen to any content. Among the users who do not complete the first part registration on their first call, 64% call again and complete this part within the next two months. But the remaining users - 18% of all users - never complete it within the first two months following their first call and do not access any content in this time period. Thus, a substantial share of users fails to obtain any agricultural advice from the system.

[6] Additionally, we sampled 600 development agents from the population of agents in four regions of the country. Data from this part of the survey is not used in this paper, however.

[7] Cutoffs between sampling bins were determined based on the distribution of the number of unique contents items accessed in the most active year of each caller, as indicated by the percentiles indicated in Table A.1.

[8] System users are identified based on their phone numbers. Count of users as of 25/07/2017. The IVR system has been advertised regularly on radio since its initiation. See figure A.6 for details on radio campaigns between 2014 and 2017, and the associated growth of the user base.

[9] Estimate based on household size, occupation, language and mobile phone ownership according to the latest available DHS and population data from World Bank Open Data.

[10] We select this time interval because the IVR operated unchanged over this period. Before 2016 and after May 2017, the user registration process was slightly different from the one described in the previous section.

Having completed the first part of registration, 68% of users call again. At the mean, these users make seven additional calls over the following two months and listen to equally many content items. However, the distributions of additional calls and content items are very skewed.[11] At the median, these users only make four additional calls and listen to three content items. More than 25% of them make no more than two additional calls and only 82% complete the second part of the registration process within the following two months. Hence, even among those who have completed the first part of the registration process, many are not retained.

Why is retention so low? Is there simply no demand for further information? Or do users face barriers interacting with the system? To shed light on these questions, we draw on the complementary data collected through our telephone survey (as described in section 3.2). When asked about barriers to using the IVR system effectively, farmers report substantial difficulties interacting with the system: 74% of the survey respondents report problems operating the system (see Figure A.7). These difficulties also become apparent when comparing the location information entered into the IVR system with survey responses. The share of respondents providing consistent region information in the system and the survey is only 75%. The corresponding figures for zone and district information are even smaller, 48% and 18%, respectively. Thus, the available evidence points to user difficulties with the IVR system rather than lack of demand for advice as the underlying cause for low content access and user retention.[12]

On the bright side, this suggests that improved system design could lead to increased content access and retention. In the remainder of the paper, we show explicitly that there are indeed simple system changes that increase content access in the short- and medium-run significantly.

5 Experiments

Over a four-month period, a total of four randomized control trials was carried out in collaboration with our partner organization with the aim to improve IVR user experience and ultimately increase access to agricultural advice. This section reports on these experiments.

5.1 Experiment 101: Removing registration

Agricultural advice provided by the IVR system is not customized to users based on information provided in the registration process. However, user profiles are stored with the aim to enable the platform provider to send targeted messages to farmers, e.g. location-specific alerts on weather or

[11] See figures 3 and 4 for the distributions of calls and content items listened to in the first two months following the completion of the first part of registration. The former excludes 78 users that make more than 50 calls over the two months following the completion of the first part of registration and the latter excludes 118 users that listen to more than 50 content items over this time period.

[12] An alternative interpretation of the inconsistency in location information provided by users is that users intentionally enter incorrect information due to mistrust towards the government. However, when asked in the survey, most users (94%) indicate that they trust the recommendations given by the IVR system. Moreover, degree of trust is positively correlated with inconsistency in location information across survey respondents - not negatively, as one might expect in the case of intentionally misspecified information due to a lack of trust.

pests. But the benefits of acquiring this information are likely to be limited because the accuracy of the information provided in the registration process is low, as revealed by our telephone survey. Moreover, the registration process itself may pose a major barrier to many users seeking to access content. As shown in section 4, many new users do not progress beyond the initial stages of the registration process and never access any content.

In this experiment, we test whether registration itself is indeed an important barrier to accessing content. New users are randomly assigned to a treatment and a control group (with equal probability). New users in the treatment group are not prompted to register but are immediately directed to the *Top Menu* from where they can access content.

We estimate the average treatment effect on accessing content using the following regression specification:

$$y_i = \alpha + \beta T_i + \epsilon_i \tag{1}$$

where T_i is a treatment dummy and y_i is a measure of the content accessed by user i. Table 1 provides an overview of the different measures used. The underlying data sample includes all users who made their first call to the IVR system between 29 November 2017 and 31 December 2017.[13]

Results are summarized in Table 2. We find that removing registration has a large positive effect on content accessed, both in the first call made by users and in subsequent calls. The probability of accessing any content in the first call increases by 11.2 percentage points (pp) relative to a control mean of 27.1 pp, corresponding to a 41% increase (column 1). The number of content items listened to in the first call increases similarly from on average of 0.63 in the control group to 0.88 in the treatment group, corresponding to a 40% increase (column 2). The effect on content accessed over the following two months is somewhat smaller, but still substantial. The probability of accessing any content increases by 17%, the number of content items listened to by 16%, and the number of unique content items listened to by 18% (columns 3-5). Finally, we verify that, consistent with random assignment of users to treatment and control, treatment is not correlated with users accessing the language menu (column 6).

5.2 Experiment 102: Adding menu replay if no option is selected

After ten seconds of inactivity (no audio being played by the system and no key being pressed by the user), the system automatically hangs up. In the pre-experimental analysis, we observe that 4% of first calls are terminated by the system without users completing language selection. Similarly, 6% of calls that reach the top menu are terminated by the system without a choice being made in this menu. One possible explanation is that system options are read out too fast, and

[13] We do not use data from earlier users because of implementation issues in the period between the start of the experiment on 10 November 2017 and 29 November 2017. Call logs of all users in the data sample cover 60 days from the date of their first call.

users forget the options.[14]

This experiment tests whether replaying the menu if no selection is made decreases the termination of calls by the system. New users are randomly assigned to a treatment and a control group (with equal probability). Unlike in the control group, users in the treatment group are not hung up on by the system if they are inactive for 10 seconds after the language or top menu have been played. Instead, these menus are replayed up to twice more before the systems hangs up automatically.

We estimate the average treatment effect on call termination by the system as well as content accessed using regression specification (1). The underlying data sample is the same as for experiment 101 and summary statistics are provided in Table 1.

We present our results in Table 3. We find that the treatment leads to a substantial reduction in users having their calls terminated by the IVR system when they reach the language menu or the top menu. In the control group, 7.1% of users are hung up on by the system when reaching the language menu at least once in their first two months. In the treatment group, the share of users that experiences this is only 1.6% (column 1). The corresponding call termination figures for the top menu are 13.3% in the control group versus 7.3% in the treatment group (column 2). Thus, the relative reductions in call termination by the system are large in both cases, amounting to 78% and 45%, respectively. We barely find any effects on content accessed, however (columns 3-5). This suggests that users affected by the treatment, i.e. those who would have been hung up on by the system in absence of the treatment, face additional constraints to accessing content. For example, menus other than the language and the top menu may also be read out too fast for them.

5.3 Experiment 103: Adding pauses between language options

In this experiment, we test another approach to improve the comprehension of menus. We examine how adding pauses of two seconds between options in the language menu affects language selection and content subsequently accessed. New users are randomly assigned to a treatment and a control group (with equal probability). In the treatment group the above mentioned pauses between options are introduced while the menu is replayed without these pauses in the control group.

We use regression specification (1) to estimate the average treatment effect on language selection and content accessed. The underlying data sample is the same as for experiments 101 and 102, and summary statistics can be found in Table 1.

We do not find any effects on content accessed and even a small negative effect on language selection ($< 1\%$) - see Table 4. Hence, the introduction of pauses between menu options does not appear to address the problem of quickly spoken menus as voiced by farmers. One potential explanation is that pauses of two seconds come across as artificially long while leaving the speed

[14] In our telephone survey, 4% of respondents list quickly spoken menus as one of the three main issues they face in using the IVR system.

of speech itself unchanged.

5.4 Experiment 104: Removing prompt to save crop to profile

The system prompts users to save the selected crop to their profile before listening to content, if the crop has not been added before. The saved information is then used by the platform provider to send crop-specific messages to farmers (e.g. alerts regarding pest outbreaks). However, information on selected crops is also easily available from call logs, thus rendering the crop saving prompt unnecessary for the purpose of message targeting. Moreover, users report that the prompt to save their crop is confusing and they do not understand how to respond to the menu options. In line with this, pre-experimental analysis reveals that 2.5% of the calls in which farmers succeed to select a crop are terminated when farmers are prompted to save the crop to their profile subsequently - despite the fact that the system will even move on to play the selected content if users simply hold the line for ten seconds without pressing any key.

This experiments tests whether removing the prompt to save the selected crop to the profile increases content accessed. Users are randomly assigned to a treatment and a control group (with equal probability). For users in the treatment group, the prompt to save the selected crop to their profile is removed.

We use regression specification (1) to estimate the average treatment effect on call termination following crop selection and content accessed. The underlying data sample consists of all users who called the IVR system between end of November 2017 and end of December 2018. Summary statistics can be found in Table 5.

Table 6 displays the regression results. We find that the treatment is not correlated with whether users select a crop in any of their calls or whether their calls are terminated prior to crop selection (column 1). This is expected as the treatment only affects calls after crop selection has been completed. The share of users with calls terminated prior to any content having been played, conditional on completed crop selection, is substantially lower in the treatment group. While 7% of users in the control group have calls terminated between crop selection and content replay, only 2.5% of users in the treatment group have calls terminated at this stage, representing a 65% decrease (column 2). As a result, treated caller access more content. The probability of accessing any content is 0.9 pp higher in the treatment group, and the number of content items accessed is 0.26 larger, corresponding to a 1.4% and a 5.1% increase relative to the mean in the control group, respectively (columns 3 and 4). Similarly, the number of unique content items accessed is 5.8% higher in the treatment group. Hence, removing the prompt to save the crop to the profile leads to a small but significant increase in content accessed.

6 Discussion

Designing IVR system improvements is not straightforward. Although all treatments are developed based on quantitative and qualitative evidence, two of them fail to increase content accessed by users. However, we also identify two simple system changes - removing the profile registration process and removing the prompt to save the crop - that lead to a significant increases in agricultural advice accessed. Additionally, the cost of these changes is arguably small because the collected information is either highly inaccurate and thus of limited use for targeting messages to farmers, or available in the system anyway.

A key question that remains unanswered is whether users listening to more content translates into a higher degree of behavioral change and higher yields. Without explicit data, this question cannot be addressed. However, results from the telephone survey suggest that farmers by and large call the system in order to learn about farming practices. When asked about the purpose of their calls, 75% of survey respondents state that they seek information about modern farming practices.[15] Nonetheless, difficulty in accessing agricultural advice through the IVR system is certainly only one barrier to behavioral change among farmers and it remains an open question to what extent the advice delivered through the IVR system leads to changes in farming practices and yields. Existing evidence from Africa and Southern Asia allows us to paint an optimistic picture. Both in Kenya and in India, telephone-based agricultural advice has been shown to spur behavioral change among farmers (Cole et al. 2019, Fabregas et al. 2019) and to lead to increased yields (Casaburi et al. 2014, Cole and Fernando 2016). And even if access to information on modern farming practices on its own is not sufficient to cause behavioral change and yield increases among farmers in the context at hand, it still remains a necessary condition. How, after all, can one expect any changes in farmer behavior as long as farmers do not even manage to access information about improved farming practices?

7 Conclusion

Technological progress has led to the rise of information management systems. Over the last decades, these have spread globally and with the support of international organizations, they have been installed across governments in low-income countries. As a result, many developing country governments collect large amounts of administrative data. However, there is little feedback from this data to the design of public service delivery systems.

In this paper, we show that introducing a feedback loop from administrative data on public service delivery to the design of service delivery systems can lead to significant system improvements. In particular, we collaborate with a government agency in a developing country and analyze the performance of their phone system for agricultural advice. We detect potential areas for system improvements through data analysis, and subsequently develop and test targeted in-

[15] Other common reasons for calling the IVR system are to learn about new crops or the weather (see Figure A.8).

terventions using randomized control trials. We find that small changes to the design of the IVR system can have large effects on the amount of agricultural advice accessed by farmers. Thus, the introduction of feedback loops can indeed lead to substantial improvements in public service delivery.

The fact that successfully tested interventions were subsequently either implemented throughout the IVR system - the prompt to save the crop to the user profile has been abolished - or followed upon by further experimentation - two additional experiments have been conducted to further improve the registration process - suggests that system development was not held back by lack of political will but rather by lack of government capacity to identify beneficial system changes. In other words, in our context the foregone potential for system improvement appears to have been due to passive rather than active government failure.

More broadly, this paper suggests that investments in the analysis of administrative government data and impact evaluation can unlock great potential for the improvement of public service delivery in developing countries - especially in the light of the recent rise of management information systems for public service delivery in general and the spread of phone-based systems for agricultural advice in particular (e.g. in India, Kenya and Pakistan).

References

Bandiera, Oriana, Andrea Prat, and Tommaso Valletti. 2009. "Active and Passive Waste in Government Spending: Evidence from a Policy Experiment." American Economic Review, 99 (4): 1278-1308.

Casaburi, L., Kremer, M., Mullainathan, S. and Ramrattan, R., Harnessing ICT to Increase Agricultural Production: Evidence From Kenya, Harvard University Working Paper, 2014.

Cole, S. and Fernando, N., Mobile'izing Agricultural Advice: Technology Adoption, Diffusion and Sustainability, Harvard University Working Paper, 2016.

Cole, S., Fernando, N. and Seo, H., Agricultural Extension, Technology Adoption and Information Spillovers: Evidence from a Cluster Randomized Experiment, Harvard University Working Paper, 2019.

Fabregas, R., Kremer, M., Lowes, M., On, R. and Zane, G., Can SMS-extension increase farmer experimentation? Evidence from Six RCTs in East Africa, Harvard University Working Paper, 2019.

Getnet, M., van Ittersum, M., Hengsdijk, H., and Descheemaeker, K. (2016). Yield gaps and resource use across farming zones in the central rift valley of Ethiopia. Experimental Agriculture, 52(4), 493-517. Doi:10.1017/s0014479715000216

Van Ittersum, Martin K., Lenny G. J. van Bussel, Joost Wolf, Patricio Grassini, Justin van Wart, Nicolas Guilpart, Lieven Claessens, Hugo de Groot, Keith Wiebe, Daniel Mason-DCroz, Haishun Yang, Hendrik Boogaard, Pepijn A. J. van Oort, Marloes P. van Loon, Kazuki Saito, Ochieng Adimo, Samuel Adjei-Nsiah, Alhassane Agali, Abdullahi Bala, Regis Chikowo, Kayuki Kaizzi, Mamoutou Kouressy, Joachim H. J. R. Makoi, Korodjouma Ouattara, Kindie Tesfaye, and Kenneth G. Cassman. Can sub-Saharan Africa feed itself? PNAS December 27, 2016 113 (52) 14964-14969.

Van Loon, Marloes P., Nanyan Deng, Patricio Grassini, Juan I. Rattalino Edreira, Endalkachew Wolde-meskel, Frederick Baijukya, Helene Marrou, Martin K. van Ittersum, Prospect for increasing grain legume crop production in East Africa, European Journal of Agronomy, Volume 101, 2018, Pages 140-148.

Tables

Table 1: Summary statistics - Experiments 101, 102, 103

Variable	Mean	Std. Dev.	Min.	Max.
Any content accessed in first call	0.327	0.469	0	1
Any content accessed in first two months	0.638	0.481	0	1
Content items accessed in first call	0.755	1.579	0	80
Content items accessed in first two months	5.204	10.823	0	402
Unique content items accessed in first two months	2.951	4.974	0	83
Language selected in first two months	0.887	0.316	0	1
Call terminated in language menu in first two months	0.043	0.204	0	1
Call terminated in top menu in first two months	0.103	0.303	0	1
Treated in experiment 101	0.5	0.5	0	1
Treated in experiment 102	0.499	0.5	0	1
Treated in experiment 103	0.499	0.5	0	1
Users (N)		67316		

Table 2: Treatment effects - Experiment 101

	First call		All calls in the first two months			
	(1)	(2)	(3)	(4)	(5)	(6)
	Any content	# Content	Any content	# Content	# Unique content	Language
Treated	0.112***	0.254***	0.102***	0.778***	0.482***	0.00249
	(0.00359)	(0.0121)	(0.00368)	(0.0834)	(0.0383)	(0.00244)
R2	0.0143	0.00645	0.0114	0.00129	0.00235	0.0000155
N	67316	67316	67316	67316	67316	67316
Control	0.271	0.628	0.586	4.815	2.711	0.886

Language is a dummy variable that takes the value one if a language was selected by the user. Standard errors in parentheses: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 3: Treatment effects - Experiment 102

	All calls in the first two months				
	(1)	(2)	(3)	(4)	(5)
	Terminated LM	Terminated TM	Any content	# Content	# Unique content
Treated	-0.0551***	-0.0601***	0.00706*	-0.000388	0.00752
	(0.00156)	(0.00233)	(0.00371)	(0.0834)	(0.0383)
R2	0.0183	0.0098	0.0001	0.0000	0.0000
N	67316	67316	67316	67316	67316
Control	0.0709	0.133	0.634	5.205	2.948

Terminated LM and Terminated TM are dummy variables that take the value one if any call by the user was terminated by the system upon reaching the language menu (LM) or the top menu (TM). Standard errors in parentheses: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 4: Treatment effects - Experiment 103

	All calls in the first two months			
	(1)	(2)	(3)	(4)
	Language	Any content	# Content	# Unique content
Treated	-0.00620**	-0.00225	-0.0804	-0.0554
	(0.00244)	(0.00371)	(0.0834)	(0.0383)
R2	0.0001	0.0000	0.0000	0.0000
N	67316	67316	67316	67316
Control	0.891	0.639	5.244	2.979

Language is a dummy variable that takes the value one if a language was selected by the user. Standard errors in parentheses: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 5: Summary statistics - Experiment 104

Variable	**Mean**	**Std. Dev.**	**Min.**	**Max.**
Any content accessed	0.637	0.481	0	1
Content items accessed	5.199	10.834	0	463
Unique content items	2.948	4.972	0	92
Any call terminated following crop selection	0.048	0.213	0	1
Any crop selected	0.646	0.478	0	1
Treated in experiment 104	0.498	0.5	0	1
Users (N)		68377		

Table 6: Treatment effects - Experiment 104

	All calls in the first two months				
	(1)	(2)	(3)	(4)	(5)
	Any crop	Terminated CS	Any content	# Content	# Unique content
Treated	-0.00208	-0.0455***	0.00886**	0.261***	0.167***
	(0.00366)	(0.00162)	(0.00368)	(0.0829)	(0.0380)
R2	0.0000	0.0114	0.0001	0.0001	0.0003
N	68377	68377	68377	68377	68377
Control	0.647	0.0703	0.633	5.069	2.865

Terminated CS is a dummy variable that takes the value one if in any call, a crop was selected and the call was terminated subsequently without any content having been played. Standard errors in parentheses: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Figures

19138234	17366	2018-03-26 09:12:16	Incoming call started	162	fa9e5036-ed3c-431
19138247	17366	2018-03-26 09:12:24	Welcome message played	1	fa9e5036-ed3c-431
19138401	17366	2018-03-26 09:13:24	The application hung up the phone	33	fa9e5036-ed3c-431
19138412	17366	2018-03-26 09:13:29	Incoming call started	162	b9db961d-74e6-4f2
19138430	17366	2018-03-26 09:13:37	Welcome message played	1	b9db961d-74e6-4f2
19138463	17366	2018-03-26 09:13:52	Woreda Menu - Enemor Ener	-1	b9db961d-74e6-4f2
19138486	17366	2018-03-26 09:14:01	Gender Menu - Female option selected	128	b9db961d-74e6-4f2
19138487	17366	2018-03-26 09:14:01	Profile registration complete	137	b9db961d-74e6-4f2
19138525	17366	2018-03-26 09:14:17	Top Menu - Rain option selected	301	b9db961d-74e6-4f2
19138534	17366	2018-03-26 09:14:22	Main Menu - Pre Planting option selected	15	b9db961d-74e6-4f2
19138550	17366	2018-03-26 09:14:28	Menu 1 - Land Preparation option selected	280	b9db961d-74e6-4f2
19138566	17366	2018-03-26 09:14:38	Crop Menu - Maize option selected	35	b9db961d-74e6-4f2
19138634	17366	2018-03-26 09:15:11	Content Played - Land Preparation - Maize - Am…	1000506	b9db961d-74e6-4f2
19138654	17366	2018-03-26 09:15:18	Content Menu - Content information for a diffe…	50	b9db961d-74e6-4f2
19138730	17366	2018-03-26 09:16:04	Crop Menu - Go to Main Menu option selected	42	b9db961d-74e6-4f2
19138753	17366	2018-03-26 09:16:17	Top Menu - Reset Profile option selected	303	b9db961d-74e6-4f2
19138755	17366	2018-03-26 09:16:18	Reset Menu - Reset Menu replayed	352	b9db961d-74e6-4f2
19138766	17366	2018-03-26 09:16:24	Top Menu - HHI option selected	302	b9db961d-74e6-4f2
19138778	17366	2018-03-26 09:16:29	HHI Main Menu - Pre Planting option selected	305	b9db961d-74e6-4f2
19138784	17366	2018-03-26 09:16:32	HHIMenu 1 - HHI Pre-irrigation option selected	325	b9db961d-74e6-4f2

Figure 1: IVR System Call Log

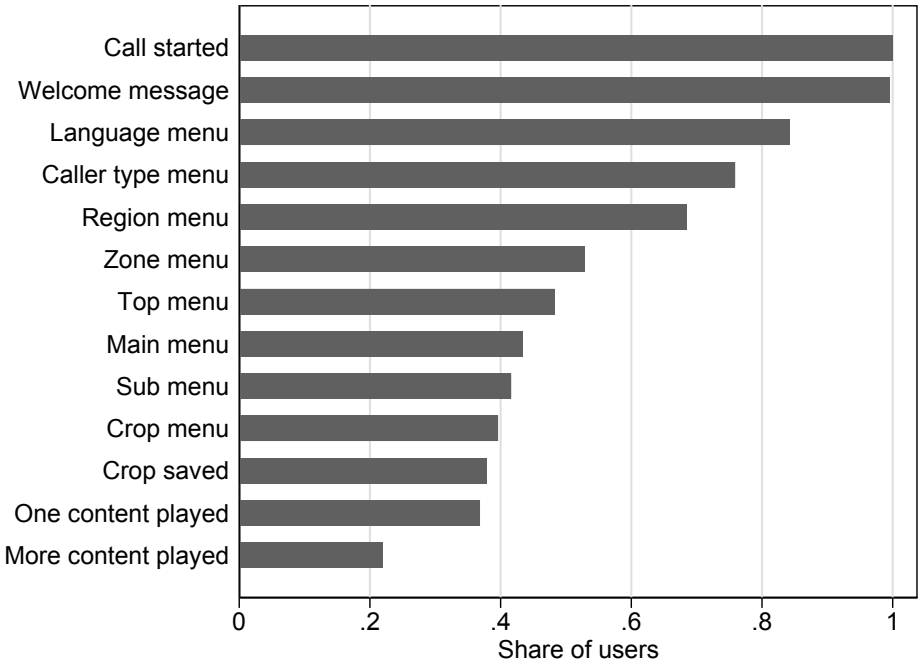

Figure 2: User progress on first call

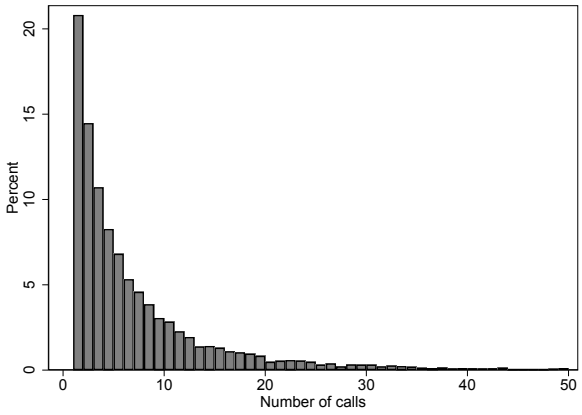

Figure 3: Distribution of number of calls post registration (two months) across users

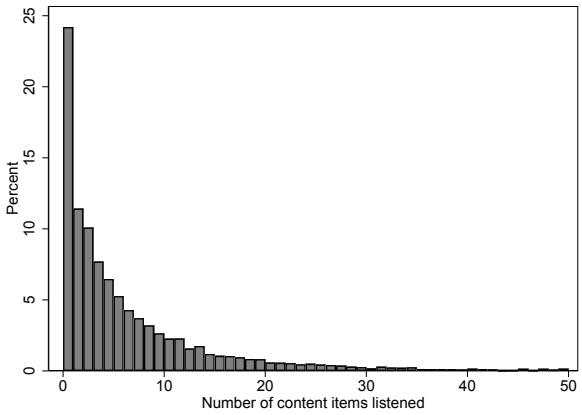

Figure 4: Distribution of number of content items post registration (two months) across users

A Appendix

A.1 Telephone Survey Instrument

This appendix section displays the complete telephone survey instrument. The survey consisted of six sections:

A Personal information

B Consent

C Demographics and literacy

D Farming practices

E Experience with IVR system

F Experience with alert system

In this paper, we largely focus on the results from section E - Experience with IVR system.

TELEPHONE SURVEY INSTRUMENT

SECTION A: PERSONAL INFORMATION AND CALL STATUS

FO: Unless instructed otherwise, please do not read any of the below questions to the respondent.		
A1.	Date	|___|___| - |___|___| - |___|___|___|___| Day Month Year
A2.	Start Time	|___|___| : |___|___|
A3.	Field Officer (FO) Name	{SELECT FROM LIST}
A4.	Please enter Respondent Phone Number (from checklist)	
A4A.	Please re-enter Respondent's Phone	[error message if different than A4.]
P1.	Respondent's Language	{prefilled}
P2.	Respondent's Region	{prefilled}
P3.	Respondent's Zone	{prefilled}
P4.	Respondent's Woreda	{prefilled}
P5.	Respondent's Gender	{prefilled}
P6.	Type of respondent (Farmers/ Model Farmer / DA / Expert)	{prefilled}
P7	Caller ID	{prefilled}
A5.	Do phone, region, zone, woreda and phone number match checklist?	1 [ ] Yes 0 [ ] No → Please go back and re-enter Farmer's phone number.
A6.	What is the phone status?	1 [ ] Call answered →Continue with the survey Not answered: → **SECTION Z – question Z3 END)** 2 [ ] Phone Off 3 [ ] Not Answering 4 [ ] Busy 5 [ ] Wrong Number 6 [ ] No Longer in Service 7 [ ] Out of Service
A7.	My name is _____ [Check for language understanding and preferences] I am calling on behalf of the Agriculture Transformation Agency (ATA). May I talk to the main user of this phone?	1 [ ] Yes 0 [ ] No -> **A7.A** When could I talk to the main user of this phone? (specify) 1 [ ] Now 2 [ ] Later (specify A7.B) 1 [ ] Date (calendar): 2 [ ] Time: [ ] 1. Between 8am – 11am [ ] 2. Between 11am – 2pm

		[ ] 3. Between 2pm – 5pm 3 [ ] Phone number belongs to a respondent who doesn't speak the language of the enumeration. Specify language and skip to SECTION Z (END) 1. [ ] Amharic 2. [ ] Oromiffa 3. [ ] Tigrigna 4. [ ] Sidamigna 5. [ ] Wolatigna 6. [ ] Agewigna 7. [ ] Kunamigna 8. [ ] Erobigna
A8.	Currently, we are speaking to different users of the free 8028 hotline that offers access to relevant information to improve their farming practices, Are you a Development Agent or Woreda Expert?	1. [ ] Yes **-> FO read: Thank you, at this moment we are contacting just farmers, but in a couple of days one of my colleagues might call you back - Thank you for your time-> END survey section Z** 0. [ ] No
A9.	Our records show that you have been accessing the recommendations of the 8028 hotline on regular and we would like to ask you some questions about your experience with the 8028 Hotline and we could improve it moving forward for other farmers in your woreda. Do you have 20 minutes to answer some questions. [If no, schedule call-back time.]	1 [ ] Now SECTION B (CONSENT) 2 [ ] Later (specify A7.A) 1 [ ] Date (calendar): 2 [ ] Time: 1. [ ] Between 8am – 11am 2. [ ] Between 11am – 2pm 3. [ ] Between 2pm – 5pm SECTION Z – question Z3 (END) 3 [ ] Hang Up → **SECTION Z (END**

SECTION B: CONSENT

FO: Please read.
Precision Agriculture for Development is conducting an evaluation study on the 8028 Program on behalf of Agriculture Transformation Agency (ATA). Busara is contracted by Precision Agriculture for Development to undertake the field data collection. Currently, we are speaking to different farmers to understand the awareness, usage, and benefit of different programs offered by the Agricultural Transformation Agency's (ATA). Particularly, we would like to ask you some questions about the toll free number that farmers can call to access relevant information to improve their farming practices, There are no right or wrong answers to the questions we will be asking you. We strongly encourage you to be open and give us your honest opinions, as well as tell us about your experiences truthfully. We would also like to assure you that what you tell us today will not be shared with others. No experts, or any other who works in the development of the IVR system, will be able to know what any individual says.

The information you give us today will be very helpful 'to improve the quality of the 8028 service being provided to you and millions of other farmers. If you have any questions about the study please contact ATA		
B1.	Do you consent to participate in this survey today?	1. [ ] Yes → **B3** 0. [ ] No
B2.	*[FO: Do not read]* What is the reason why the respondent does not want to participate in the study?	1. [ ] Doesn't have time 2. [ ] Doesn't know/trust ATA 3. [ ] Other:_____
B3.	Did the person hang up after consenting to the survey? *[FO: If the respondent does not have time to complete the phone survey now select "Yes" and be sure to indicate the call-back time in the comments section at the end.]*	1. [ ] Yes → **SECTION Z (END)** 0. [ ] No

SECTION C: DEMOGRAPHICS AND LITERACY

FO read: Now I would like to ask you some questions about your background and the characteristics of your household.		
C1.	(FO: Don't read): What is the respondent's gender?	0. [ ] Male 1. [ ] Female
C2.	Are you a Model Farmer of your village?	1. [ ] Yes 0. [ ] No
C3.	What is your age in years? (FO: If the respondent is unsure, please write down his or her best guess).	|__|__| years *[restrict 18<x<100]*
C4.	In which Region do you live?	{SELECT FROM LIST}
C5.	In which ZONE do you live?	{SELECT FROM LIST}
C6.	In which Woreda do you live?	{SELECT FROM LIST}
C7.	What language do you most frequently use at home? *[FO: Only mark one language]*	1. [ ] Amharic 2. [ ] Oromiffa 3. [ ] Tigrigna 4. [ ] Sidamigna 5. [ ] Wolaytigna 6. [ ]. Agewigna 7. [ ] Kunamigna 8. [ ] Erobigna 99.[ ] Other:_____

C8.	Which other languages do you speak fluently besides the one you just mentioned? *[FO: mark all that apply]*	1. [ ] Amharic 2. [ ] Oromiffa 3. [ ] Tigrigna 4. [ ] Sidamigna 5. [ ] Wolaytigna 6. [ ]. Agewigna 7. [ ] Kunamigna 8. [ ] Erobigna 99 [ ] Other:_____ -97 [ ] Doesn't speak another language_
C9.	What is your highest education level?	0. [ ] No formal education 1. [ ] Primary (1-8 grade) |__|__| 2. [ ] Secondary (9-12 grades): |__|__| 3. [ ] Diploma or Certificate 4. [ ] University 5. [ ] Post-graduate studies 6. [ ] Informal education
C10.	Can you write a letter in the language you speak at home?	1. [ ] Yes 0. [ ] No
C11.	Can you read a letter in the language you speak at home?	1. [ ] Yes 0. [ ] No
C12.	Which local word do you use to express the measurement of your farm land? (FO: this is a very important question!!! - It will be preloaded in the next questions and sections)	1. [ ] Kada 2. [ ] Timad 3. [ ] Gasha 4. [ ] Gezim 5. [ ] Gemed 99. [ ] Other (specify)_____
C13.	How many l**${(Local_C12)}** make an hectare?	_____ [ ] -98 Don't Know
C14.	If the DA recommends you to apply 100 kg of fertilizer per hectare, how many kilograms you should apply in one **${(Local_C12)}**?	_____ [ ] -98 Don't Know
C15.	What is your relationship to the household head? You would say that you are (READ OPTIONS) of the household head?	0. [ ] I am the household head 1. [ ] Spouse 2. [ ] Daughter / Son 3. [ ] Brother / Sister 4. [ ] Niece / Nephew 5. [ ] Grandchild 99. [ ] Other (specify):_____
C16.	Are you the person who buys most of the agricultural inputs for your plots? *[FO: Explain that this question is asking about the person who goes to the shop to purchase seeds, fertilizers, pesticides, and/or herbicides]*	0. [ ] No 1. [ ] Yes 2. [ ] Yes, jointly with my spouse 3. [ ] Yes, jointly with my parents/elders in the household

C17.	When you want to call someone, do you dial the number yourself or you ask someone else to do it for you?	1. [ ] Yourself -> **C19** 2. [ ] Someone else dials for you
C18.	Who helps you to dial when you want to make a phone call?	1. [ ] Spouse 2. [ ] Daughter / Son 3. [ ] Brother / Sister 4. [ ] Nice / Nephew 5. [ ] Grandchild 99 [ ] Other (specify):_____
C19.	Are you the person who normally recharge the balance of this phone by either dialing *805 or 909?	1. [ ] Yes 0. [ ] No

SECTION D: LR 2017 FARMING PRACTICES

*[FO: Read] "Now I am going to ask you some questions about your plots and your farming practices in the Rain Season that has just finished, **last Rain Season.**"*		
D1.	How many **${(Local_C12)}** of land do the members of your household and you planted, either owned or rented)? *[FO: Clarify to the respondent to report the total size of ALL the land farmed by the household.]*	_____ LOCAL MEASUREMENT → go to **Section E if answer 0**
D2.	Now, I am going to ask you about your cereal crops. Which cereals did your household plant **this last Rain Season**? *[FO: first mark the cereal crops that were planted, and then ask the total land planted for each cereal, the total number of bags harvested and the number of kilograms of those bags]*	
	1. [ ] Barley D2.1.1 Total land area ____C16 UNIT D2.1.2 Did you finish harvest? [ ] 1. Yes [ ] 0. No D2.1.3 Total # of bags harvested (or expect to harvest harvest) ___ D2.1.3 How many kilograms per bag___ 2. [ ] Maize D2.2.1 Total land area ____C16 UNIT D2.2.2 Did you finish harvest? [ ] 1. Yes [ ] 0. No D2.2.3 Total # of bags harvested (or expect to harvest harvest) ___ D2.2.4 How many kilograms per bag___ 3. [ ] Sorghum D2.3.1 Total land area ____C16 UNIT D2.3.2 Did you finish harvest? [ ] 1. Yes [ ] 0. No	4. [ ] Tef D2.4.1 Total land area ____C16 UNIT D2.4.2 Did you finish harvest? [ ] 1. Yes [ ] 0. No D2.4.3 Total # of bags harvested (or expect to harvest harvest) ___ D2.4.4 How many kilograms per bag___ 5. [ ] Wheat D2.5.1 Total land area ____C16 UNIT D2.5.2 Did you finish harvest? [ ] 1. Yes [ ] 0. No D2.5.3 Total # of bags harvested (or expect to harvest harvest) ___ D2.5.4 How many kilograms per bag___ 6. [ ] Millet D2.6.1 Total land area ____C16 UNIT D2.6.2 Did you finish harvest? [ ] 1. Yes [ ] 0. No

	D2.3.3 Total # of bags harvested (or expect to harvest harvest) ___ D2.3.4 How many kilograms per bag___	D2.6.3 Total # of bags harvested (or expect to harvest harvest) ___ D2.6.4 How many kilograms per bag___ 7. [ ] Sesame D2.7.1 Total land area ____C16 UNIT D2.7.2 Did you finish harvest? [ ] 1. Yes [ ] 0. No D2.7.3 Total # of bags harvested (or expect to harvest harvest) ___ D2.7.4 How many kilograms per bag___
	FO read: "Now I am going ask you questions about your practices of the plot that was planted with **${(NAME OF CHOSEN CROP)}.** FO: FOR THE NEXT SET OF QUESTIONS THE TABLET WILL CHOOSE THE CROP THAT OCCUPY THE LARGEST AMOUNT OF LAND (ie **${(NAME OF CHOSEN CROP)}**. IF THERE IS A TIE, THE TABLET WILL RANDOMLY PICK ONE OF THE CROPS.	
D3.	What did you do with the crop residues from the previous season?	1. [ ] incorporated to the land 2. [ ] feed the animals 3 [ ] use for fire 4 [ ] sell them
D4.	How many times your land was ploughed before planting **${(NAME OF CHOSEN CROP)}** during the last Long Rain Season?	_____ times
D5.	Were your ${**(NAME OF CHOSEN CROP)}** plot planted manually, using oxen, or machinery?	1. [ ] Manually 2. [ ] Oxen 3. [ ] Machinery
D6.	Were organic fertilizer/compost applied in the land where you planted ${**(NAME OF CHOSEN CROP)}** last Long Rain Season?	1. [ ] Yes 0. [ ] No
D7.	Were modern chemical fertilizers applied on your **(NAME OF CHOSEN CROP)** plot?	1. [ ] Yes 0. [ ] No **-> D11**
D8.	How many times did you apply modern chemical fertilizers your ${**(NAME OF CHOSEN CROP)}** plot?	_____ times
D9.	Did you apply modern chemical fertilizers at planting in your ${**(NAME OF CHOSEN CROP)}** plot?	1. [ ] Yes 0. [ ] No
D10.	Which chemical fertilizers were applied in your${**(NAME OF CHOSEN CROP)}** plot, how many kilograms of each one in total? *[FO: Listen and mark all that apply and complete the amount of kilograms only for the fertilizers that were applied]*	1. [ ] DAP (black) (**D10.1.1)** Total Amount__kg 2. [ ] NPS (grey) / blended fertilizer (**D10.2.1)** Total Amount_____kg 3. [ ] UREA (white) (**D10.3.1)** Total Amount_____kg 4. [ ] Other 1 (specify) (**D10.4.1)** Total Amount_____kg 5 [ ] Other 2 (specify) (**D10.5.1)** Total Amount_____kg
D11.	Did you use your own ${**(NAME OF CHOSEN CROP)}** seeds or did you buy them at the Cooperative Store, or Private Dealers?	1. [ ] Own seeds 2. [ ] Cooperative Store 3. [ ] Private Dealer/Local market 4. [ ] Borrowed seeds

	[FO: mark all that apply.]		
D12.	Were the seeds planted in rows or by traditional broadcasting in the ${**(NAME OF CHOSEN CROP)}** plot?	1. [ ] rows 2. [ ] traditional broadcast	
D13.	Were any chemical pesticides on your ${**(NAME OF CHOSEN CROP)}** plot?	1. [ ] Yes 0. [ ] No	
D14.	How many times did you weed your ${**(NAME OF CHOSEN CROP)}** plot last season?	_____times	
D15.	Were herbicides applied to your ${**(NAME OF CHOSEN CROP)}** plots last season?	1. [ ] Yes 0. [ ] No	
D16.	Did you and/or are you planning to apply any chemical pesticides after harvest on your ${**(NAME OF CHOSEN CROP)}** on produce?	1. [ ] Yes 0. [ ] No	
D17.	Which others crops did your household plant this last Rain Season 2017? *[FO: listen and mark all that apply]*	**Pulses, Oil Seeds and Cash Crops** 1. [ ] Sesame 2. [ ] Fava Bean 3. [ ] Chickpea 4. [ ] Common Bean 5. [ ] Cotton 6 [ ] Rice 7 [ ] Lentils	**Vegetables** 8. [ ] Potato 9. [ ] Carrot 10. [ ] Onion 11. [ ] Garlic 12. [ ] Tomato 13. [ ] Pepper 14. [ ] Head Cabbage **Fruits** 15. [ ] Bananas 16. [ ] Mango 17. [ ] Avocado 99 [ ] Other -97 [ ] No other crop was planted
D18.	In general, what are the three most regular problems you faced with your crops that reduce your yield? Please name them by order of importance *[FO: choose three and specify the rank*	1. [ ] Rain shortage___rank 2. [ ] Floods___rank 3. [ ] Lack of soil fertility 4. [ ] Worms/Pests __ rank 5. [ ] Weeds ___ rank 6. [ ] Shortage of seeds at the store__rank 7. [ ] Shortage of fertilizers at the store_rank 8. [ ] Shortage of pesticides/herbicides at the store_rank 9. [ ] Lack of credit to buy inputs 10. [ ] Lack of Machinery / Oxen	
D19.	In order to solve these problems, who are your three primary source of information? *[FO: choose three and specify the ranking)*	1.[ ] Woreda Expert _____rank 2.[ ] DA _____rank 3.[ ] Model Farmer _____rank 4.[ ] Other farmers _____rank 5 [ ] Family members _____rank 6 [ ] Radio _____rank 7 [ ] TV _____rank 8 [ ] 8028 _____rank 9 [ ] Social Media _____rank 10 [ ] Other (specify) _____rank	

SECTION E: EXPERIENCE WITH 8028 HOTLINE

FO: Now, I would like to ask you some questions about the the 8028 hotline, that offers agricultural recommendations to farmers in your area

Screening

E1.	Have you ever heard about the 8028 hotline?	1. [ ] Yes 0. [ ] No **-> E4**
E2.	How did you hear about the 8028 Hotline **for the first time**? *[FO: listen and mark all that apply]*	1. [ ] Radio 2 [ ] Development Agent 3 [ ] Fellow farmer 4 [ ] Adult relatives 5 [ ] Children 6 [ ] Registration Bookmark/Pamphlet 7 [ ] Other (specify):_____
E3.	Do you think you have to spend your phone credit to call to the 8028 hotline?	1. [ ] Yes 0. [ ] No
E4.	Have you or someone used this phone to call into the 8028 hotline to access recommendations on agricultural practices?	1. [ ] Yes 0. [ ] No **FO: if the respondent answered NO to E1 and E4 -> Section F Alerts**
E5.	Who accessed the 8028 hotline?	0. [ ] Myself -**> E9** 1. [ ] Spouse 2. [ ] Daughter / Son 3. [ ] Brother / Sister 4. [ ] Nice / Nephew 5. [ ] Grandchild 99[ ] Other (specify):_____
E6.	Have you listened to the recommendations with this person?	1. [ ] Yes -**> E9** 0. [ ] No
E7.	When could I talk to this person?	1 [ ] Now 2 [ ] Later (specify **E7.B)** 1 [ ] Date (calendar): 2 [ ] Time: 1. [ ] Between 8am – 11am 2. [ ] Between 11am – 2pm 3. [ ] Between 2pm – 5pm **-> FO: continue with this respondent on Section F Alerts**
E8.	**FO: Introduce yourself and the study to the new respondent** My name is _____I am calling on behalf of the Agriculture Transformation Agency (ATA). Currently, we are speaking to different users of the free 8028 hotline that offers access to relevant information to improve their farming practices, The user of this phone told me that you have called the 8028 hotline before and we would like to know more about your experience with	1. [ ] Now 2. [ ] Later (specify **E8.1)** 1. [ ] Date (calendar): 2. [ ] Time: 1. [ ] Between 8am – 11am 2. [ ] Between 11am – 2pm 3. [ ] Between 2pm – 5pm **-> FO: continue with the first respondent on Section F Alerts** **-**

	the system. Do you have 5 minutes to answer some questions?	

Question about usage

E9.	Has someone ever taught you to use the 8028 hotline?	1. [ ] Yes 0. [ ] No
E10.	Who taught you?	1. [ ] Trained by DA / Woreda Expert 2. [ ] Trained by other farmer 3. [ ] Trained by teacher 4. [ ] Trained by children 99. [ ] Other
E11.	Why do you normally call the system? *[FO: listen and choose all that apply]*	1. [ ] To learn about modern farming practices 2. [ ] To learn about new crops 3. [ ] To learn about weather 99. [ ] Other
E12.	Have you discussed the 8028 recommendations with someone? If so, who did you discuss?	1. [ ] Yes -> E12.1 Who? 1. [ ] DA 2. [ ] Fellow Farmer 3. [ ] Household Member 4 [ ] 5 to 1 group 5 [ ] Other 0. [ ] No
E13.	Who do you think put these recommendations together?	1. [ ] The Agricultural Transformation Agency (ATA) -> E13.1 Do you think that the Agricultural Transformation Agency is party of the Government or an NGO? 1. [ ] The Ethiopian Government 2. [ ] An NGO 2. [ ] The Ethiopian Government 3. [ ] Ministry of Agriculture 4. [ ] Universities / Research Centers / Researchers 5. [ ] An NGO 6. [ ] Ethiotel 99. [ ] Other (specify): _____ [ ] -98 Don't Know
E14.	How much do you trust recommendations from 8028 hotline? [FO: PLEASE READ THE OPTION[	1. [ ] Never trust the recommendations at all 2 [ ] Hardly trust t the recommendations 3 [ ] Mostly trust the recommendations 4 [ ] Always/Completely trust the recommendations

E15.	What are the major barriers you face to follow the recommendations from the 8028 hotline? [FO: LISTEN AND MARK ALL THAT APPLY)[	1. [ ] Couldn't adapt the units of measurement to the land size 2. [ ] Didn't understand with the recommendation 3. [ ] Didn't agree with the recommendation 4. [ ] Didn't know where to buy the products they recommended 5 [ ] Didn't have the money 6. [ ] Prices of the inputs were too high . 99. [ ] Other ,specify (**E15.A**)_____ -97 [ ] Didn't face major barriers
E16.	Now, I will ask you to think about the famers in your area. Out of 10 typical farmers in your village, how many do you think are using the system very well?	_____ out of 10
E17.	What are the three main issues/limitations farmers in your area facing to use the system as well as you related to accessing the system, using their phone, literacy, language, listening to the recommendations, etc.)	**Problems accessing the system and/or us phones** 1. [ ] Network connectivity 2. [ ] No reliable source of electricity 3. [ ] Do not have working phones 4. [ ] No credit 5. [ ]/buttons not working **Literacy problems** 1. [ ] Low level of numerical literacy, cannot recognize numbers 2. [ ] Don't speak the languages available in the system 3. [ ] Lack of ability to use a phone 4. [ ] IVR concept unfamiliar, hard to learn without training **Problems with the recordings/menus** 1. [ ] Can't complete profile question 2. [ ] Recommendations/Menu recordings spoken too fast, 3. [ ] Mistakenly chose a different language and can't undo 4. [ ] Menus where two digits have to be pressed (e.g. "07" for some woreda, or crop, or region) 5. [ ] Farmers don't know what * and # mean **Problems with the content of the recommendations** 1. [ ] Some terms in the recommendations unfamiliar 2. [ ] Some menu options have unclear or multiple meanings/interpretations 3. [ ] Unfamiliar measurement units used 4. [ ] Too many detailed mentioned in content messages (too many numbers, product names not always familiar) 5. [ ] Difficulty adapting measurement units (given per hectare) to smaller land sizes **Problems implementing the recommendations**

		1. [ ] Lack of money / finance to adapt the recommendations 2. [ ] Recommended inputs unavailable locally
E18.	Have you ever tried to train other farmers to use the system?	1. [ ] Yes 0. [ ] No

SECTION F: EXPERIENCE ALERT SYSTEM

FO: Now, I would like to ask you some questions about the 8028 alert		
F1.	Have you received a call from the 8028 system with a voice recorded message? If so, did you answer the call?	1. [ ] Yes, but didn't pick up 2. [ ] Yes, I answer the call → **F3** 0. [ ] No → **F7** -98. [ ] Don't know/ Don't remember → **F7**
F2.	Why didn't you answer the call? *[FO: listen and mark all that apply]* **Answer the question and skip to → F7**	1. [ ] I thought that it was a scam call 2. [ ] I thought that it was Ethiotel 3. [ ] I thought they will charge me 4. [ ] Thought it was from abroad. 5. [ ] Other:_____ -98. [ ] Don't know
F3.	What was the voice recorded message about? *[FO: listen and mark all that apply]*	1. [ ] Drought 2. [ ] Flood 3. [ ] Disease outbreak 4. [ ] Pest outbreak -98. [ ] Don't know
F4.	Did you share the message of the alert with anybody?	1. [ ] Yes 0. [ ] No → **F7** -98. [ ] Don't know/Don't remember → **F7**
F5.	Who did you talk with about the content of the alert? *[FO: Don't read question options and mark all that apply.]*	1. [ ] Other farmers 2. [ ] Development Agent 3. [ ] Neighbors 4. [ ] Friends 5. [ ] Family members 99.[ ] Other, specify: _____
F6.	How clear are the recommendations received?	1. [ ] Very unclear 2. [ ] Unclear 3. [ ] Clear 4. [ ] Very clear
F7.	Have any of your friends, relatives or neighbor received a call from the 8028 hotline with recorded message that provide an alert of an upcoming weather, disease and/or pest alert?	1. [ ] Yes 0. [ ] No → **End** -98. [ ] Don't know/Don't remember → **End**
F8.	Did they share that information with you?	1. [ ] Yes 0. [ ] No -98. [ ] Don't know/Don't remember

SECTION Z: END

[FO: Read] "*Thank you for agreeing to participate in this short survey."*		
Z1.	Should this person be called back?	1. [ ] Yes → **Z3** 0. [ ] No
Z2.	Why should this person not be called back?	
Z3.	FO: Please record any comments or notes about this survey.	
Z4.	End Time	|___|___| : |___|___|

A.2 Appendix Tables

Table A.1: Telephone survey - Sample stratification by IVR system usage bins

Usage bin	1	2	3	4	5
Number of unique contents	> 20	13-19	7-12	2-6	< 2
Percentile	> 95th	90-95th	75-90th	50-75th	< 50th

A.3 Appendix Figures

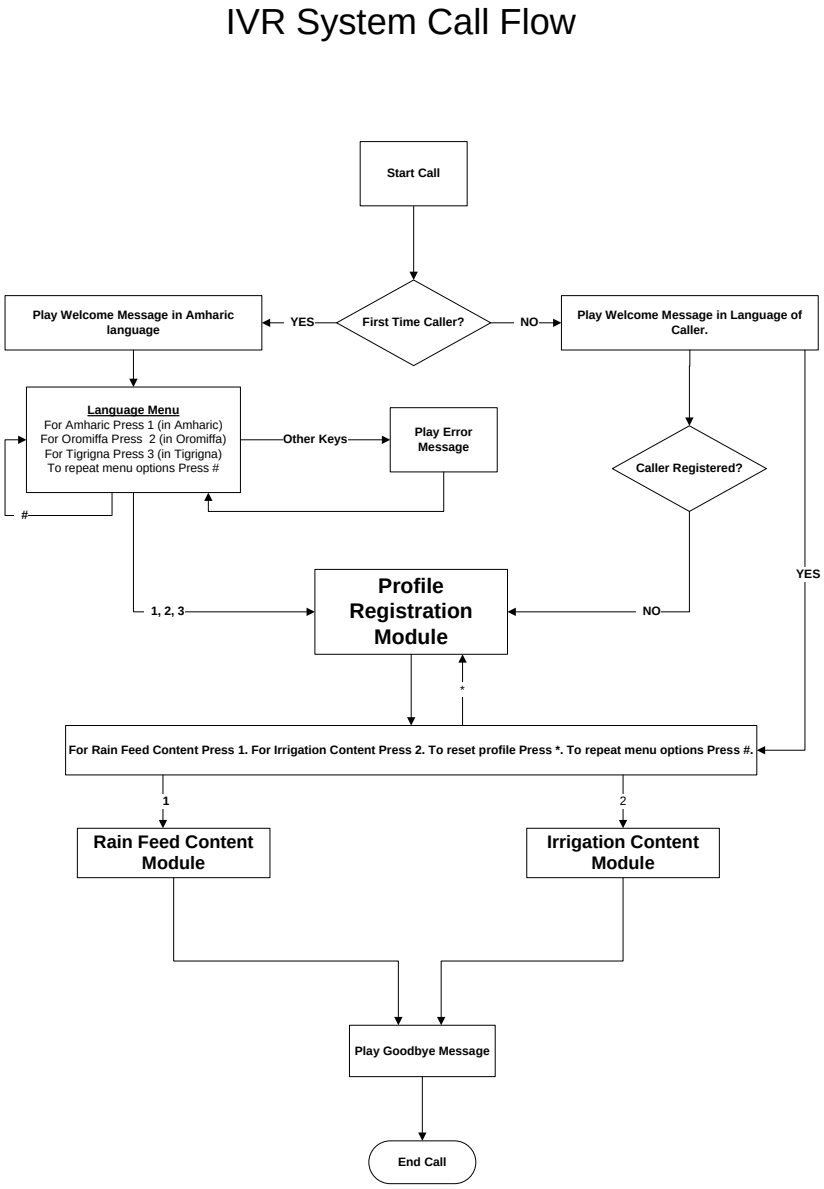

Figure A.1: Flow chart of call to IVR System

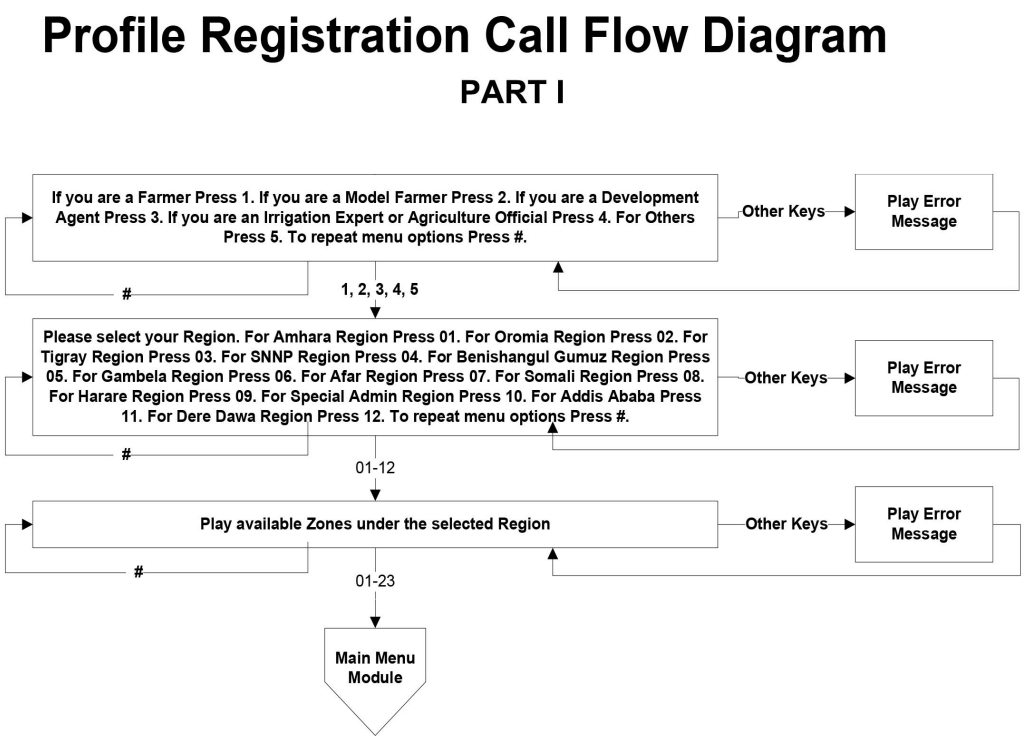

Figure A.2: Flow chart of profile registration module - part 1

Profile Registration Call Flow Diagram

PART II

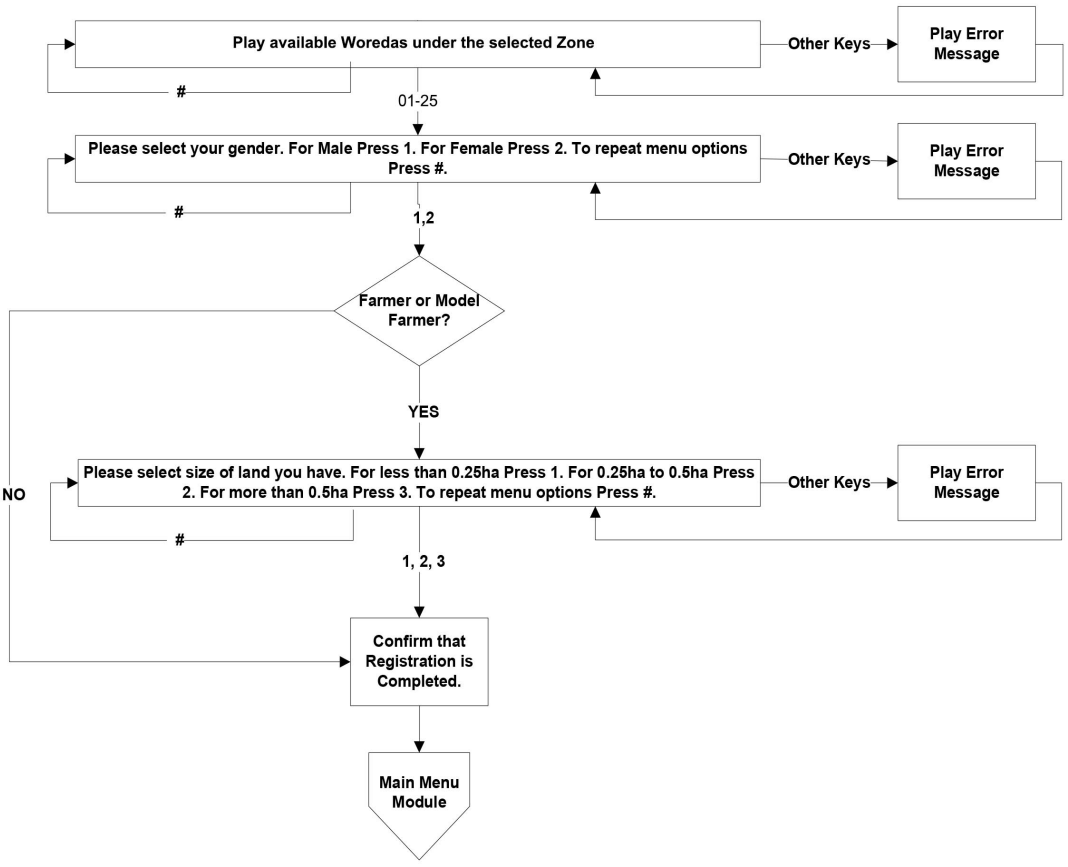

Figure A.3: Flow chart of profile registration module - part 2

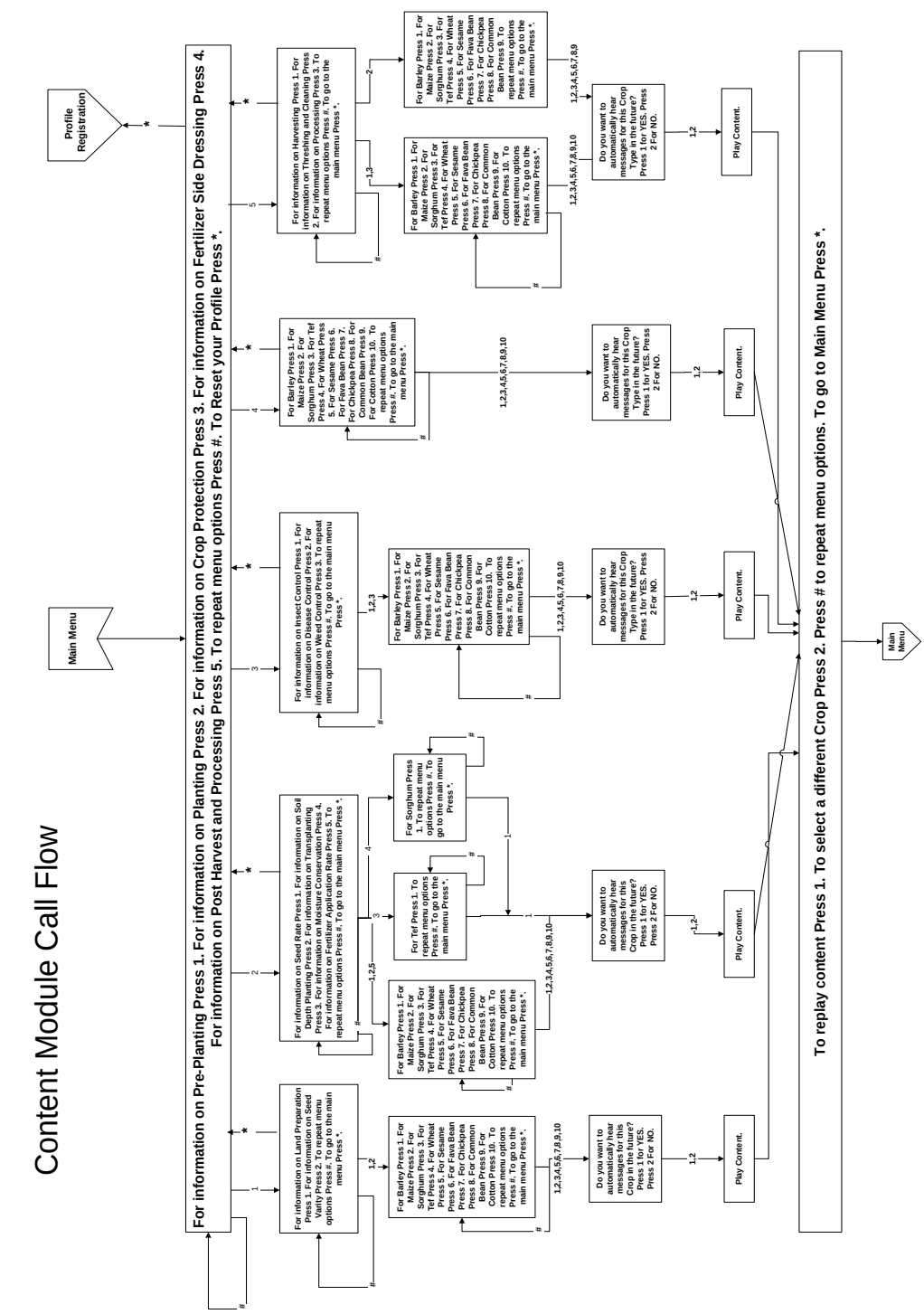

Figure A.4: Flow chart of rainfed content module

Figure A.5: Flow chart of irrigation content module

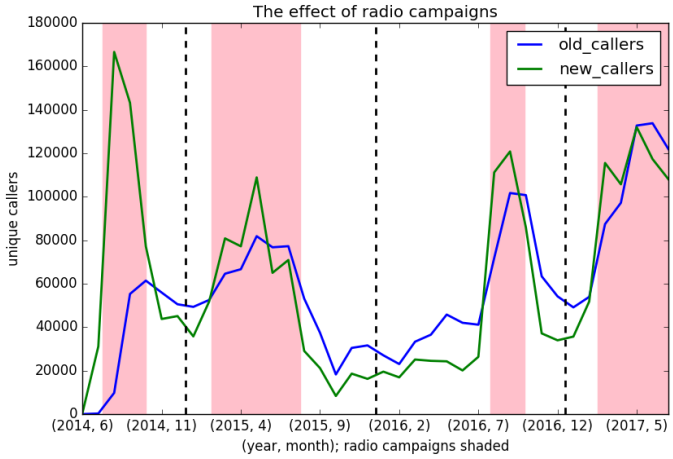

Figure A.6: Recruitment of IVR system users through radio campaigns

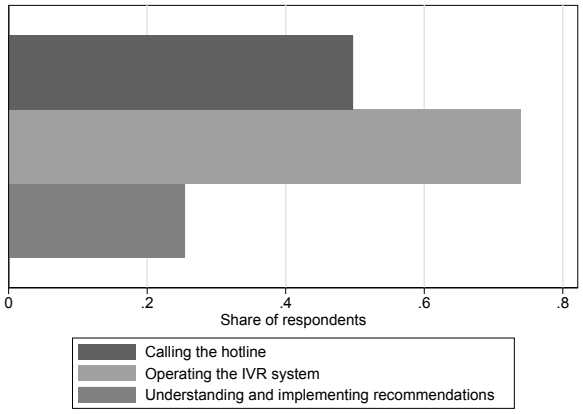

Figure A.7: Barriers to IVR system use as reported by respondents of telephone survey

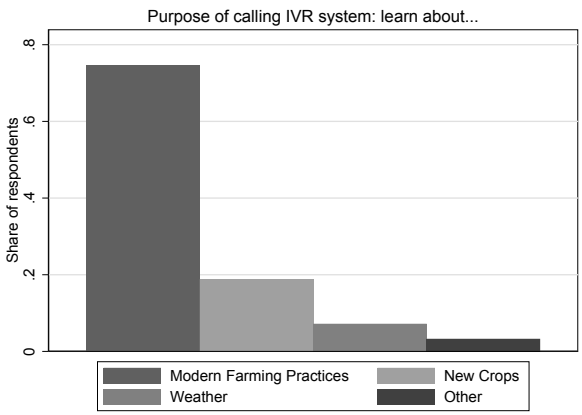

Figure A.8: Reasons for calling the IVR system as reported by respondents of telephone survey