

KRISHI TARANGA

**A customized mobile phone-based extension
service for coffee growers**

*A Collaboration Between Coffee Board of India and Precision Agriculture for Development
India Foundation (PADIF)*



Executive Summary

Coffee growers across India suffer from stagnating yields. Support is limited with roughly 200 extension workers supporting more than 300,000 coffee growers. Advice when available might not be relevant or useful. Digital technologies provide tremendous potential to revitalize the coffee industry. Low-cost, scalable mobile phone-based extension systems can support traditional extension systems by providing customized, timely and regularly updated advice to farmers. Coffee Board and Precision Agriculture for Development India Foundation (PADIF) are running a pilot for PADIF's flagship two-way IVR (interactive voice response) service to provide mobile phone-based advice to 15,000 coffee growers in two districts in Karnataka by March 2019. In addition to the IVR service providing advice to coffee growers, PADIF is also developing a mobile phone-based application to train extension workers and disseminate advice to smartphone users (both farmers and extension workers), creating multiple channels for dissemination of information. Early results are very promising and show tremendous potential to scale up to the 300,000 coffee growers across India in a cost-effective manner. Highlights include:

15,000 coffee growers registered on PADIF's two-way IVR service as of March 2019. Greater than 80% pick-up rates throughout the season for weekly outbound advisory messages. Over 13,000 inbound calls to ask questions or listen to price information (page 6)

91% of surveyed farmers would recommend the service to friends/family (page 9)

83% of surveyed farmers adopted a recommendation from the service (page 10)

28% increase in farmers' knowledge across 6 recommended practices from end of the season relative to beginning of the season (page 12-13)
(Percentage increase in farmer knowledge ranges from **16% to 107%** for different practices).

55.5% of surveyed farmers paid a nominal fee (between 120-240 rupees) to purchase an annual subscription of the service (page 15).

Problem Statement

Traditional agricultural extension systems in India are limited by lack of resources, scalability and ability to provide timely information. Within the Coffee Board of India, roughly 200 extension workers serve over 300,000 coffee growers across India. Given stagnating coffee yields, information on new technologies and best practices can help revitalize the coffee industry. Additionally, extension workers are often overburdened and don't have the capacity to improve the quality and frequency of extension they provide. Smallholder farmer livelihoods in particular are adversely affected given they face higher barriers to information. Access to actionable and timely information has the potential to improve farmer productivity, and ultimately livelihoods.

Precision Agriculture for Development India Foundation (PADIF) leverages the promise of digital technology to help address information asymmetries for smallholder farmers. With active projects in Gujarat, Odisha and Karnataka, PADIF uses an evidence-based model to provide customized advisory to farmers through their mobile phones. As part of Coffee Board's initiative to transform the industry using technological innovations, PADIF brought its expertise in digital extension to coffee growers in Karnataka with the goal of strengthening the existing extension machinery.¹

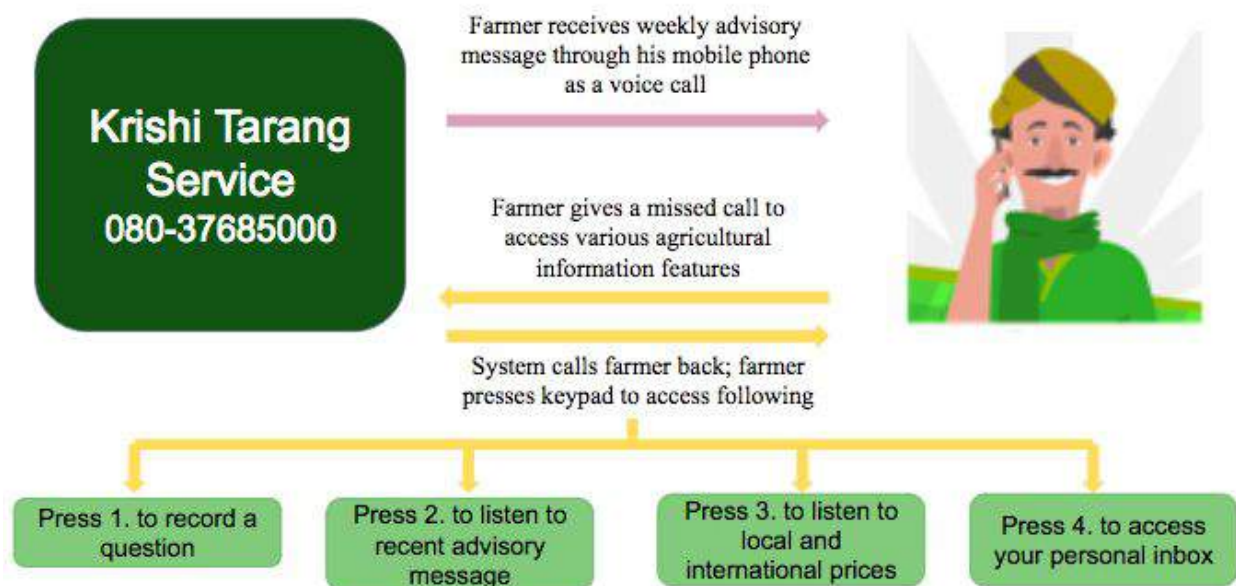
Project at a Glance

Precision Agriculture for Development India Foundation (PADIF) and Coffee Board of India collaborated on a pilot project to provide mobile phone-based advisory to coffee farmers in two districts in Karnataka, India. The pilot leveraged PADIF's flagship two-way interactive voice response (IVR) service, Krishi Taranga, to provide customized, relevant and timely advice to coffee growers in Chikmagalur and Hassan districts. The target of this pilot project was to cover 15,000 coffee growers in Chikmagalur and Hassan district in Karnataka between July 2018 to March 2019. If successful, the project can be scaled up to provide advice to more than 300,000 coffee growers across the major Coffee growing states in the country.

¹ See Appendix for a detailed description of the work PADIF does with farmers across the country, leveraging evidence-based digital interventions to empower smallholder farmers.

Through this service, coffee growers received a weekly two-minute long voice message providing advice and recommendations based on the crop cycle (“outbound service”). Additionally, farmers could also give a missed call to access a toll-free helpline that would allow them to ask questions answered by coffee experts, listen to local and international price information, review weekly advisory messages, and access their own history of questions asked through the service (“inbound service”).

Figure 1. Overview of the Krishi Taranga IVR service



With increasing smartphone penetration among coffee growers and rapid adoption of technology among extension workers, **PADIF is also developing a mobile application in collaboration with EkStep Foundation** to support the existing extension system for coffee in the region. This app will serve a two-fold purpose: 1) meeting the diverse information needs of coffee growers by providing extension through pictures, video and other visual mediums and 2) building capacity within the extension system by providing training modules to extension workers and creating an interactive system that encourages information sharing and learning among extension workers.

PADIF has brought its data-driven and experimental approach to this pilot as well to conduct an array of activities to assess the potential for sustainable scale-up of this service to coffee growers across India. Among this are detailed surveys for a subset of users to track changes in farmer behavior and adoption of recommendations through the IVR service as well as ongoing pilots to assess revenue models where farmers might be willing to pay a nominal fee for the service. Preliminary results from both these

exercises are very encouraging, and present tremendous potential for scaling up PADIF’s service to coffee growers in both traditional and non-traditional coffee growing areas.

Content

From the inception of the project in July 2018 until February 2019, PADIF has sent voice messages across 30 unique topics to cover the entire coffee cultivation cycle. Recommended practices across a range of practices are translated into a concise audio message typically 1-2 minutes long. Farmers receive a weekly voice call on their mobile phones with this audio through our service titled “Krishi Taranga”.

Figure 2: Content Topics for Coffee covered throughout the crop cycle

August	September	October	November	December	January	February
Seeds & Sowing	Pest & Disease Management	Pest & Disease Management	Soil Management	Harvesting	Pest & Disease Management	Pest & Disease Management
Fertilizer Management	Fertilizer Management	Weed Management	Pest & Disease Management	Pest & Disease Management	Nursery Management	Market Price
<ul style="list-style-type: none"> Gap Filling for uprooted plants due to disease Mid-monsoon urea application 	<ul style="list-style-type: none"> White stem borer management Coffee rust management Mid-monsoon urea application 	<ul style="list-style-type: none"> White stem borer mgmt. Short hole borer mgmt. weed mgmt. 	<ul style="list-style-type: none"> Soil Sampling Soil Testing Lime Application White Stem Borer mgmt. 	<ul style="list-style-type: none"> Arabica Harvesting Coffee Berry Borer mgmt. Coffee Effluent mgmt. 	<ul style="list-style-type: none"> Coffee Berry Borer mgmt. Targeted messages to those growing nursery 	<ul style="list-style-type: none"> Coffee Berry Borer mgmt. Gleaning Local and International Market Price

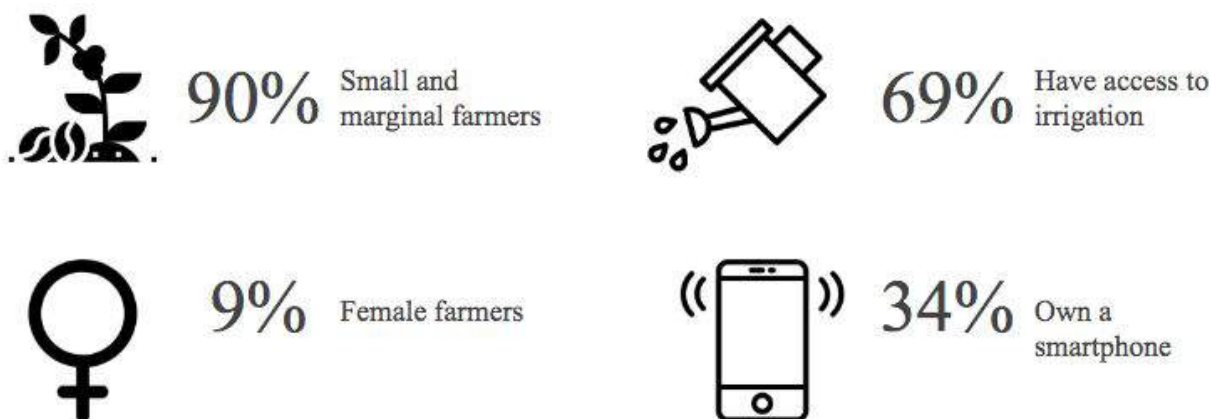
We have covered information on topics ranging from pest and disease management (for instance, white stem borer identification and control for arabica coffee and coffee berry borer control for robusta coffee), fertilizer management (including lime application and post-monsoon fertilizer application), soil sampling and coffee estate management. **For specific topics, information is customized based on the end user’s farming practices** - for instance, we sent lime application recommendations to those farmers who were due to apply lime this season conditional on soil moisture. Similarly, we also sent nursery management information to the subset of coffee growers that have nurseries around preparation of nursery beds, fertilizer application and so on.

On the inbound end, PADIF provided information across a variety of parameters for coffee. Among these, PADIF answered farmer queries across a variety of farming practices including irrigation management, coffee post-harvest practices, etc. PADIF also provides daily updated price information for both international and local coffee markets. For international markets, the metric used is the International Coffee Organization (ICO) indicator price for US markets (in Indian rupees/kg) for arabica and robusta coffee (both for cherry and parchment) for clean coffee. For local prices, raw coffee prices for the state of Karnataka calculated based on prices for local markets are reported in rupees/kg. This allows farmers to track both immediate selling prices but also trends in the global coffee market. As a next step, PADIF is working with Coffee Board to map recommendations generated by Central Coffee Research Institute (CCRI) to soil samples provided by Krishi Taranga users to generate and disseminate personalized recommendations around fertilizer management practices.

Farmer Engagement

As of March 2019, 15,000 coffee growers are active on the Krishi Taranga service.² In order for PADIF to be able to provide customized agricultural advice (making it different from generic messages distributed to farmers), PADIF collects detailed profiles of coffee growers at the time of registering farmers onto the service. Information is collected on parameters ranging from land acreage, variety of coffee grown, irrigation availability, gender, smartphone usage, literacy, among others.

Figure 3. Descriptive characteristics of coffee farmers registered on Krishi Taranga



² PADIF is on track to meet the goal of 15,000 farmers by end of March 2019.

For a subset of farmers, PADIF also collected more detailed adoption and knowledge information including information on controls for pests like black rot disease, white stem borer as well as information on when they last applied lime and how much was applied.

Once farmers are profiled and registered on the service, they are also trained on how to use this service. Based on PADIF's work across India, farmers that receive training are in general, more likely to engage with the various features available through Krishi Taranga. This training is done either in person or over the phone, by PADIF or Coffee Board staff with the goal of ensuring farmers understand all the benefits of this service.



Coffee Growers being trained on the Krishi Taranga service by Coffee Board extension staff

All Krishi Taranga users receive a weekly advisory message from the IVR service. On average, **farmers pick up 81% of the weekly advisory calls** - this pick-up rate has stayed constant throughout the season. Among those that pick-up the weekly advisory message, the **average listening rate for messages is around 66%**.

At the end of a message, farmers can rate the messages on a scale of 1 to 5 (with 5 being excellent). **Average rating for content is 4.2 out of 5.**

Sample weekly advisory message sent to coffee farmers

Pest and Disease Management focused on White Stem Borer Management for Arabica coffee
(November 3rd Week)

"Namaskar, Welcome to Krishi Tarang service. Emergence season of adults of the white stem borer is called flight period. There are two peak flight periods in a year, one from April-May and another from October- December. Trace the infested plants prior to flight period i.e. before end of march and September every year by looking for ridges on the main stem and thick primaries. Collar prune the infested plants, uproot if borer has entered into the root and burn the affected plants immediately. Spray Chloropyriphos 50 EC at the dosage of 240ml+ Cypermithrin 5EC in 200l of water along with 200ml of any wetting agent."

Sample weekly advisory message sent to coffee farmers

Arabica Harvesting and Post-Harvest Management: Preparation of Parchment by Wet Method
(December 3rd Week)

"Namaskar, welcome to Krishi Tarang. For Preparation of parchment by wet method, picking of right type of fruits is very essential. Coffee fruits should be picked as and when they are just ripe. Coffee fruit is considered just ripe when on gentle squeezing, the bean inside pops out easily. Presence of unripe (greens) and over-ripe fruits would affect the final quality of coffee in the cup. The unripe or green fruits result in production of immature beans while the over-ripe fruits result in foxy beans which are considered undesirable in coffee quality circles. Arabica coffee is harvested in 2 to 3 rounds. Hence, sorting would become necessary before pulping of fruits. The bags/ baskets used for harvesting of fruits should be kept clean by frequently washing and drying. Fertilizer bags should not be used for collecting harvested fruits since the final beans tends to acquire fertilizer taint which is undesirable. While harvesting and transporting to the drying yard, damage to the coffee fruits should be avoided or minimised."

On the inbound calls, the Krishi Taranga service **received 13,600 calls through the missed call service** between July 2018 to February 2019. Question and answers and price information are the most valued features.

Figure 4: Number of inbound calls by feature access

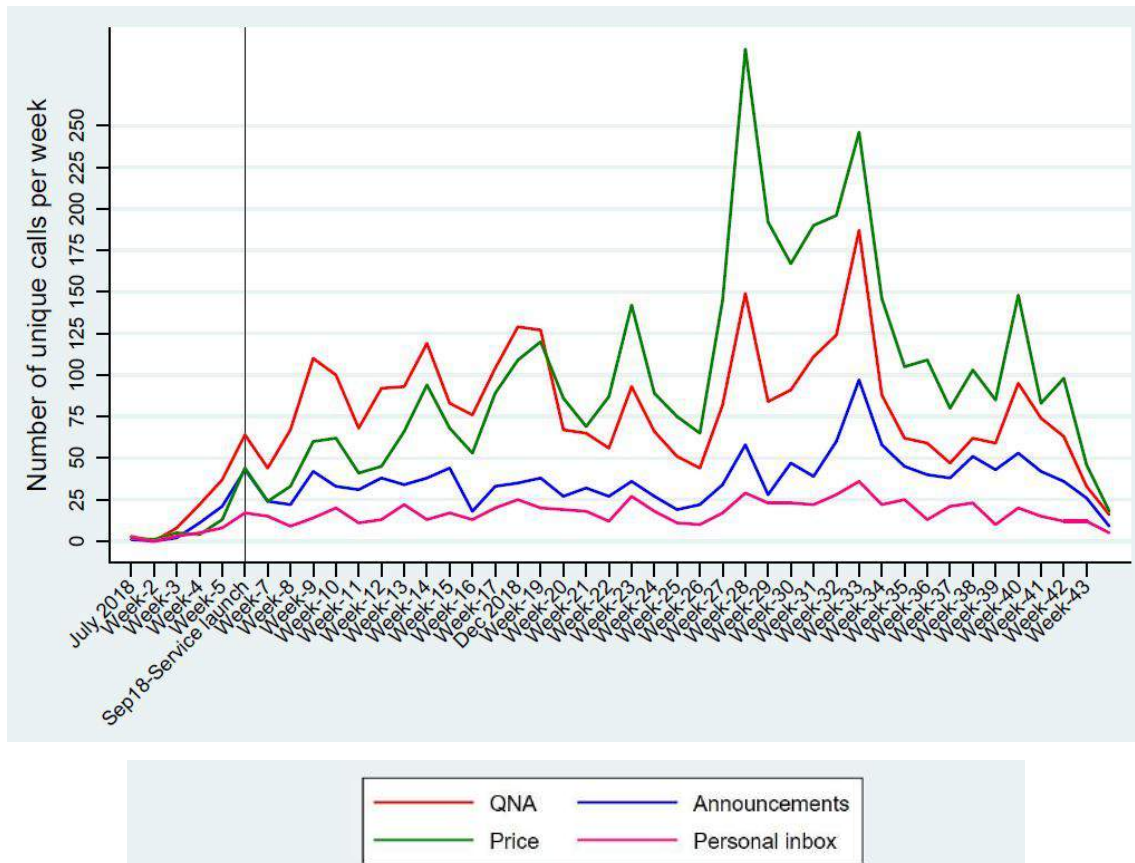


Figure 4 shows a disaggregation of calls by feature access by week. During cultivation season, farmers visited the question and answer feature most frequently. However, once harvesting season nears (January 2019), there was an uptick in calls visiting the price feature, presumably since this information can help them make selling decisions.

PADIF and Coffee Board agronomists answered over 1,600 questions received through the Krishi Taranga service from July to February.³ PADIF promised farmers that all questions will be answered within 48 hours. **In fact, 50% of questions are answered within 3 hours, which enables farmers to have near-immediate access to information through their mobile phones.** Among the questions Krishi Taranga received, the most popular questions are related to pest & disease management (30% of questions), market information (10%) and fertilizer management (5% of questions).

Sample questions asked by coffee farmers with answers provided by coffee experts

Question: How can I control/minimize the fruit drop in my coffee?

³ Note that farmers were added onto the Krishi Taranga service in a phased manner, starting with 1,000 farmers in July, reaching 10,000 farmers in December with currently 14,000 farmers registered as of February 2019.

Answer: For effective management of fruit dropping problem, integrated management practices should be followed which includes removing the criss-cross branches and tender shoots from the centre, as well as dead and dry branches, suckers and fallen leaves from the canopy of bushes. Drain the drainage and cradle and make the excess water dry and apply 1 bag (50) kg of urea per acre during post monsoon season to activate plant rooting activity. If disease is noticed remove and destroy the affected leaves and berries and to control black rot affected areas during a break in monsoon spray 120g Carbendazim 50WP+ Wetting Agent mixing with one barrel (200 litre).

Question: What can I do for Leaf Rust Management?

Answer: To control Coffee Leaf Rust disease in standing crop you should spray spray 0.5% Bordeaux mixture for rust tolerant varieties. For susceptible cultivars like S795 and Cauvery spray any one of the systemic fungicide like Bayleton 25WP@ 160 g OR Contaf 5% EC @400ml mixing in barrel of 200 litre of water.

Feedback & Iteration

The entire service is designed to create feedback loops to incorporate continuous feedback from the farmers and improve the quality of information being provided. A random sample of users are surveyed every week to understand service satisfaction and current crop conditions. Based on data collected from July 2018 to February 2019, feedback has been overwhelmingly positive. For instance, **93% of farmers said they find the information received through weekly advisory messages useful.**

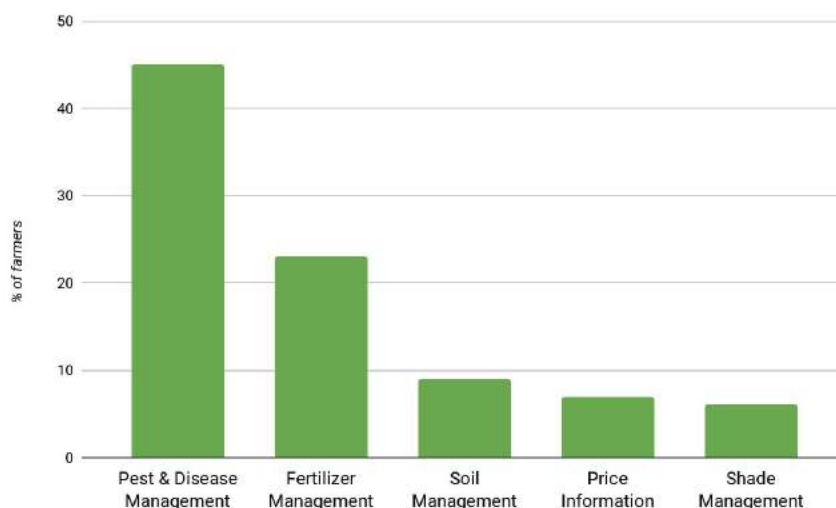
During these user surveys, farmers also identified current crop conditions they face and PADIF's advisory is iterated upon using this real-time information. One recent example is PADIF agronomists noticed farmers in mid-February asking questions on irrigation management for robusta coffee, a trend which also seemed to emerge in the feedback surveys. As a result, PADIF agronomists designed a customized advisory message to robusta farmers on sprinkler irrigation management. In the same week, other farmers received price information, while those that were growing nursery received information on fertilizer management. This is a simple depiction of the dynamism and customization that the Krishi Taranga service supports.

In a more comprehensive survey with over 1,000 farmers⁴ :

⁴ At the time of writing this report, surveys from roughly 700 users have been completed. Data reported here is indicative of this sample.

91% of coffee growers said they would recommend the service to their friends or family to use as a source of information

Topics that farmers find most useful from weekly advisory messages



Within less than 6 months of using the service, Krishi Taranga has very quickly become an important source of information for farmers across a variety of topics. For instance:

33% of farmers considered Krishi Taranga their primary source of information for **pest and disease management**.

The other sources of information were self-experience (25%), input dealers (22%), Coffee Board extension staff (16%).

29% of farmers considered Krishi Taranga their primary source of information for **fertilizer management**

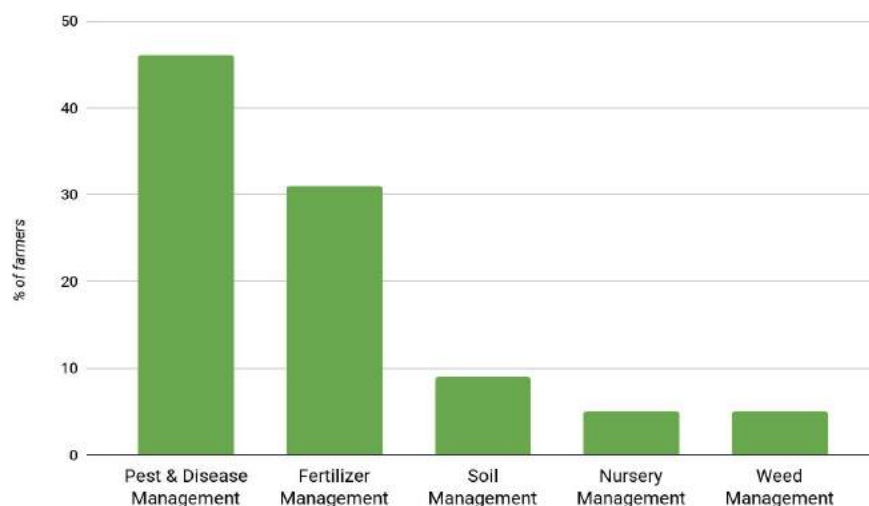
The other sources of information were self-experience (28%), input dealers (21%), Coffee Board extension staff (18%).

Tracking Changes in Farmer Behavior: Adoption & Knowledge

For a random sample of 1,000 users⁵, PADIF collected detailed information on a variety of adoption measures as well as knowledge on best practices for coffee cultivation across various parameters. We summarize the highlights of the observed trends below:

83% of farmers said they had adopted a recommendation from the Krishi Taranga service. The most common recommendations followed by KT farmers include:

Agricultural practices across which farmers adopt recommendations from Krishi Tarang



Among those farmers that called in to listen to price information:

44% said they used **price information** from Krishi Taranga to make a selling decision.

PADIF also collected information on whether or not farmers adopted specific recommendations from Krishi Taranga. Overall, we observe that **those who reported using Krishi Taranga as their primary source of information are more likely to follow recommended practices** across 9 recommendations we asked about in the survey.

Pest & Disease Management	
61.8%	Adoption rate among those who consider Krishi Taranga their primary source of information
58.1%	Adoption rate among all surveyed users (including those who report relying on other sources of information)

⁵ Data collection for the final round of surveys is ongoing, this represents preliminary results for 70% of the survey sample (~ 700 users)

Fertilizer Management	
33.24%	Adoption rate among those who consider Krishi Taranga their primary source of information
32.41%	Adoption rate among all surveyed users (including those who report relying on other sources of information)

However, the data on individual recommendations indicate that this trend is stronger for some practices (particularly on pest & disease management) than for others. A detailed breakdown of adoption practices can be found below:

Adoption of specific practices recommended by Krishi Taranga

Recommended Practice	All Surveyed Farmers	Primary source of information: Krishi Tarang
	Adoption rate (%)	Adoption rate (%)
Pest & Disease Management		
Control for black rot disease	60.80%	69.69%
Control for leaf rust disease	70.33%	68.83%
Control for coffee berry borer (robusta)	33.09%	31.19%
Control for white stem borer (arabica)	73.12%	69.30%
Performed tracing (identification) of white stem borer (arabica)	56.80%	70.80%
Fertilizer Management		
Adopted lime (when recommended)	45.45%	47.50%
Performed soil sampling	10.60%	12.50%
Adopted lime for nursery	39.80%	38.75%
Adopted rock phosphate for nursery	33.80%	34.20%

Many of these practices are quite time sensitive. For instance, if tracing is done at an incorrect time, white stem borer management becomes difficult and damages productivity. Similarly, Coffee Board has been stressing that farmers must submit soil samples to ensure that they are applying precise fertilizer recommendation based on their soil moisture content and not under or over-using fertilizers.

Insights from the field: Farmer Testimonial



“I find the Krishi Taranga service very useful. It has become a source of timely and correct information on coffee management. Particularly, on white stem borer management, I realized I was applying controls in the wrong month. Following your advice has helped control the spread of white stem borer in my coffee estate. I also learnt that pulping should be done on the same day rather than waiting for 5-6 days like I used to. This recommendation I think has really helped improve the quality of my coffee this season. I also call in to listen to price information since it is so easily accessible and have particularly recommended this feature to my other friends that grow coffee as well” - Malleth Gowda, Chikmagalur

Lastly, PADIF also tracked **changes in knowledge** on recommended practices for selected topics before and after using the Krishi Taranga service. A first round of surveys was conducted in July - August 2018 before farmers were registered onto the Krishi Taranga service (“baseline”). The second and final round of surveys was conducted with the same set of users in February 2019, after they had received an entire season of advice from Krishi Taranga (“endline”). PADIF used this to track whether information from Krishi Taranga was associated with higher average knowledge among users at the end of the season as compared to before the start of the season.

Overall Score (% of farmers with correct knowledge across 6 recommended practices)

Before using Krishi Taranga	After receiving advice from Krishi Taranga for a season	% change in knowledge score
-----------------------------	---	-----------------------------

32%	41%	↑ 28%
------------	------------	--------------

In general, **knowledge across recommended practices is substantially higher after having received Krishi Taranga information across an entire season** (more so for some practices than others). It is important to note that behavior changes among Krishi Taranga farmers before vs. after the intervention do not reflect the causal impact of the service. They could, however, provide insights into the scope of potential impact.

As you can see above, across a range of 6 practices for coffee, knowledge at the end of a season (endline) of receiving Krishi Taranga information was 28% higher relative to the beginning (baseline). We see that the magnitude of change varies considerably across practices. The table below shows the average percent of users that were able to correctly identify the best practices before and after getting weekly advisory messages on these topics through the season.

Changes in knowledge (across 5 recommended practices) for Krishi Taranga farmers

Practice on which knowledge was assessed	Baseline (Pre-Krishi Tarang)	Endline (Post-Krishi Tarang)	% change from endline relative to baseline
	Average (%)	Average (%)	
Control for black rot	41.80	52.70	↑26%
Control for leaf rust	38.50	45.01	↑17%
Control for berry borer (robusta)	6.70	13.89	↑107%
Timing of tracing for white stem borer (arabica)	25.90	30.10	↑16%
Timing for lime application	48.90	62.50	↑28%

The largest increase can be seen in coffee berry borer pest for robusta farmers (107% higher at end of the season compared to the beginning). This is a pest that has recently become more aggressive in terms of crop damage on robusta coffee, and there is a

clear need for information among growers for control of this pest, as can be seen in the more than doubling of knowledge on control methods for coffee berry borer.

If this service is scaled up beyond the pilot, PADIF will work on developing more rigorous experiments including A/B tests or comparison of farmers with and without access to the service to delve deeper into the question of impact of the Krishi Taranga service, and address whether or not the service changes farmer behavior and increases knowledge.

Pathway to Financial Sustainability: Farmer Willingness to Pay

Preliminary scoping surveys over the phone with a randomly selected subset of users revealed that on average, 60% of farmers said they would be willing to pay a nominal fee for the service (between 120 - 240 rupees), roughly equal to PADIF's marginal cost of providing the service. Of course the percentage that reported they were willing to pay was much higher at the lower price point of 120 rupees (70%) as compared to a higher price point of 240 rupees (50%).⁶

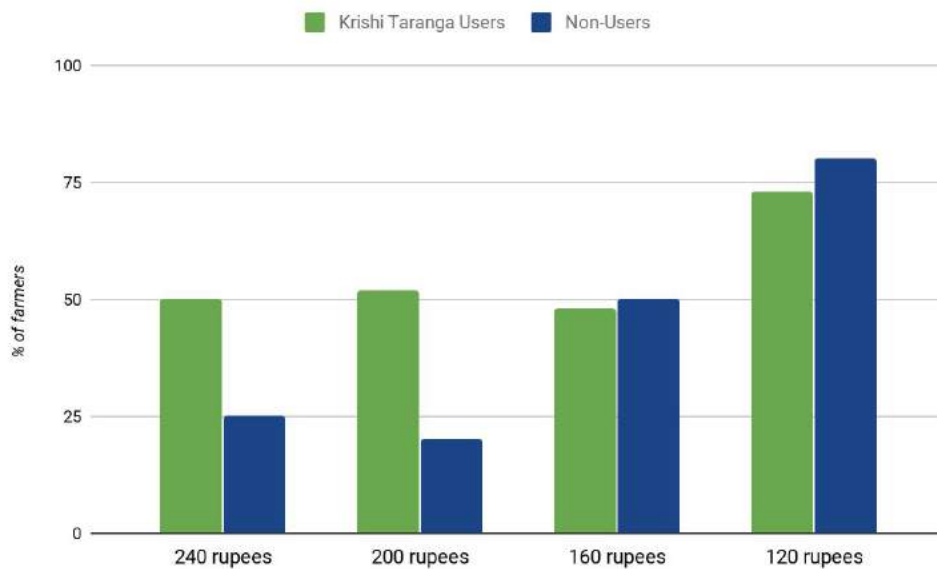
One concern from simply asking farmers whether they are willing to pay is that it might overstate the potential for monetization since farmers might simply not pay the cash at the time of collection. To alleviate these concerns, PADIF conducted a pilot experiment in 3 villages using a randomized price lottery. Farmers (80% Krishi Taranga users, 20% non-users) were offered a random annual fee (either 240, 200, 160 or 120 rupees) and were asked to pay cash to extend this service for another year.⁷ Farmers did not know the other price options and so simply had to make the decision to buy or not at the offered price. Preliminary results are very encouraging:

55.5% of surveyed Krishi Taranga farmers paid cash to extend the service by another year.

Distribution of farmers paying for the service at different price points

⁶ These costs were calculated to include a range of scenarios in which PADIF and Coffee Board might be able to sustainably operate the service, ranging from including only variable costs to covering all fixed and variable costs of running the service.

⁷ This pilot experiment was done with roughly 100 Krishi Taranga users located in 3 different villages in Chikmagalur district and another 20 non-users in 2 of these villages.



Payment rates were much higher for the lowest price point of 120 rupees (70%), although they did not know beforehand that this is the lowest price.

Interestingly, the results at the lower prices (120 and 160 INR) do not seem to differ between users and non-users, indicating that **there is a demand for timely, easily accessible and low-cost advisories for coffee farmers and that farmers value the Krishi Taranga service**. If this project is able to achieve a scenario where more than 50% of farmers would pay for a coffee-focused mobile phone-based extension system, this presents a sustainable path to scale. PADIF recognizes that these are initial results and is working with Coffee Board to identify how to deepen these experiments going forward to better understand the potential for monetizing this service and to capture information from a larger sample of coffee farmers.

Expanding to smartphone-based applications

The PADIF model at its core is a technology enabled platform to service smallholder farmers. IVR is our most widespread channel as it can reach almost anyone with a mobile phone. However, PADIF has found that smartphone adoption is rising rapidly in the coffee growing areas aided by budget smartphones and cheap data plans. Additionally we have observed less engagement from smartphone owning farmers with our IVR service, across geographies.

PADIF has created a Krishi Taranga android application and it is live in Gujarat. The application apart from replicating all the functionality of IVR, supports image and video based advisory which can drive additional farmer engagement. The marginal cost incurred to service farmers also goes down as there is no telecom airtime costs which are currently required to make the calls through the IVR service. Apart from the advisory to farmers through smartphones, **PADIF is partnering with EkStep Foundation (founded by Mr. Nandan Nilekani) to build a mobile application designed to build capacity and train extension staff to provide higher quality service to the coffee growers.** The platform would provide learning modules and assessment to the extension staff on their phones. The idea is to supplement the education and training provided by Coffee Board of India in a more mobile friendly, accessible and frugal way.

As we scale this service to more farmers, PADIF will bring a dynamic approach to both platforms and content to ensure the relevance of this service to an increasing base of users situated in different contexts and geographies.

Appendix: Brief Overview of PADIF

PADIF is a non-profit (Section 8) organization with a mission to support smallholder farmers in developing countries by providing customized agricultural information and services that increase productivity, profitability, and environmental sustainability. PADIF is pioneering a model for agricultural extension: delivering farmers personalized agricultural advice via their mobile phones. PADIF implements this model in collaboration with partner organizations and gathers evidence on its impact.

A key element of our approach is helping partners with wide reach – such as governments, contract farming organizations, telecommunications firms, agribusiness, and NGOs – to design, build, evaluate, and improve customized mobile phone-based agricultural advisory systems. We help partners structure and improve their service offerings through the incorporation of the latest availability technologies and data as well as insights from behavioral economics and social learning theory. Learning from our different projects, we bring experience on what has worked elsewhere to every engagement and continue to optimize to local contexts using A/B testing and rigorous evaluation.

In India, PADIF now has operations in Gujarat, Karnataka and Odisha, with a farmer reach of roughly 250,000 farmers who receive advice from PADIF through their mobile phones. PADIF maintains a lab setting in Gujarat to use experimental evidence to inform the quality of advice as well as the platforms offered by us. We are pleased to be supporting the Governments' of Odisha and the Coffee Board of India in building, customizing, and evaluating mobile phone-based advisory systems that they own and integrate into their existing extension infrastructure. We are also entering into new projects with the Government of West Bengal and are in conversations for potential collaborations in Punjab and Haryana as well.