



Precision
Agriculture for
Development

2018 Annual Report

**Improving
Livelihoods.**

**Empowering
Millions.**





Dear friends and supporters,

2018 was PAD's third full year of operations and the number of smallholder farmers we reached this year grew to 858,000, a 150% increase over 2017. Moreover, PAD surpassed the one million milestone of total cumulative farmers who have benefitted from our personalized agricultural advisory services since our inception.

Small farmers, who constitute the majority of the world's poor, need and appreciate the timely and accurate agricultural intelligence that PAD provides. This information is critical in the farmers' efforts to grow and sell enough crops to cover their families' basic needs including food, education, health, and shelter, and invest in their future.

In 2018, PAD's advisory content more than doubled and we launched Android apps to complement our Voice and SMS services. PAD also continues to leverage the rapid spread and use of mobile phones to transform the way farmers learn and make decisions about seeds, fertilizers, pests, diseases and new market opportunities.

PAD is close to or on the cutting edge with regards to mass customization in delivering services to farmers in developing countries. Through A/B testing and other rigorous measurement tools we continue to build the evidence and fortify our observations that when clear and culturally appropriate information is delivered to farmers through the appropriate channels, they adapt their practices, leading to yield increases of 7% to 28%.

We are deeply grateful and humbled to have a set of visionary and aligned funders and partners who recognize the necessity and opportunity to bring customized advice to smallholder farming families in developing countries. With you and our continued efforts and ability to attract top talent, reduce our unit costs (from \$5.2 in 2017 to \$3.7 in 2018), and focus on learning and adaptation, we are looking with confidence into the future. We invite you to be part of PAD in 2019.

Heiner Baumann, Managing Director

Shawn Cole, Board Chair



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Helping farmers make informed decisions in the field.

PAD at a glance

Mission and Approach

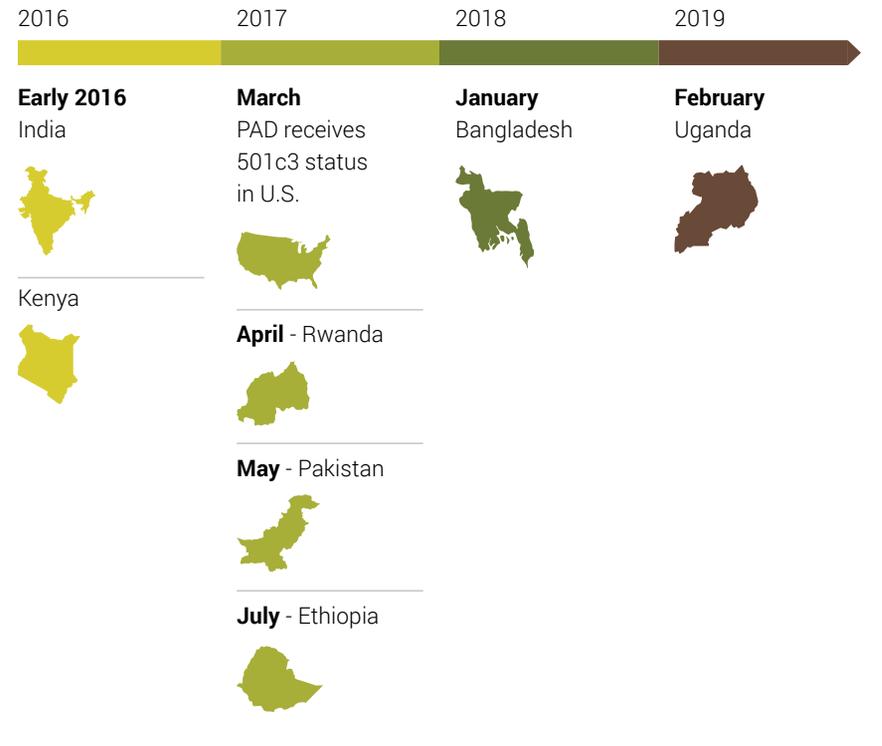
PAD is a non-profit organization with a mission to support smallholder farmers in developing countries by providing customized information and services that increase productivity, profitability, and environmental sustainability.

We collaborate with in-country partners and local governments to reach farmers with mobile-based personalized agricultural advice, gathering evidence on its impact. Using this model, PAD aims to improve the lives of 100 million farmers in developing countries.

Using two-way communication and information aggregation, we offer farmers useful information customized to their geography, market, and farmer characteristics. As farmers realize the benefits of this service, they have incentives to contribute accurate information into the system that continuously improves our recommendations. PAD incorporates insights from behavioral economics and social learning theory, making use of A/B testing and machine learning techniques designed to identify what types of information and delivery mechanisms work best for farmers.

At PAD, *Precision Agriculture* involves using data and technology to empower farmers to better allocate their limited resources onto their farms, and improve farm practices to achieve better yields while reducing poverty and environmental degradation.

Continued Worldwide Demand for PAD Services



ANNUAL FARMER REACH

28,325
Farmers in 2016

345,727
Farmers in 2017

858,221
Farmers in 2018

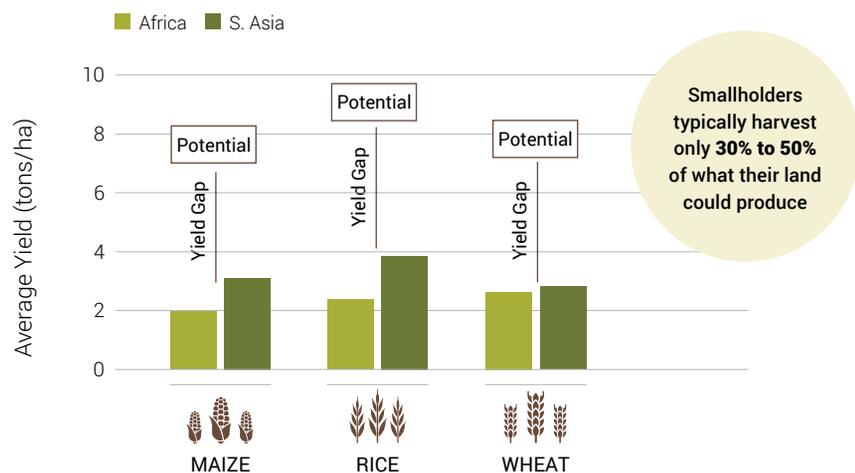
Why PAD? Why Now?

The vast majority of the world's 450 million farmers live in a village setting in a developing country, growing crops to feed their families and still provide enough income to meet their needs. Together with their households, these smallholders represent almost one third of humanity, and two thirds of the world's poor. While they face many challenges, such as small (and shrinking) farm sizes, and limited resources, an immediate and direct cause of their poverty is what is known as the **yield gap**—the difference between potential and actual on-farm production. Smallholders typically harvest only 30% to 50% of what their land could produce—meaning the opportunity to profitably and sustainably increase production, and reduce poverty, is enormous. Yield gaps exist, after all, due to suboptimal farming in quickly changing contexts. Whether it is misapplication of inputs such as fertilizer and pesticides, use of low quality seeds or too much or little water—the *potential* yield of these farms is not reached. Climate change presents an additional, confounding challenge and risk, especially to smallholders relying

primarily on rainfed cultivation. Despite significant budgets spent on over 1 million agricultural extension workers every year, farmers continue to lack the advice they need to close the yield gap and maximize their agricultural net incomes.

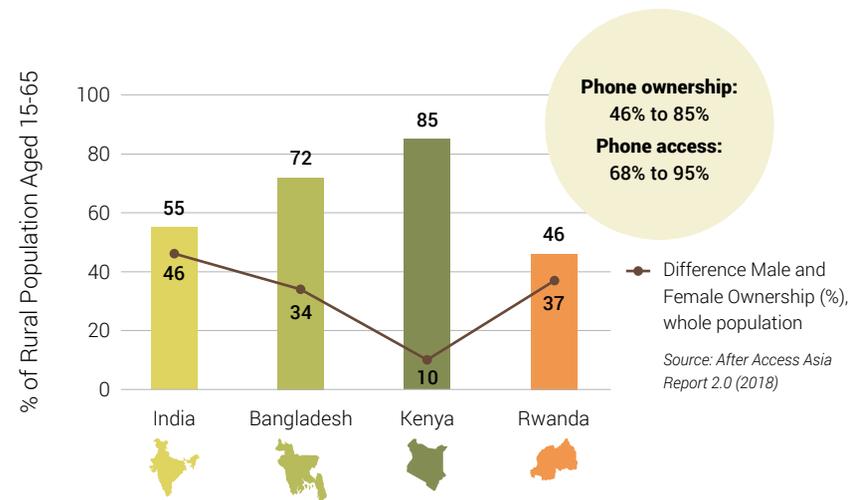
But we are optimistic. Today, the globe is more connected than ever before. The vast majority of people on earth already use mobile phones—including farmers in developing countries. Mobile phone ownership ranges from around 50 to 70% and access to mobile phones is typically 70% to 90%. Men own more phones than women, but women are increasingly starting to catch up. For the first time in history, the majority of smallholder farmers can now benefit from *digital* agricultural advisory services—right in the palm of their hand. PAD leverages this opportunity by empowering farmers to improve their on-farm practices through access to knowledge, inputs and markets that is relevant, customized and affordable.

Average Yields and Yield Gaps in Africa and South Asia



Source: FAOSTAT

Mobile Phone Subscriptions per 100 people in selected Countries



Source: After Access Asia Report 2.0 (2018)

Impact & Learning: Deepening the Evidence Base

PAD was inspired by academic research projects, and a central part of our mission is to explore and document what works (and what does not). This extends well beyond process monitoring and evaluation (which we do). We leverage the power of technology to create continuous, real-time feedback loops, from which we constantly learn, improve, and expand the foundation of evidence upon which others can build. PAD uses a wide spectrum of data, and follows a range of outcomes. We track user engagement and measure impact on farmer behavior, such as input adoption and farming practices. Whenever possible, we make an effort to evaluate the impact on yields, profits, and sometimes even “spillover” effects on neighbors. We share this evidence base and practical knowledge with a broad audience, through policy, practitioner, and academic channels. As PAD grows, a high priority is to conduct coordinated, multi-site evaluations to identify how the effect of interventions varies across countries and settings.

PAD uses various approaches to build a broad knowledge base:

Pilots: initial live tests of concepts or services, which require iteration and refinement. We gauge comprehension and reactions on message design with farmers in the field, observe them navigate our advisory service to identify pain points, and incorporate their requests and suggestions into our design.

A/B Trials: the comparison of two (or more) versions of a service feature or content, assigned randomly, is used to determine which works best. Using big data analytics, we can further identify patterns in the data that will help improve targeting and customization of our messages.

Impact evaluations: most often include measuring the impact of a digital intervention on farmer outcomes of interest at a scale that is large enough to detect impact with statistical power.

PAD Evidence (selected findings) to date

2012-2015	2016-2017	2018	
India	Kenya	Kenya/Rwanda	India
800	2,000+	2000 - 150,000	1500+
cumin, cotton	sugarcane	maize	cotton
+7% cotton yield +28% cumin yield 10:1 benefit-cost	-22% late fertilizer delivery +8% yields	+18% in lime adoption 6:1 benefit-cost	+5% Urea adoption +100% Potash adoption +82% Zinc adoption
			
CUMIN	SUGARCANE	MAIZE	COTTON

The table reports the findings from selected studies that highlight the potential of PAD's approach. To date, PAD and affiliated researchers have conducted 10 rigorous evaluations. Seven show promising impacts on farmer behavior and/or yields, and in two studies, we find insignificant effects but cannot rule out either the possibility that the effect is zero or that it is as large as those of similar studies shown in the table. They demonstrate that PAD's approach can change farmer behavior, improve agricultural outcomes, and lift the lives of millions of smallholder farmers around the world.

Examples of How We Learn

Evidence on Input Adoption in Kenya, Rwanda & India

Six experiments in Kenya and Rwanda and one experiment in India, where PAD designed messages to encourage farmers to adopt agricultural lime and specific fertilizers, all find significant increases in the likelihood of adopting recommended inputs. In Kenya and Rwanda, the results are overwhelmingly positive—all of the SMS campaigns designed by PAD were found to increase input adoption by 10-20%, while an evaluation of the SMS campaign on lime adoption created by a separate third party organization showed no impact. In India, where less common fertilizers (MoP and zinc) were promoted, much higher increases (by 100 to 200%) were observed.



A/B Trial on User Preferences in Gujarat, India

To better understand the preferences of users, the PAD India team conducted an A/B trial to determine the impact of variations in the weekly push call service containing agronomic advice on farmer pick-up and listening rates. The pick-up rate is the share of push calls answered, whereas the listening rate is the share of content heard by farmers—given that they can hang up prior to the end of the call. Users were divided into 3 groups: Group 1 received one 2-minute call per week; Group 2 received two 1-minute calls, and Group 3 was given the option to choose. The farmers given the option to choose (Group 3) not only answered the calls at a higher rate than Group 1 (88% vs. 80%), but also listened to a higher share of the agricultural content provided (39% vs. 30%).



Gender Research in India

Women face specific challenges in accessing and acting upon agricultural information. In many of PAD's initiatives, women are less likely to have graduated from secondary school, to own a phone, and to have a bank account. As a result, women face many barriers to accessing and benefiting from digital agricultural advice. To address these, PAD India is forming a strategy that includes: i) developing women-oriented content (such as by recording messages with female narrators), ii) leveraging existing social architectures and networks to register, train, and engage women, and iii) encouraging men to engage women in accessing information via household phones.





INITIATIVE HIGHLIGHTS

India: The Karnataka Coffee Initiative

Focus Crop: Coffee

Total Reach: 10,000 farmers

Key Partner: Coffee Board of India



The Coffee value chain is the most lucrative of all crops, worth over \$100 billion.

In India, the 7th largest producer in the world, the coffee bean has been grown for over 300 years. Of the roughly 300,000 coffee growers, over 70% live in Karnataka, a southern state known for its lush, tropical hillsides. Indian coffee is known to be particularly eco-friendly since its shade-grown cultivation is with a minimal environmental footprint, supporting a rich biodiversity across the 16 agro-climatic zones in which it is grown.

The Coffee Board of India, a central government body responsible for protecting and promoting the valuable industry across the country, has asked PAD to pilot an agronomic advisory service for 15,000 farmers in Karnataka. They are interested in boosting the reach and efficacy of extension services to coffee growers, which currently reach only 1 out of 4 growers.

PAD has set up a pilot project in the districts of Chikmagalur and Hassan in Karnataka starting July 2018. As of December 2018, 10,000 coffee growers are registered on PAD's two-way voice-based service (on track to meet the target of 15,000 growers by March 2019). Roughly 80% of these growers are small and marginal coffee growers.

In High Demand

Every week, farmers receive a recorded voice call with a 2-minute advisory message through PAD's Krishi Tarang service. The advisory content targets both robusta and arabica farmers, as well as provides customized information to those who manage coffee nurseries separately. On average, 80% of farmers pick-up the phone to listen to these weekly advisory messages. Listening rates (conditional on pick-up) are roughly 70%. In addition, farmers can also give a missed call at any time and ask a question answered by our coffee experts, or listen to daily updated information on prices from local markets as well as international coffee prices (since over 70% of Indian coffee is meant for exports, this is a valuable data point for coffee farmers). Since July 2018, the service has received over 13,000 inbound calls with coffee experts answering roughly 1,600 unique questions.

By the Numbers:

10,000

coffee growers registered on PAD's two-way voice-based service

>80%

pick-up rate throughout the season for weekly outbound advisory messages

91%

would recommend the service to friends/family

83%

adopted a recommendation from the service

28%

increase in farmers' knowledge score across 6 recommended practices

56%

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

Exploring Revenue Models

Early feedback from the pilot has been very encouraging: high referral rates, stated adoption of recommendations, and usage of market information. At the end of the pilot, PAD explored the potential for revenue generation by conducting a randomized price lottery with growers across 3 villages in Karnataka. On average, 56% of farmers paid cash to extend the service for another year. At scale, even if only 50% of farmers would be willing to pay for customized, mobile phone-based information, this represents a tremendous opportunity for building a financially sustainable platform for information dissemination. As a next step, PAD hopes to systematically test various models for financing the further refinement and scale-up of the initiative.



"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 learned 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."

Mallesh Gowda

Chikmagalur District, Thiruguna Village

Kenya: Controlling the Fall Armyworm Epidemic via SMS

Focus Crop: Maize

Total Reach: 140,000 farmers

Key Partners:

- Ministry of Agriculture
- Centre for Agriculture and Bioscience International (CABI)
- Safaricom Kenya



The Fall Armyworm (FAW) represents a new and complex emergency on the African continent.

It is a destructive, fast-moving pest that feeds on Africa's main food staple crops. In only 2 years since its migration onto the continent from the Americas, it has invaded every African country and was expected to cause \$3 billion in crop damage in 2018 year alone, with an additional \$13 billion of crops at risk. Kenya's 6 million small-scale farmers are especially at high risk. Because FAW attacks major staple crops, including maize, sorghum and millet, it threatens the food security of millions of Kenyans, 200 million Africans, and has now reached India.

To address this growing threat, PAD has developed the 'MoA-INFO' platform which provides farmers with an interactive, two-way SMS service that both disseminates and collects information about FAW. We have developed advisory content with the Kenyan Ministry of Agriculture and Irrigation (MoAI), the Centre for Agriculture and Bioscience International (CABI), and various other stakeholders. The service allows farmers to receive free recommendations about FAW to help them manage the pest in their fields and limit crop damage.

Success Factors:

Strong Partners Through an impressive campaign conducted by Safaricom, Kenya's largest mobile network, the platform has reached over 140,000 active users in its first 6 months of operation.

2-Way Interactions Beyond simply receiving information, farmers can also use a simple SMS tool to measure and report the level of FAW infestation in their field and take appropriate actions based on the assessment result. This monitoring tool has been completed by 12,667 (8%) platform users, and provides interesting insights:



Observed FAW on their farm



Of those who observed FAW, used a natural treatment"



report using pesticides



report doing both



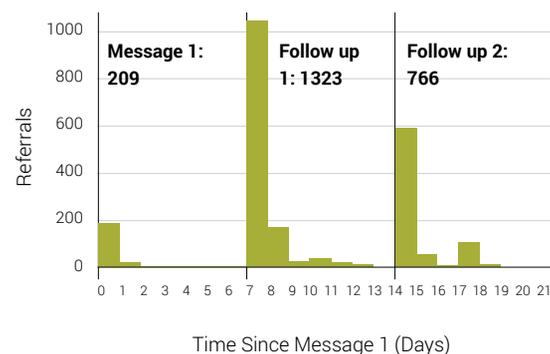
report doing neither

Farmer-Focused Adapting the service to include user name and customizing to the specifics of their location and crop calendar gives farmers a more focused and personalized experience.

Following Up We found positive responses when farmers were reminded about our service. This was especially true when asking farmers to recommend the service to their friends.

Media Coverage The MOA-INFO service was covered across multiple media, including: Standard News, Kenya Broadcasting Corporation, The Star, The People and Smart Farmer Magazine.

The importance of following up



Referrals increased significantly after reminder messages were sent.

"The messages from MOA-INFO have given me instructions that have helped me to increase my yields. Before I started receiving these messages I did not know how to deal with FAW, but now I know what chemicals to apply and I have managed to invite over 20 farmers to the platform. Even if we do not have money to buy pesticides we can use pepper, ash and sand."

Javan Akwabi Waliaro



"I thought these were normal worms, but when I started getting SMS about how to manage them I realized that these were dangerous and I started following the instructions."

Kassim Oduor

INITIATIVE HIGHLIGHTS

Odisha, India: Improving Rice Production

Focus Crop: Rice

Total Reach: >100,000 farmers

Key Partners:

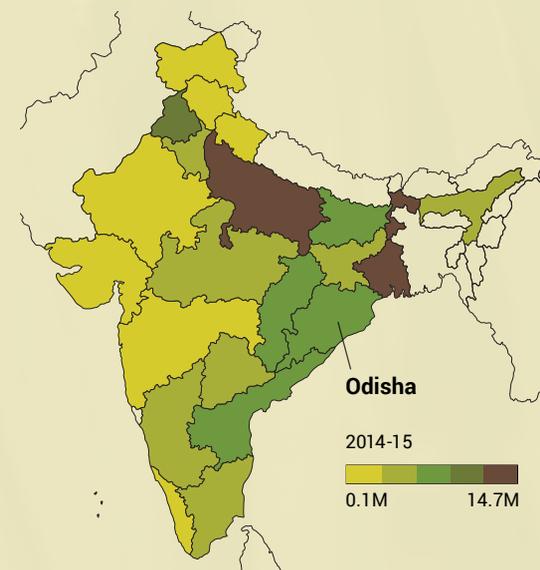
- State Government of Odisha, Department of Agriculture and Farmer Empowerment (AFE)
- Bill & Melinda Gates Foundation (BMGF)



India has the largest area of any country under rice cultivation, and grows 20% of all rice produced in the world.

In the state of Odisha, rice is synonymous with food. It accounts for 69% of the cultivated area, and is an important food and income source for millions of farmers. Yet the region's average yield is roughly 35% less than the national average, and over **5 times less** than potential. Average fertilizer application rates in the state of 61 kg / hectare, while 70 times greater than in 1960, are still less than half of recommended rates.

Rice production in India (million tons)



By breaking down the 7,600 questions asked by farmers, we may see what is most important to them:



Rice Paddy -
pests and
disease

“Why are my paddy seedlings becoming white and how can I control this?”



Rice Paddy -
fertilizers

“I have grown black gram and the variety is Shekhar-2. Please tell me how much and which fertilizers I should apply.”



Other

“My groundnut crop is drying up, 30 days after sowing. What should I do?”



Partnering with Government

With support from the BMGF, PAD has developed a strong partnership with the State Government of Odisha to develop an agricultural advisory platform for the state’s 5 million rice paddy farmers. Odisha government has approved \$2.5 million to build the system and ensure the long-term sustainability of the service, and set the ambitious goal of reaching at least 1 million farmers by 2021. PAD’s first step was to set up a call center with roughly 100 operators who profile, train and collect feedback from farmers. The two-way voice-based communication service consists of regular push calls sent weekly to farmers, and an interactive voice response (IVR) hotline that farmers can use to ask questions and listen to previous push calls and announcements, and share their own experiences

with the service. This two-way service also acts as an early warning system with feedback loops for iteration.

Expanding Reach

This service is available in 28 districts and has reached over **100,000 farmers**. This year, the outbound service had an overall pickup rate of 78%, a listening rate of 66% (conditional on initial pickup), with 49% of calls listened to in their entirety by the farmer. For the inbound service, ~29,000 unique callers had placed a total of ~67,000 inbound calls, with an average call duration of ~3.5 minutes. For the majority of these calls, the farmer did not ask a question but rather used the IVR hotline to listen to frequently answered questions, previously recorded push messages or to access other functions.

“The training we received from PAD was very good, we remember how to record questions using our phones. I have recorded two questions about my rose flowers and my papaya plant. I asked: “What should I do to make rose flower bloom, and increase its size?” and “What is the reason that my papaya plant is small?” My questions were answered at the right time and the information was useful. I will make sure to follow the advice I received.”

Kanchanbala Nanda
President of SHG, Miteipur village



Pakistan: Working with Changes in Government

Focus: Soil Health

Projected 2019 Reach: 100,000 farmers

Key Partners:

- Governor of Punjab
- Minister of Agriculture



Through the recent political transitions in Pakistan, PAD's reputation and initiatives remain intact

PAD has been working with the Government of Punjab in Pakistan since 2017 to implement “Extension 2.0”—an initiative to redesign their Soil Health Cards and provide a digital advisory service to improve comprehension of the soil health cards.

In 2018, however, we faced significant challenges due to a major change in the local political environment—election year and change of government. In June, the incumbents stepped down to allow a caretaker government to take its place and hold general elections. By design, the caretaker government tried to avoid implementing any new initiatives and tended to adopt a holding pattern. This meant that our plan to begin piloting SHC distribution in June was frozen. When elections were finally concluded in August, a new central and local government was elected into office. There was then a drawn-out transition process, coinciding with a severe fiscal and economic crisis nationwide.

Surviving Transition

During this period, a policy of fiscal austerity was put in place with development expenditures cut by 66% and a moratorium on new expenditures and projects. This directly threatened our SHC and IVR service since it was primarily funded by the previous government.



Soil Health Card: Redesigned to account for government changes, which improved farmer comprehension from 8% to 82%.

However, we were able to justify the value of the initiative and demonstrate the considerable spade work that the government and PAD had already put in. As a result, the Extension 2.0 initiative funding was not cut, and has survived a drastic political transition.

New Government, New Proponents

The key to the turning point for our fortunes with the new government was finding champions in the Government who believed in the work we are doing. The secretary for Agriculture, Dr. Wasif Khurshid, and the minister for Agriculture in Punjab, Mr. Malik Nauman Ahmad Langrial, became ardent supporters once they were briefed

on all aspects of the project and in particular the work that PAD had done for the Punjab government. During a high-level meeting in January, we were able to secure a firm commitment from them about rolling out SHC distribution as a pilot in 3 districts in Punjab.

Furthermore, because of our history of collaboration with the Punjab Government, PAD also attracted interest from the Government of Balochistan (Pakistan's most remote and underserved province). In Balochistan we are in the process of finalizing an MOU for helping set up an IVR- and SMS-based advisory system for 100,000 farmers in 10 districts of Balochistan. More recently, the Prime Minister's Reform Team (PMRT) asked PAD to put together a concept note highlighting our vision. This exciting development may allow us to embed our farmer-centric philosophy into the bedrock of national agriculture policy, and illustrates the importance of perseverance through transitions.

With 5.2 million

smallholder farmers in Punjab and only **2,800 Department of Agriculture Field Assistant staff**, the in-person support each farmer can get is very limited. The potential for outreach to smallholder farmers using **ICT based services** is enormous.



"PAD has been playing a critical role as a partner for the Department Of Agriculture's flagship program Extension Services 2.0. They are helping us to deliver timely, accurate and viable advisory to farmers so that the goals associated with crop diversity and productivity can be met. PAD is at the forefront for devising effective and efficient communication models and the Soil Health Card initiative is heading to become a big success story."

Sharjeel Murtaza

Project Director, DoA, Government of Punjab



Bangladesh: Partnering with Successful Organizations

Focus Crop: Potato, Mung Bean, Rice, Chili, Watermelon

Total Reach: ~10,000 farmers

Key Partners:

- mPower



Improving the performance of the agricultural sector in Bangladesh can be a major driver of poverty reduction.

With more than two-thirds of Bangladeshis directly employed in agriculture and 87% of rural households relying on agriculture for at least a part of their income, Bangladesh is a high-potential country for PAD's model of digital agricultural extension. Beginning in 2018, PAD has partnered with mPower, a Bangladesh-based social enterprise, to enhance the effectiveness of two of their flagship agriculture products, Agriculture 360 and GeoPotato. PAD is using its unique data-driven approach to design and run A/B test experiments to compare the efficacy of different product design features and help mPower maximize the impact of these two products.

60%

potential potato yield losses due to late blight

87%

of rural households rely on agriculture for at least part of their incomes

Improving Agriculture 360

Agriculture 360 is a SMS- and voice-based service providing timely and customized agricultural recommendations to farmers. A major finding from early scoping work was that some farmers prefer SMS messages so they have a written message that can be discussed with other farmers or agrodealers, while other farmers prefer voice messages to overcome literacy barriers. Based on these findings, PAD designed and implemented a series of A/B tests to determine whether adding voice messages to the existing SMS service could expand the reach and impact of the Agriculture 360 service.

We first tested this hypothesis during the summer 2018 season with 2,199 rice and chili farmers, but this experiment did not show conclusive results, likely due to the limited number of farmers. To investigate this question further, we are conducting a second experiment in the winter 2018-2019 season with 8,320 mung bean and watermelon farmers, with an additional component to test

if voice messages in regional dialects are more effective than messages in standard Bangla—the country’s main language and often the 2nd language of farmers in the study.

Product Branding & GeoPotato

GeoPotato is a geodata-driven decision support service (DSS) that uses data from remote weather stations to predict outbreaks of late blight, a fungal infection that damages potato crops. GeoPotato sends SMS alerts to farmers warning them of potential outbreaks and encourages timely application of fungicide to reduce crop damage. For the 2018-2019 potato growing season, PAD and mPower partnered with Bayer, a global agricultural input supply company, to explore the impact of product branding in advisory messages, with the goal of developing a commercial version of the GeoPotato service that could benefit both farmers and private companies. PAD helped mPower design and implement an experiment to test the effects of branding on farmers’ trust in the service and uptake of GeoPotato recommendations.



“In a country like Bangladesh, agricultural technologies take a lot of time to reach the fields of smallholder farmers. At mPower, we’re trying to use the power of mobile phones to reduce the time. PAD helps us evaluate the effect our services have on farmers. We highly value PAD’s contribution to our service as now we know better what actually works and where are the opportunities.”

Shah Mushfiq Rahma

Director of e-Agriculture,
mPower Social Enterprises Ltd



Mung Beans



Rice



Chili



Watermelon



Ethiopia: Getting Timely Agricultural Content to Farmers

Focus Crop: Tef, Barley, Maize and others

Total Reach: 287,500 farmers

Key Partner:

- Agricultural Transformation Agency (ATA)



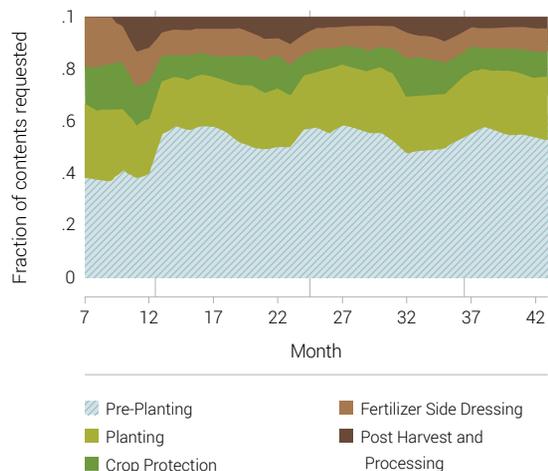
Since 2014, the Ethiopian Agricultural Transformation Agency (ATA) has been using a government-run interactive voice response (IVR) platform to provide farmers with agricultural advisory information on 21 high priority crops such as maize, barley, and tef.

This 'Farmers' Hotline' service has reached close to 4 million farmers, with an average of roughly 130,000 callers per month in 2018. PAD has been assisting the ATA with improving the Farmers' Hotline since 2017, digging deeply into how farmers use the service and identifying ways to improve it. One of the most critical needs for any agricultural advisory service is to get the right content to farmers at the right time.

Identifying the issue

During PAD's assessment of the Farmers' Hotline, we found that 60% of all content accessed was related to one of the five stages of the cropping cycle—pre-planting—and that this was consistent across all months of the year (see figure on next page). In our farmer focus group discussions, we found no explanation of why they would prefer pre-planting over other topics. However, pre-planting corresponds to users pressing 1 in the cropping stage menu, and other menus produced similarly lopsided distributions in favor of option 1.

Farmer calls into ATA System – Topics chosen by months



Digging Deeper with A/B Trials

So to test the hypothesis that many users were selecting option 1 by default, we designed an A/B trial that rotated the menu options seasonally so that option 1 always corresponded to the current stage of the cropping cycle. The results were impressive—instead of 60% of farmers selecting pre-planting, users selected the most relevant content 60% of the time throughout the season.

However, these results did not change the fact that farmers still disproportionately selected 1, and did not answer the question of why farmers disproportionately select 1. We considered the hypotheses that farmers have too many options and can't decide between them, or that they don't

understand how to use an automated menu to select from a set of options. However, the evidence for these hypotheses is weak given that there are many more options in the crop menu (ATA's hotline includes 21 crops) and yet content by crop is much more evenly distributed.

Our next hypothesis is that farmers don't understand the names of the stages of the cropping cycle, or they don't understand which topics fall into each stage. Our next step is to test this hypothesis with a new A/B trial in 2019 testing the impact of creating clearer names for each stage of the cropping cycle and reorganizing the content into a more intuitive structure of which topics fall into each stage. This is similar to other work PAD did in 2018 to help ATA simplify the content for 14 of the 21 crops in the Farmers' Hotline to improve user comprehension.

The Importance of Organizing Information

In conclusion, while one of the strengths of ATA's Farmers' Hotline is its breadth of information, it is possible that too much information may become overwhelming to farmers if they aren't able to access the right content at the right time. To test this theory, PAD and ATA will implement a new A/B trial to test the impact of bypassing the cropping stage menu and taking users to the most relevant stage of the cycle by default, while still making all content available if users want it.





“The future of extension is digital.”

Nady El-Shal, Lead of Extension Efforts for 1AF in Rwanda

Top: A happy farmer takes home six free seedlings of *Grevillea robusta* to plant on his farm.

Bottom: As the trees arrive for distribution, this farmer looks forward to planting *Grevillea robusta* on her farm.



INITIATIVE HIGHLIGHTS

Rwanda: Promoting Adoption of Agroforestry

Focus Crop: Agroforestry Trees

Total Reach: 2,292 farmers

Key Partner:

- One Acre Fund (1AF)
- Rwanda Agricultural Board (RAB)

Edible crops are not the only important species in agriculture.

In Rwanda, the country's agricultural board, in partnership with the 1AF, has been running a unique campaign to distribute **6.3 million** trees across the country to encourage farmers to practice agroforestry—the intentional intercropping of food crops with tree varieties. Trees are important to any environment in combating global warming and promoting biodiversity. But they also have specific benefits for smallholder farmers: they reduce soil erosion and can provide fodder to livestock, raw material for fuel or construction, and cash for covering financial needs. Some varieties even reduce total nitrogen fertilizer requirements by fixing nitrogen from the air into the soil.

1AF, a local NGO active across East Africa, asked PAD to help them integrate an SMS messaging campaign to complement this tree distribution campaign. The initial intervention was designed to encourage farm promoters (FPs)—volunteer extension workers—to register farmers in their villages to sign up to receive trees. The idea was to randomly alter various messaging treatments and measure their efficacy at encouraging FPs to meet their target number of farmers registering for 8-10 free trees during the campaign.

Preliminary analysis suggests the intervention increased the number of farmers who arrived to receive trees as well as the share of farmer promoters who met their target number of farmers. These results are exciting, however tentative, since they highlight the potential of digital interventions in cost-effectively improving the impact of traditional extension services. They provide further evidence that efficiency gains can be captured by collecting real-time information through mobile phones and feeding that information back into the system—for example by sending more trees to jurisdictions where farmer promoters were exceeding their targets.

INITIATIVE HIGHLIGHTS

Gujarat, India: Designing Customized Advice

Focus Crop: Cotton

Total Reach: 1,500 farmers

Key Partner:

- Agricultural Technology Adoption Initiative

No two farms, and no two farmers, are the same.

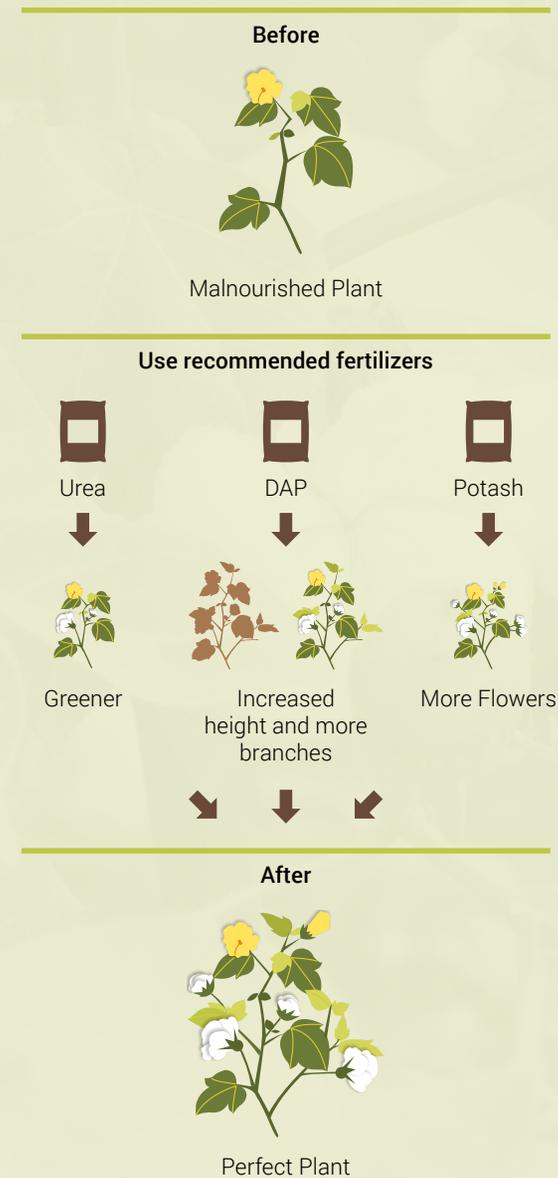
In Gujarat, India, PAD has been focusing on ways to provide better, more localized advice to farmers using something they all have in common: the soil. Information about the soil—its pH and chemical composition—can help determine optimal lime and fertilizer applications, and yet most farmers know very little about their soils. As a result, fertilizer applications are not pinned precisely to what is needed, and often a one-size-fits-all fertilizer regime is promoted by extension services that results in over- or under- application. At the same time, a large knowledge gap exists among farmers.

To help solve this, the Government of India developed Soil Health Cards—one page summaries of farm-level soil tests to help farmers understand their fertilizer targets. However, many farmers face challenges interpreting these, and translating them into practice.

This is why PAD has begun to develop a digital communication strategy and to redesign the SHCs: to better enable farmers to understand the current health of their soils, and apply appropriate fertilizer amounts. We conducted a randomized experiment among about 1,500 cotton farmers, with about half of the farmers receiving customized messages based on their Soil Health Card results, and the other half serving as control.

Preliminary analysis suggests that customized advice increased adoption of recommended fertilizers by 3-12 percentage points during the sowing period, leading to a significant reduction in the fertilizer gap—the difference between recommended and actual fertilizer applications.

This pictograph was developed to help farmers understand the results of their Soil Health Cards, and put them into practice.



Moving Beyond Voice & Text

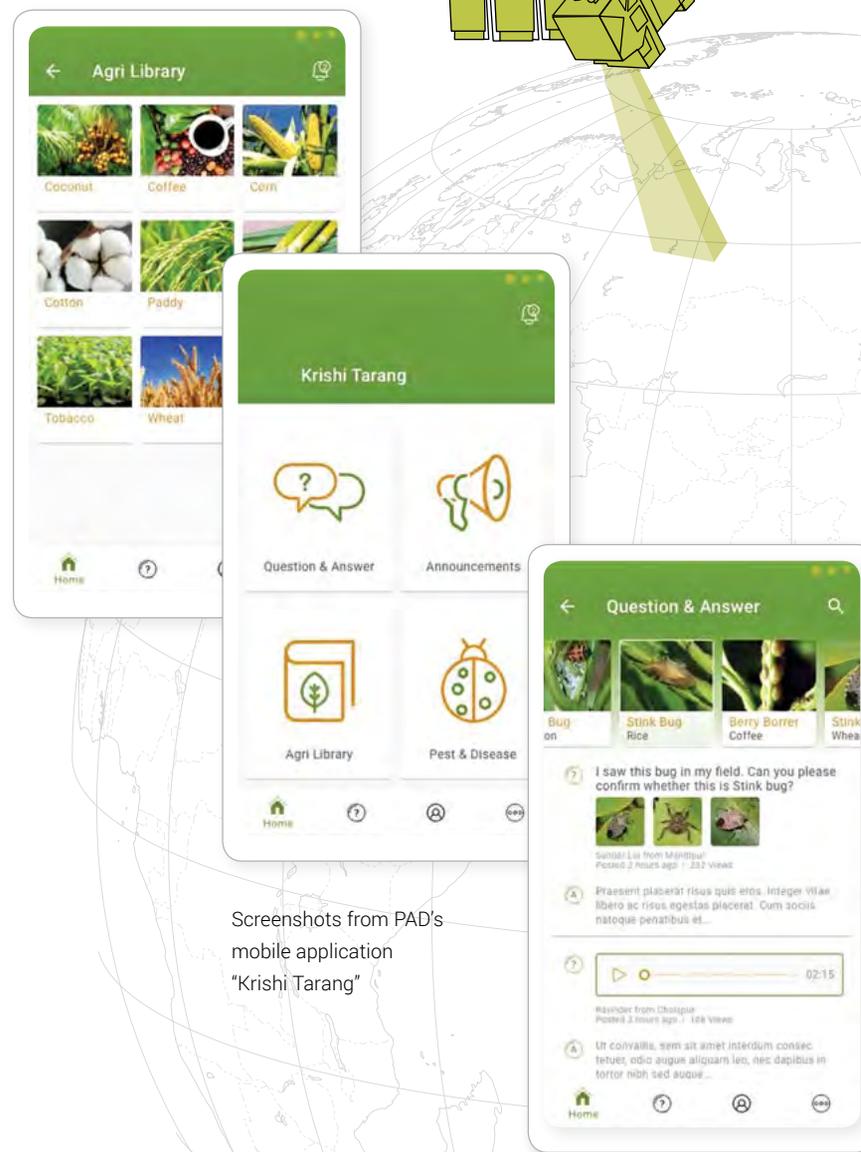
In the first two years of the organization, PAD's technological focus has been on two simple tools designed to work on most "farmer-owned phones: SMS messaging, outbound voice calls, and interactive voice response (IVR). Beyond simply a Virtual Receptionist ('Press 1 for Sales'), IVR adds an automation component to enable users to input into the system and instantly receive pre-recorded or dynamically generated content. Both platforms enable digital content to be delivered effectively at scale to the world's poorest farmers. Yet, they have their own limitations, and as more and more farmers gain access to internet connectivity through smart phones, the opportunity to provide more advanced capabilities will only increase.

Mobile Applications

A recent survey indicates that roughly 1 in 5 farmers in Gujarat have access to a smartphone. Yet, as India is one of the fastest growing mobile phone markets in the world, these numbers are expected to change rapidly. In late 2018, PAD developed and launched the "Krishi Tarang" Android Application for more connected farmers. It mirrors the content available through the Push call and IVR Hotline service, and adds more features to the service. These include a searchable Library of Agronomic Content, Record-a-Question, and an Interactive FAQ. To date, there are now over 2,000 users of the KT App—most of them obtained through organic marketing channels.

WhatsApp

The benefits of using WhatsApp include ultimately reducing the cost per message to zero and enabling access to expanded features, including voice.

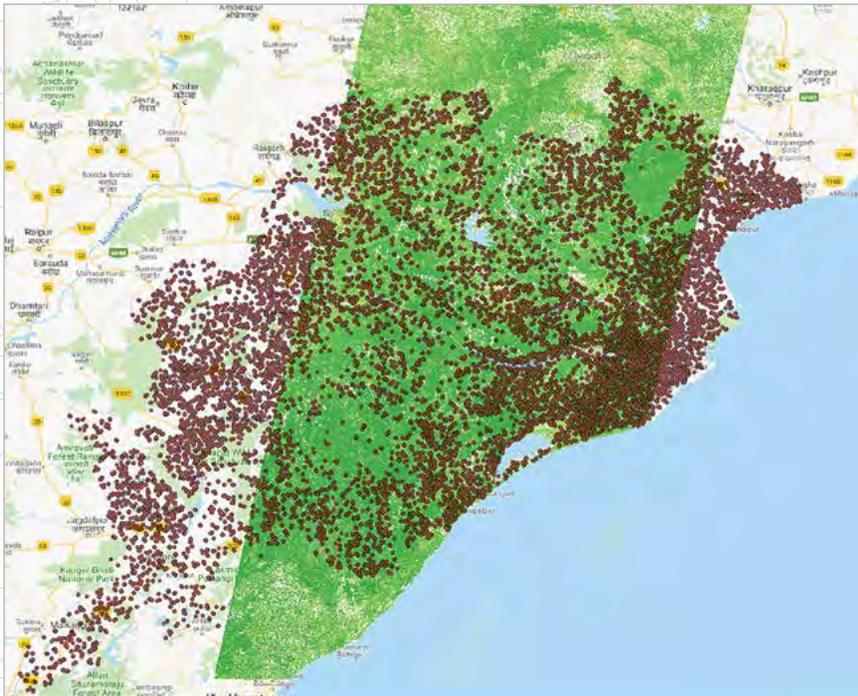


Screenshots from PAD's mobile application "Krishi Tarang"

Satellite Imagery

Satellites provide the unique ability to capture data efficiently and at a large scale through time. For individual farmers, high resolution satellite imagery is useful for experimentation because it allows for the measurement of impact in new ways, such as by estimating yields through remotely-sensed information. This approach offers two potential benefits: 1) measurements are thought to be more accurate than farmer-reported values, and 2) measurements from the previous season are also available, which helps to estimate treatment effects

A View from Above: Estimating Yields with Satellite



NDVI vegetation index (Green area) derived from the European Space Agency's Sentinel 2 Satellite and crop cut locations (Brown dots) where yield measurements have been made

with greater accuracy. The downside, at least in the near future, is that it may be expensive to scale this for actual operations, since current models and technology are not very accurate, and all satellite data needs to be ground-truthed to data from individual plots, which requires high effort and costs. Solving this problem, however, is a high priority among development researchers, and we may expect considerable progress in the coming years.

In India, for example, PAD is mapping the boundaries of about 1,500 cotton plots in order to calibrate a model derived from satellite imagery to estimate yields. In addition, once we have the plot boundaries mapped we can continue to monitor the sample at close to cost which allows us to continue the experiment without devoting a substantial amount of money to it.

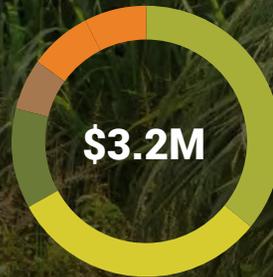
On the other hand, regional-level data, while less interesting for experiments, can inform agronomic advice that we give to farmers. For example, the figure on the left shows the annual variation in the NDVI—an indication of vegetative growth—in one area of Kenya since the year 2000, along with farmer-reported planting dates. What's most impressive about data obtained through satellite is the breadth of insights that can be made. The two rainy seasons are clearly shown as the NDVI increases, and as the season progresses, vegetative growth slows. We also see the duration of the seasons, when they start, how they change over time, and whether they are consistent from year to year. This same figure may look very different for different regions, which has important implications for agronomy—some seed varieties, for example, are better suited to longer rainy seasons, and others are more resistant to drought. This all relates directly to agronomic advice—and PAD is looking forward to digging deeper into the possibilities of remotely sensed data in the years ahead.



PAD spending

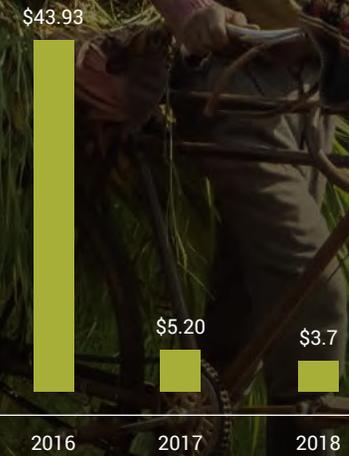


2018 expenses



East Africa	36%
India	31%
Ethiopia	12%
Pakistan, Bangladesh and Emerging Programs	6%
Total Programs	85%
Administration and Fundraising	15%

Unit cost per farmer



Financials



2016

Anonymous (2)
Agricultural Technology
Adoption Initiative
Unorthodox Philanthropy

2017

Anonymous (3)
Agricultural Technology Adoption Initiative
Benckiser Stiftung Zukunft
Bill and Melinda Gates Foundation
Dioraphte Foundation
Horace W. Goldsmith Foundation
IDB Invest
Jasmine Social Investments
Mary Eliot Jackson
Mulago Foundation
Unorthodox Philanthropy

2018

Anonymous (4)
Agricultural Technology Adoption Initiative
Benckiser Stiftung Zukunft
Bill and Melinda Gates Foundation
David Weekley Family Foundation
Dioraphte Foundation
Ethiopian Agricultural Transformation
Association
Horace W. Goldsmith Foundation
Jasmine Social Investments
Mary Eliot Jackson
Mulago Foundation
Sall Family Foundation

The entire Mulago team is excited about the scalability of mobile phone-based advisory and PAD's specific focus on understanding what works and using this knowledge to build and improve mobile-based extension systems.

Sarah Myers, Investment Principal,
Mulago Foundation

Sarah Myers from Mulago Foundation conducting due diligence on PAD in the Tigray region of Ethiopia, June 2018

Funders

People Driving Change

The PAD team consists of roughly 150 staff from more than a dozen nations, united by a passion for empowering smallholder farmers through mobile phone-based advisory services. Our backgrounds are in Research, Program Design and Implementation, Data Science, Technology, Operations and Communications.



Boston, USA (Global)

“What attracted me to PAD was its grand vision to achieve scale, rigor, and impact all at once. Our work is ambitious, complex, and very dynamic. I love that I get to look at large data, think about methods, and read about new research. I get to spend my day brainstorming with teams on research ideas or day-to-day challenges, and explore synergies with organizations doing intriguing work. I also get to observe and interact with farmers we serve while taking in the incredible growth and achievement of our teams on the ground.”

Tomoko Harigaya

PhD, Harvard University, Senior Researcher, PAD



Addis Ababa, Ethiopia

“I have been working for research organizations for years and, I was looking for an organization that values research findings and implements promising ones. After joining PAD, I find it as a unique organization in terms of getting the right balance between research, experimentation, and implementation.”

Habtamu Yesigat

PhD, Technical University Munich
Senior Research and Operations Manager, PAD



Nairobi, Kenya

“Growing up in rural Kenya with my parents being perennial farmers, I have a strong understanding of the challenges farmers face and the opportunities they lose due to a lack of information. I love being a part of a team that provides high quality farming information right into the farmers’ hand via mobile phones. As an organization, PAD has a unique composition of talented staff, we learn from each other and grow as team towards our vision.”

Carol Nekesa

MPA, Harvard University
Director of Kenya Operations, PAD



Please meet more of our staff at
precisionag.org/who-we-are/our-team



Lahore, Pakistan

"I come from a farmer family. As a child I saw stark disparities among neighboring households and even more disparities in agricultural productivity across villages. This awoke intellectual curiosity, often trying to help my father increase agricultural productivity. Now, a mathematician by training, I work on developing push call scripts for cotton and oilseed farmers, focused on developing human centered design to increase comprehension among smallholder farmers."

Bakhtawar Ali

MS, Applied Statistics University of Punjab
Research Assistant, PAD



Ahmedabad, India

"As someone whose father was also a cotton farmer struggling to find good information and make informed decisions, it gives me immense joy to be leading content delivery for an organization that focuses on improving farmer livelihoods through technology across different geographies."

Tarun Pokiya

MSc, Junagadh Agricultural University
Lead Agronomist, PAD



Bhubaneswar, India

"I do farmer profiling at PAD. I speak with around 50 farmers everyday. This has been an excellent learning opportunity for me and I feel more confident within. I feel proud of being associated with PAD by contributing in improving lives of thousands of farmers in Odisha."

Laxmipriya Behera

Call Center Surveyor, PAD



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Development

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