Precision Agriculture for Development

March 5, 2020

Outline

- **Review of Evidence**
- Cost of PAD's Programs
- Scale-Up of PAD's Programs
- Moving Forward: High Impact Opportunities

Review: Benefit-Cost Ratio of Digital Extension (Kenya/Rwanda)

Calculate BCR using the following data:

- **Observed impact estimate** of the SMS campaign on lime adoption
- **Agronomic evidence** on the impact of lime on maize yields in Western Kenya
  - Two trials run by One Acre Fund
  - Two other trials conducted by scientists
- **Available data from the literature and local data sources** on production cost, maize prices
- **Marginal cost of the program**

Benefit-cost ratio (BCR) estimated to be ~9:1

- Many assumptions to extrapolate the impact estimate on input adoption to yield increase. Ongoing work to refine this calculation.

R. Fabregas, M. Kremer, M. Lowes, R. On, G. Zane,"SMS-extension and Farmer Behavior: Lessons from Six RCTs in East Africa," Working paper (2019)

Review: Benefit-Cost Ratio of Digital Extension (India)

Benefit-cost ratio (BCR) reported in the study: 5:1 -11:1

BCR of ~32:1 with the current cost per farmer per year in India

- Program impact over 2 years
  - Revenue: +$151-279
  - Cost of production: +$50
  - Profits: $101-$229
- Program cost:
  - >$10 per farmer per year in 2012-2013
  - ~$3.41 per farmer per year in 2019 (Marginal cost of $0.60 per farmer per year)

Caveats

- Impact estimates on profits are imprecisely estimated
- The estimates are based on the most intensive digital advisory treatment arm

S. Cole & N. Fernando, "'Mobile'izing Agricultural Advice: Technology Adoption, Diffusion and Sustainability," Working paper (2018)

True impacts likely to be larger and increase over time

Spillover effects

- SMS campaign to promote the adoption of agricultural lime: 10% increase in the purchase of lime among untreated farmers in treated farmer groups (main treatment effect: 19%)
- IVR-based advisory service for cotton farmers: 27% reduction in output loss due to pest attack among untreated farmers living near treated farmers

Improve intervention design through A/B tests

- Tweak system and message designs and compare service usage
- Findings from one setting inform design and further experimentation in other locations

New technologies

- Improve customization using remote sensing data, advanced weather forecasting models, etc.
- Smartphone apps, WhatsApp, etc.

How we interpret this evidence

- Mobile phones are an extremely effective way of getting information to people cheaply at scale
- Users engage with these digital extension services, they adopt recommended practices, and this can lead to yield and income increases
- Rate of return is very high in both "high touch" and "light touch" types of programs (9:1 to 11:1)
- Based on this evidence, PAD is working to scale up these services, and to replicate similar services in other settings

Impacts vary across programs

- **Variation in intensiveness of PAD's programs**

- **"Light Touch" Programs**
  - PAD identifies a set of potential topics, conducts research to test and refine them, and then continues those that are proven to be effective…
    - E.g. lime, fall armyworm, and biofortified beans in Kenya
  - …and discontinues those that aren't
    - E.g. customized soil nutrient advisory had no detectable impact on cotton yields in India
  - More research ongoing to continue to identify and scale up effective "light touch" interventions

- **"High Touch" Programs**
  - PAD provides a comprehensive package of agronomic recommendations based on the best available science for a particular crop and setting
  - E.g. collaboration with International Rice Research Institute on rice in India
  - "High touch" programs are the accumulation of several "light touch" interventions

Impacts vary across programs

- **Variation in content delivered (crops, farming practices, agro-ecological zone, etc.)**

- **We are delivering "pills" - i.e. proven pieces of agronomic information - not creating new "pills"**
  - Lime: Agronomic trials have shown that lime can result in yield increases up to 20%
  - Hybrid seeds: Have been shown to significantly increase yields and reduce the risk of pest and disease damage
  - Fertilizer: Appropriate use can increase yields by 48% among maize farmers in Kenya
  - Pest, disease, and weed management: In irrigated areas, can increase yields by 25%
  - Reduced or zero-tillage: These and other resource-conserving practices resulted in mean yield increases of 79%

- **PAD works with a wide range of international research institutes, government ministries, agricultural universities, and others to select and validate all agronomic content and ensure it is backed by proven science before delivering it to farmers**
  - E.g. in Odisha we develop content through a committee with representatives from PAD, the state Department of Agriculture and Farmers' Empowerment (AFE), the Odisha University of Agriculture and Technology (OUAT), the International Rice Research Institute (IRRI), and others.

PAD collects evidence of our impact across 4 steps in our theory of change

User Engagement	Knowledge & Comprehension	Farmer Behavior	Farmer Outcomes
Listening and pick-up rates	User comprehension (of PAD content, soil health cards, etc.)	Adoption of recommended inputs	Crop yields
Opt-in rates	Ability to answer agronomic-related questions	Adoption of recommended farming practices	Farmer net incomes
Farmer ratings			Benefit-Cost Ratio
Quantity of content accessed by users			

PAD's Monitoring & Evaluation

User Engagement	Knowledge & Comprehension	Farmer Behavior	Farmer Outcomes
Kenya/Rwanda (Lime Adoption)			
Not possible to monitor pickup/listening rates with SMS	↑ likelihood of lime awareness with 1.21 odds ratio	10-18% ↑ in use of lime	Net income ↑ $0.40 per farmer per year (per campaign) Benefit-cost ratio of 9:1
Kenya (MOA)			
50% opt-in rate to cropping series content	10%↑ in knowledge about fall armyworm	46%↑likelihood of planting in specific week	--------

PAD's Monitoring & Evaluation (continued)

User Engagement	Knowledge & Comprehension	Farmer Behavior	Farmer Outcomes
Gujarat, India			
Listening rate of 53%	37pp ↑ in comprehension of soil health cards 7%↑ in agricultural knowledge	0.15 SD ↑ in the likelihood of adopting recommended inputs	Cotton yield ↑ 8.6% Cumin yield ↑ 26% Net income ↑ $100 per farmer per year Benefit-cost ratio of 11:1
Odisha, India			
Pick-up rates 73% Listening rates 44% Farmer ratings ~4.1 out of 5		---------- RCT planned in 2020 ----------	

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- Scale-Up of PAD's Programs
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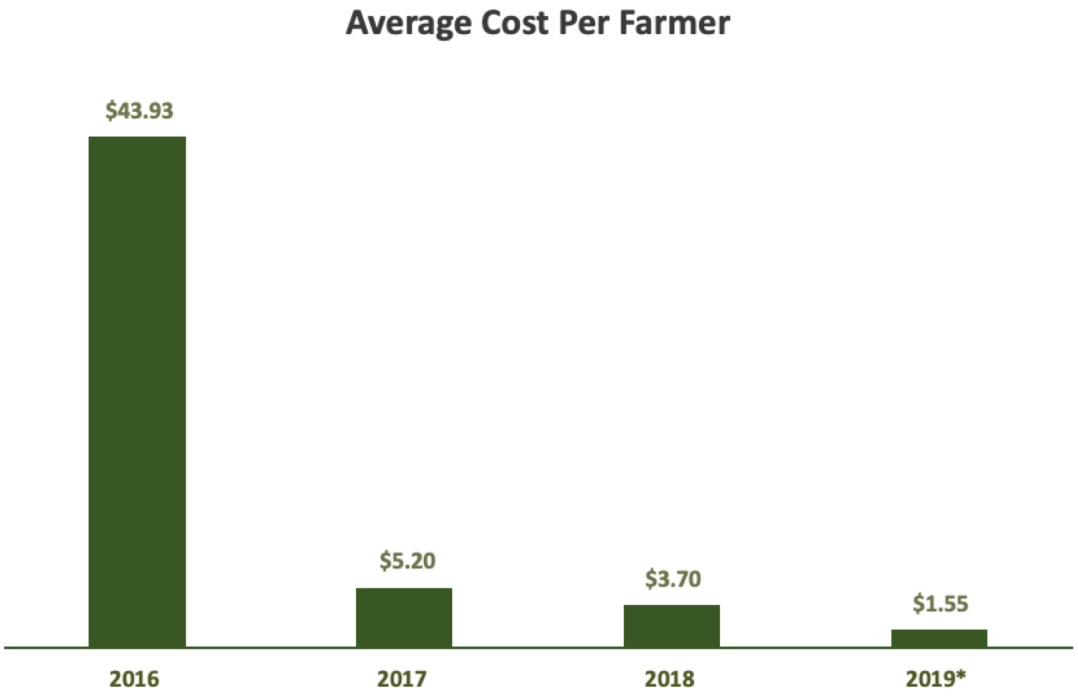
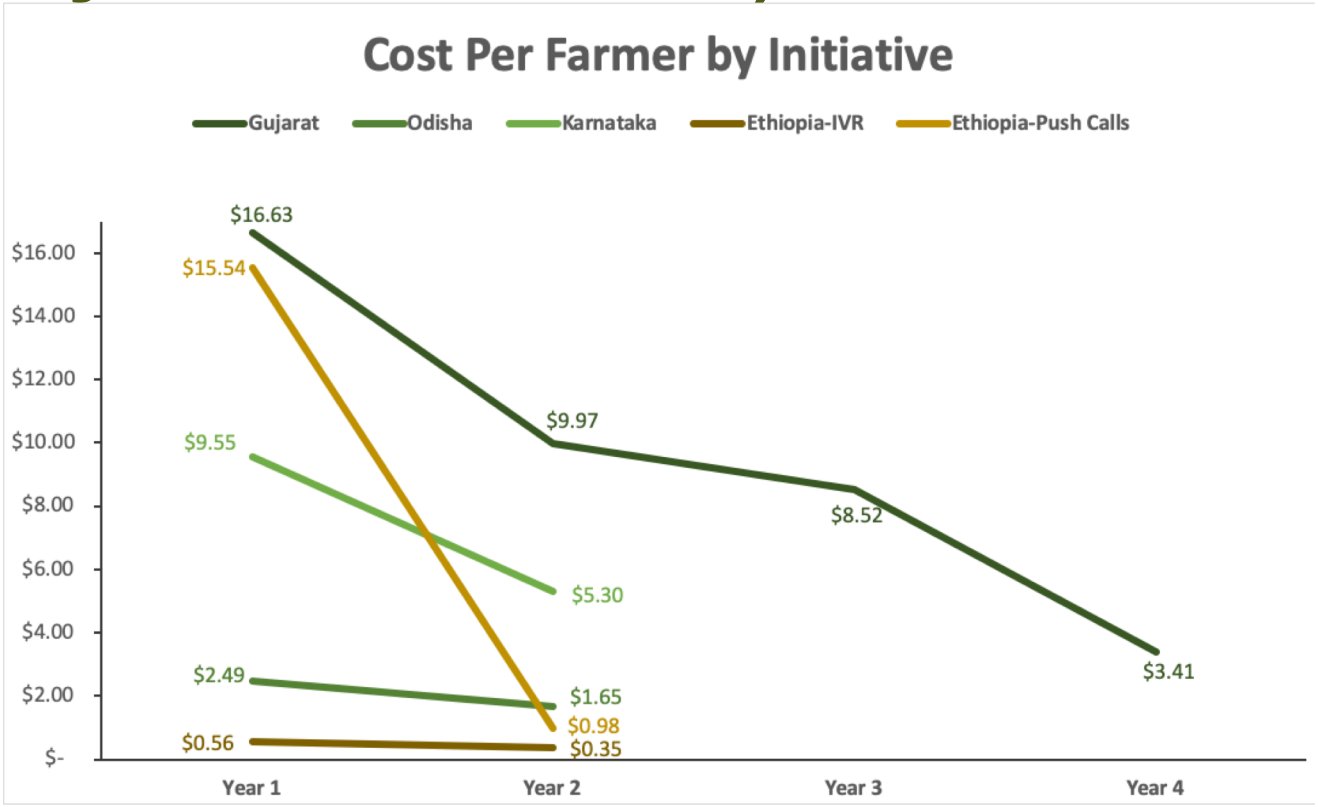
PAD's costs are rapidly falling over time

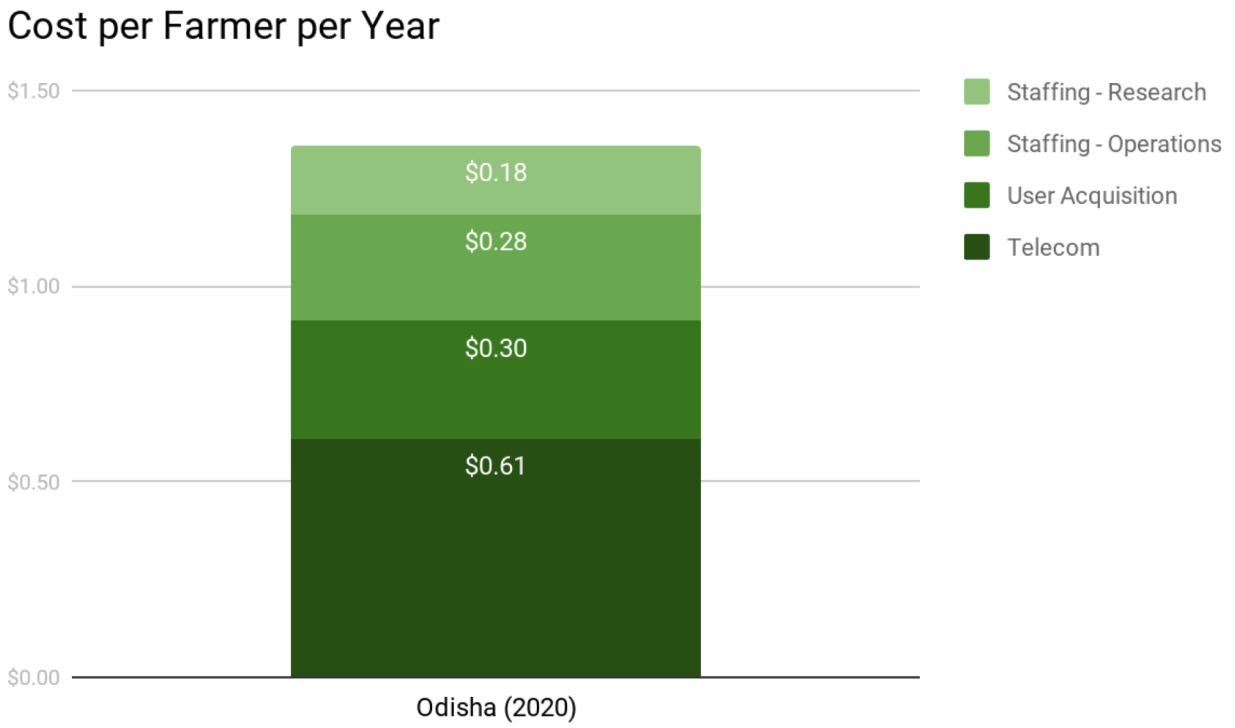


*In 2019, PAD changed its methodology for calculating average cost per farmer. The methodology calculates the average number of farmers reached in a year by taking into consideration both the number of farmers reached at the starting and ending point in a year, rather than just the ending point.

Large variation in program cost (and intensity of intervention) across initiatives



Fixed vs. Marginal Costs: Example from India



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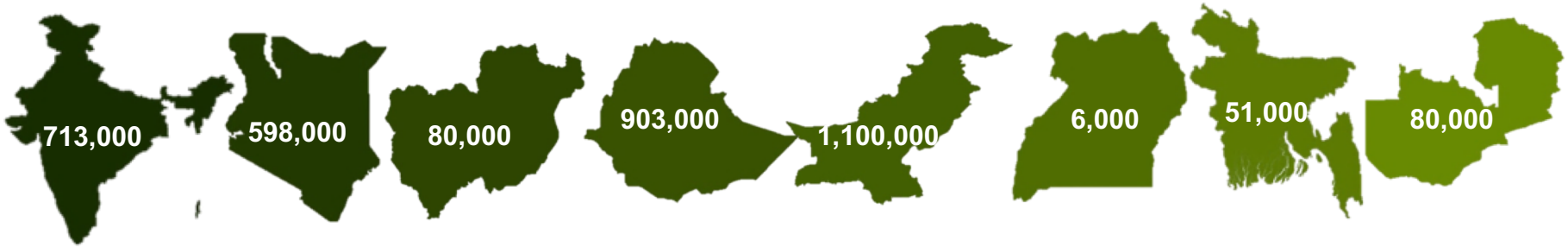
PAD is currently reaching 3.5 million farmers across 8 countries*

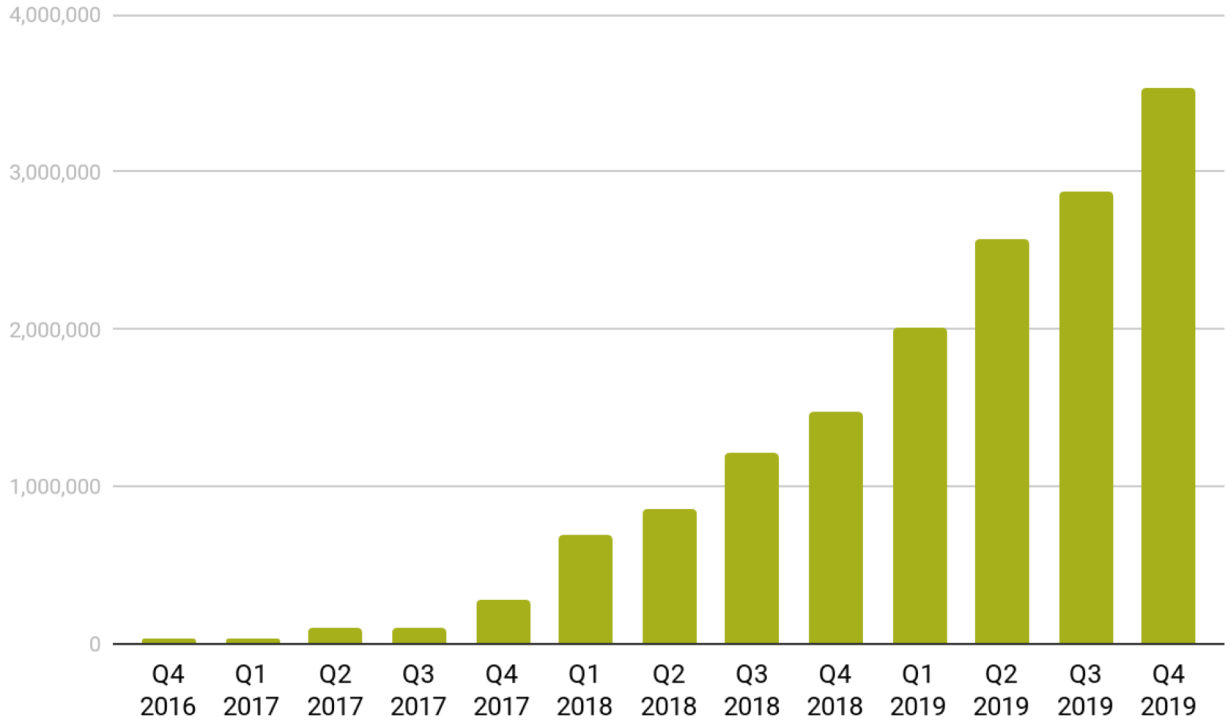


India	Kenya	Rwanda	Ethiopia	Pakistan	Uganda	Bangladesh	Zambia
• Gov'ts Odisha, West Bengal • International Rice Research Institute (IRRI) • Coffee Board • TNC	• One Acre Fund • Ministry of Ag • CABI	• One Acre Fund • Rwanda Agricultural Board	• Agricultural Transformation Agency (ATA) • Digital Green • Awaaz.de	• Departments of Ag, Punjab, KPK	• Technoserve • Hanns R. Neumann Stiftung (HRNS)	• mPower	• Ministry of Ag • CABI

**Farmer reach numbers as of Q4 2019*

PAD has grown rapidly and expects to continue this rapid growth

Farmer reach: Number of farmers who have received agricultural information via mobile phone through PAD's services in the last 12 months (from PAD directly, from services co-developed by PAD, or from services improved by PAD)



PAD has 3 distinct types of program

PAD Direct Service
(<5% of farmers)

- PAD acquires its own users, and owns and operates the product, services, and farmer relationship
- Test new ideas and learn what works
- Example:
  Gujarat, India

Partnerships: Co-Development
(55% of farmers)

- PAD works with partners to build new services, leveraging systems and farmer cohorts already in place
- Build, operate, transfer
- Examples:
  Gov't of Odisha, India
  Gov't of W. Bengal, India
  Coffee Board of India
  Kenya Ministry of Ag
  Gov't of Punjab, Pakistan

Partnerships: Advisory
(40% of farmers)

- PAD advises partners with existing digital extension services on how to improve them
- Examples:
  Ethiopian ATA
  One Acre Fund
  mPower (Bangladesh)

PAD's future plans

- **Scale:** Reach 10-15M farmers in 5 years, deepen impact per farmer, and refine evidence base
- **Advanced technologies to improve impact**
  - WhatsApp, video, photo, remote sensing, satellite and drone imagery, machine learning
- **Geographic expansion to meet the demand**
  - Multiple governments have expressed interest (DRC, Nigeria, Bangladesh, new states in India, new provinces in Pakistan)
  - Comparative advantage in fragile countries (Afghanistan, Colombia, etc.)
- **R&D and evidence generation**
  - How does the impact of digital ag extension vary by farmer characteristics and over time?
  - How can we collect more and more accurate information from farmers?
    - Farmer profiles, impact, input availability & prices, new remote sensing technologies, etc.
  - How can we increase our impact per farmer?
    - A/B testing to refine service delivery
    - Identify and develop new content

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Moving forward with digital extension

1. **Scale high potential programs that are backed by existing evidence**
   - **Already strong evidence on impact but a lot more to learn**
   - **Proceed simultaneously with scaling and research**
2. Invest more in measurement and outcome monitoring for further learning

1. Invest more in testing to increase impact and cost-effectiveness of the program

Scaling PAD's Highest Potential Programs

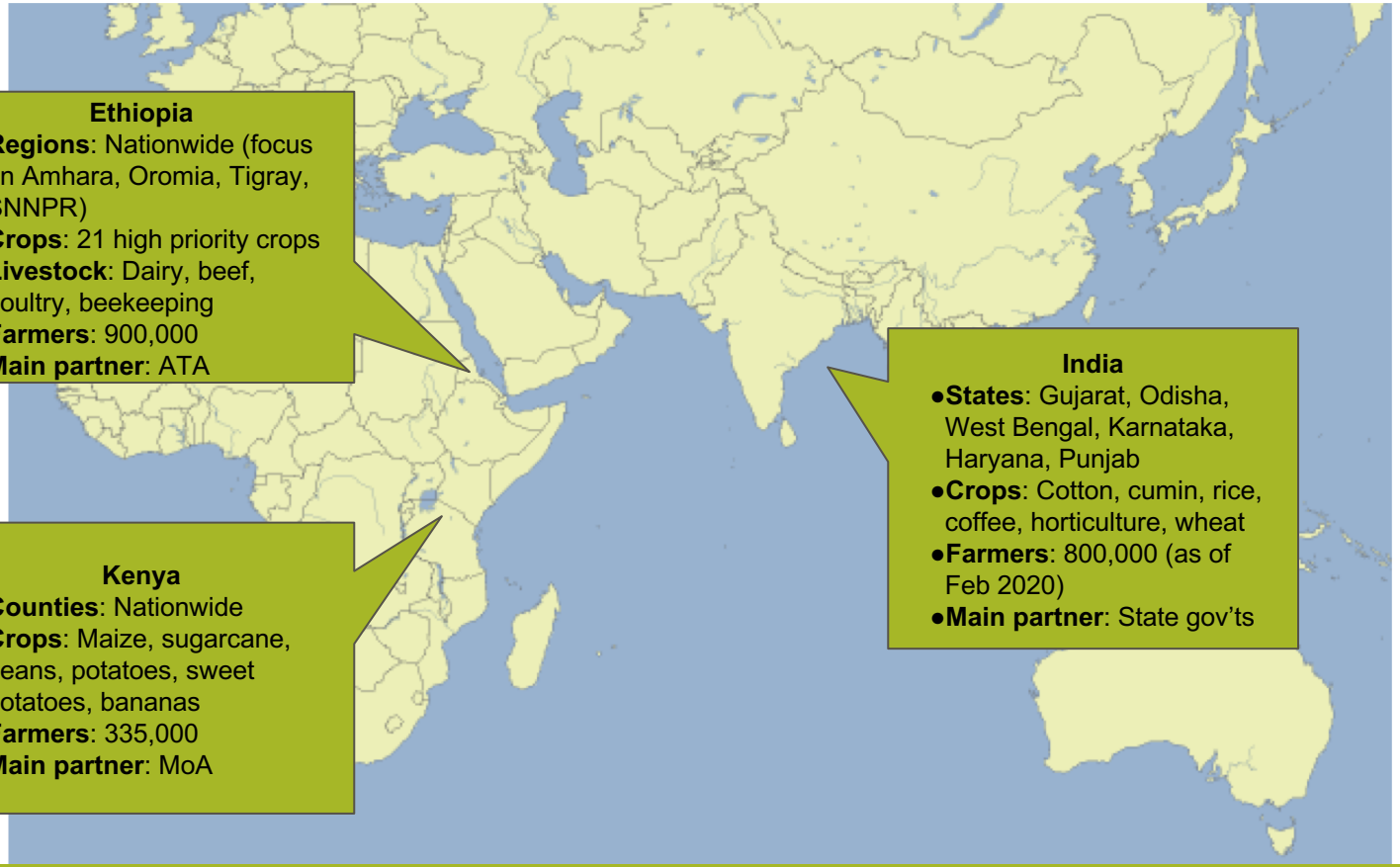
Current Programs (Similar to Existing Evidence)

- High touch programs providing voice/SMS messages on comprehensive set of topics throughout cropping season: India (Gujarat, Odisha, West Bengal, Karnataka), Kenya (MOA), Ethiopia
- Light touch programs providing voice/SMS messages on specific topics at critical times in the season: Kenya (OAF), Rwanda (OAF), Pakistan, Zambia
- 3,750,000 farmers expected in 2020
- $2,000,000 in 2020
- $0.53 per farmer per year

New Programs (Similar to Existing Evidence)

- High touch programs: India (3-5 new states), DRC
- Light touch programs: Pakistan (1-2 new provinces), Rwanda
- Potential 6,700,000 farmers in year 1
- $9,100,000 per year
- $1.36 per farmer per year

Current Program Snapshots (High Touch)

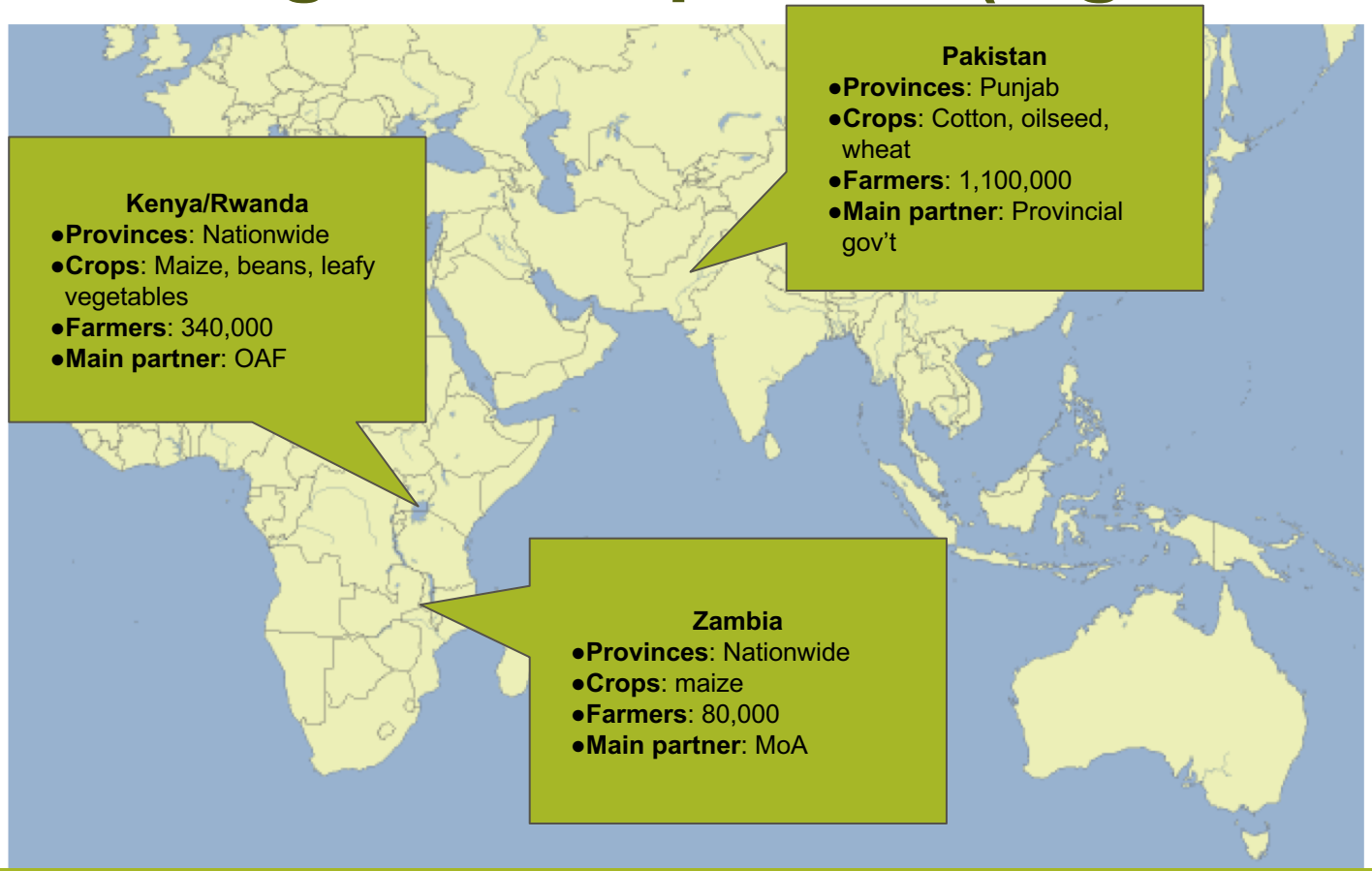


Ethiopia
- **Regions**: Nationwide (focus on Amhara, Oromia, Tigray, SNNPR)
- **Crops**: 21 high priority crops
- **Livestock**: Dairy, beef, poultry, beekeeping
- **Farmers**: 900,000
- **Main partner**: ATA

India
- **States**: Gujarat, Odisha, West Bengal, Karnataka, Haryana, Punjab
- **Crops**: Cotton, cumin, rice, coffee, horticulture, wheat
- **Farmers**: 800,000 (as of Feb 2020)
- **Main partner**: State gov’ts

Kenya
- **Counties**: Nationwide
- **Crops**: Maize, sugarcane, beans, potatoes, sweet potatoes, bananas
- **Farmers**: 335,000
- **Main partner**: MoA

Current Program Snapshots (Light Touch)



Moving forward with digital extension

1. Scale high potential programs that are backed by existing evidence
    - Already strong evidence on impact but a lot more to learn
    - Proceed simultaneously with scaling and research

2. **Invest more in measurement and outcome monitoring for further learning**
    - **Test new approaches to lower cost of outcome measurements for ongoing impact evaluations and monitoring (e.g. test satellite-based yield measurements and use of drones)**
    - **Improve estimates on other parameters for cost-effectiveness calculation**

3. Invest more in testing to increase impact and cost-effectiveness of the program

PAD's Research Plan to Measure Outcomes

Impact Evaluations Planned in Current and New PAD Programs

- **Odisha, India**
  - Objectives:
    - Measure impact on yields and net incomes within government-owned program at scale
    - Test and compare various measurement methods
      - Satellite-based yield measurement
      - Exploring the use of drones
      - Compare them against crop-cuts and self-reported yield data
  - Yield measurement study can be expanded across multiple settings for different crops.
  - RCT planned in 2020-2021 with 16,000 farmers in 1,600 villages
- **Dairy sector (Kenya)**
  - Objective:
    - Measure impact on yields and net incomes using routinely collected administrative data from milk buyers
    - Measure additional outcomes including nutrition and gender empowerment
  - RCT planned for 2020-2021 to measure the impact of SMS-based advisory service on yield
- **Input adoption (various locations)**
  - Objective:
    - Measure impact on input adoption using routinely collected administrative data from governments
  - Subsidized input programs in Rwanda and Pakistan, potentially in Zambia and Kenya

Moving forward with digital extension

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   - Improve estimates on other parameters for cost-effectiveness calculation

3. **Invest more in testing to increase impact and cost-effectiveness of the program**
   - **Tweak system and message designs & conduct A/B tests**
   - **Test the use of advanced technologies**
   - **Test the impact of using A/I algorithms for better targeting of messages, including learning across programs and geographies**

PAD's Cross-Program Investments to Improve Impact and Cost Effectiveness

Types of Investments

- **Improve Impact per Adopter**
  - Refine "high touch" interventions to optimize quantity and quality of recommendations
  - Develop new "light touch" interventions (i.e. other recommendations similar to lime adoption)
  - Develop new high-value content (e.g. weather alerts, crop insurance, nutrition, bio-fortification, etc.)
  - Develop new technologies to deliver more advanced content (e.g. video, photo, WhatsApp, mobile app, etc.)
- **Improve Adoption Rate**
  - Conduct A/B testing to maximize behavior change
  - Experiment with message framing, frequency, duration, reminders, etc.
- **Reach Additional Farmers**
  - Conduct user acquisition campaigns in existing geographies
  - Promote peer-to-peer learning among farmers
  - Expand to new geographies (national and sub-national)
  - Transition services to long-term partners (governments, donors, etc.)

PAD's funding approach

Pilots and new program/partnership development

Funding sources:
- Philanthropic donors
- Implementers (gov'ts, private sector firms, NGOs, etc.)

Scale & maintain/transfer

Funding sources:
- Long-term philanthropic donors
- Implementers (gov'ts, private sector firms, NGOs, etc.)
- Bilateral/multilateral donors
- IFIs

R&D for product innovation, experimentation, research

Funding sources:
- Philanthropic donors
- IFIs
- Research grants

Conclusions

- Best evidence suggests current digital extension programs are highly cost effective
- Many opportunities for scaling current programs and expanding to new programs
- Lots more to learn by simultaneously continuing research and investing in better outcome measures
- Maximizing potential impact requires sustained cycles of iteration and testing


Thank you!
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