



Enabling Crop
Analytics At Scale

ENABLING CROP ANALYTICS AT SCALE (ECAAS)

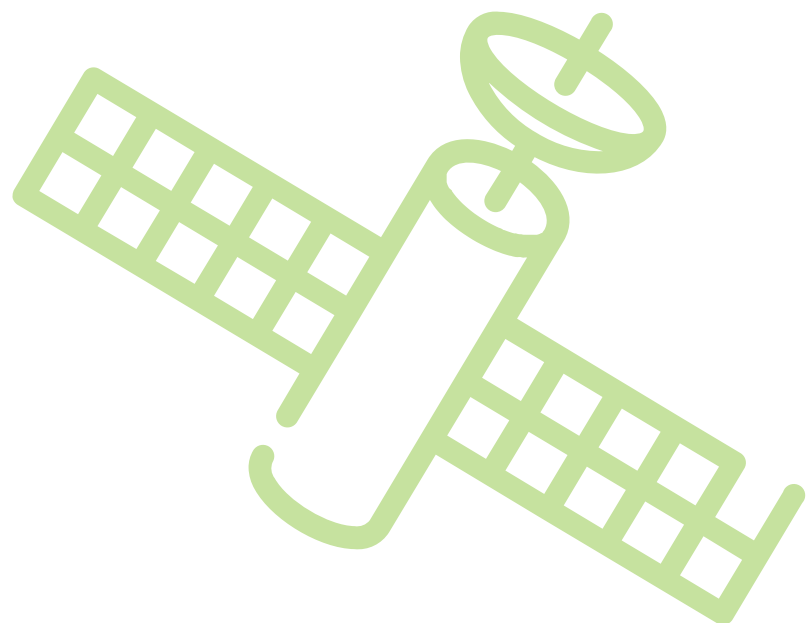
Scalable Agriculture Data Through Conversational Farm Record Keeping



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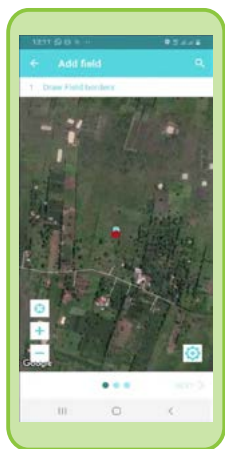


The Objective & Outcomes

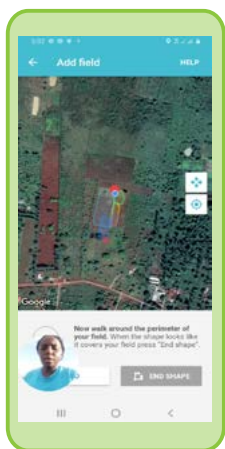
Agriculture development strategies of many developing countries and institutions require new, better, and more cost-effective tools and methodologies for data collection and analysis of agriculture statistics to drive investment and decision making. Optical and radar satellite remote sensing datasets, combined with analytical models, can provide an accurate picture of crop health and deliver detailed recommendations for better crop management. However, gathering high quality training data and understanding the context in which decisions are made is necessary to localize these models.

The objective of this project was to demonstrate a scalable software system that combined [learn.ink](#) training platform with [6th Grain's](#) Field Focus Light Android application to engage digitally-engaged farmers across East Africa to provide agricultural data including field boundaries, crop type, crop variety and previous year production in exchange for high quality farm record display and remote management of farms. We started with two independent software platforms and used them together to accelerate development.

We found that there were a number of challenges that needed to be overcome in usability before farmers in places like Kenya could digitize their own fields and use the FieldFocus application to keep records. These include making it easier for farmers to digitize their fields beyond using 'map as an interface', such as in Google maps, reducing the impact of having unreliable geo-location APIs in rural settings, ensuring data-light and off-line app functionality, and linear step-by-step work flows. The project set out to address these challenges over the past year.



A FARMER USING
FIELD FOCUS BEFORE
THE RE-DESIGN, THE
MAPPING PROCESS WAS
TOO HARD TO COMPLETE
UNAIDED



A FARMER USING
FIELD FOCUS AFTER THE
RE-DESIGN, WITH CLEAR
GUIDES IN-APP TO HELP
FIELD MAPPING
COMPLETION

Before

- 6th Grain's FieldFocus app is packed with powerful features, including all necessary functions for farmers to map fields, but to encourage and train them to do it required **face-to-face training and a dedicated person paid to use the application or many hours of calls.**
- 6th Grain had no clear means to reach the Kenyan market except through their commercial contracts who found it **cost over \$10/field** to simply get the digital outline in the application for one season.
- Users need to submit an email to register for the tool, which most farmers in Kenya do not have and will not monitor even after they register.
- Even after registering for an account with an email address, users still struggled to map fields and to enter data in a timely manner. Satellite remote sensing information, weather and other features were confusing and required significant expertise to interpret, while also requiring large transfer costs due to size.

After

- We used a human-centered design approach, delivered 100% remotely using learn.ink's unique user testing methodology, to audit and create wireframes for a new Android app, FieldFocus Light.
- 6th Grain used the wireframes to launch FieldFocus Light that allows for cell phone registrations and a data-light, offline implementation with a straightforward, linear step by step UX flow for easy field digitization and use.
- **Users are able to register for the app and map fields without the need for face-to-face training or any in-person calls.**
- We redesigned the Facebook ad campaign to first point to [6th Grain](https://6thgrain.com)'s web based training on learn.ink to help build user's knowledge and understanding of Field Focus Light's value to them and how to use it. This **reduced the cost to register users to ~\$1/new user.**
- Using the combination of a new app design + learn.ink to onboard and train users, 6th Grain was able to redesign the mapping application, communicate with the broader Kenyan farmer community, register users and map 358 fields without any face to face interaction. The cost of this engagement was low and unlocks the potential to deliver crop analytics at scale in Africa, enabling a step-change in 6th Grain's ability to deliver a state of the art, data-driven view of agricultural activity on the continent.



1

How a human-centred design approach enabled farmers to map fields 100% remotely

A new and improved FieldFocus Light Android Application



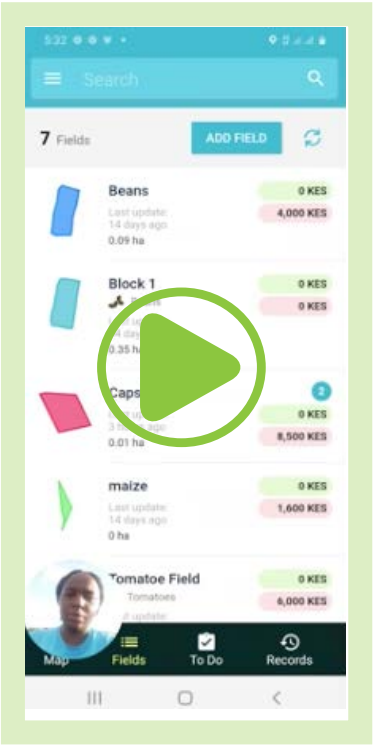
Catherine, our lead farmer tester in kenya, provides her assessment of the final version of the fieldfocus light app above. keep in mind that before we redesigned the application, virtually no farmers could map their fields using the app without significant support.


How did we get here?

1. Usability audit report

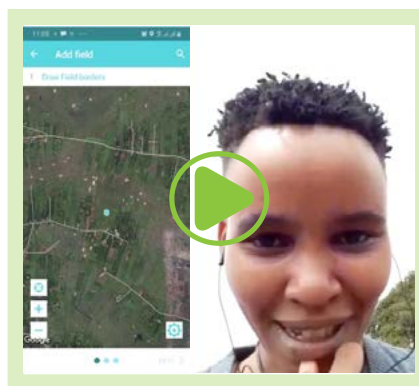
Any good human-centered design process starts with in-depth interviews and feedback from the real end users involved, so the [learn.ink](#) team digitally recruited and talked to a mix of farmers, agronomists and younger individuals potentially interested to work as rural agents.

We conducted 100% remote interviews between the UK and Kenya with farmers. We used the [learn.ink](#) system itself to help guide and capture critical information from farmers. You can see a summary snapshot of the interviews below. A huge thanks to our amazing testers, who provided incredible feedback that helped guide the design and development teams moving forward. The video below shows the kind of guidance we received that allowed us to create the wireframes.

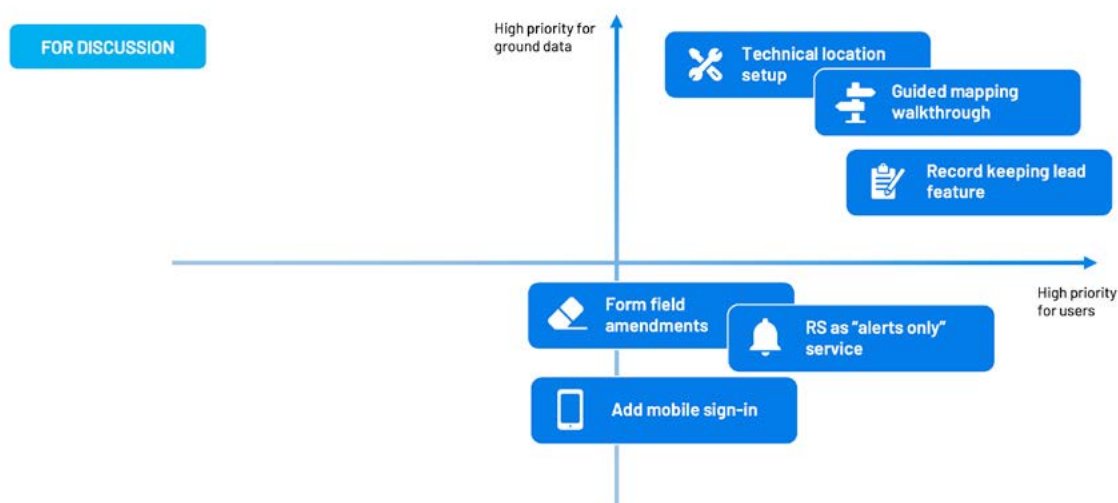


| | Name | Profile | Gender | Short bio |
|---|-----------|-----------------|--------|--|
|  | Catherine | Farmer | Female | Experienced and digitally connected farmer, works full-time on farm |
|  | Stella | Farmer | Female | Farming a few years, works as accountant in Nairobi while managing farm remotely |
|  | Oscar | Farmer | Male | Student turned full-time farmer, just starting out and keen to learn |
|  | Daniel | Potential agent | Male | Small shop owner, buys herbs from farmers and sells over WhatsApp |
|  | Charles | Potential agent | Male | Starting a farmer training venture focused on growing strawberries |
|  | Monica | Potential agent | Female | Non-agricultural, recent graduate, working on online projects and research |
|  | George | Agronomist | Male | Experienced agronomist who has worked over most major regions of Kenya |
|  | Geoffrey | Agronomist | Male | Agronomist who works with farmers frequently over Facebook & WhatsApp |
|  | Justus | Agronomist | Male | Agronomist running frequent field days |

The [learn.ink](#) team provided the 6th Grain software development team a comprehensive usability audit report. We highlighted three major areas for improvement to the app that we believed, once resolved, would enable farmers to map their field boundaries without the need for costly and time consuming support. What was important was that once farmers realized what Field Focus could do for them they were incredibly enthusiastic. The issue was that the value was hidden out of view behind some challenging parts of the interface.



Priority map of recommendations



The three major areas for improvement were:

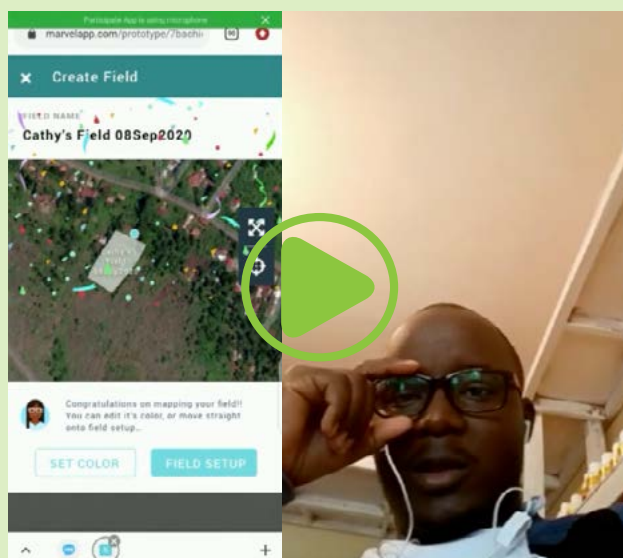
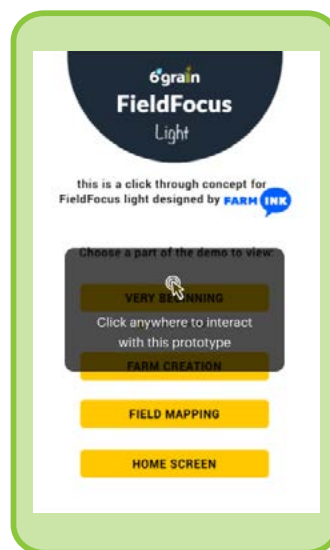
Technical location setup: minimize requirements for the user to setup their own device for field mapping, e.g. by providing them in-app prompts to turn on location as well as informing the user when the GPS chip on their device was providing a reading (avoid using cell tower location readings, which are too inaccurate in this context).

Guided mapping walkthrough: testers themselves provided us excellent ideas and feedback about how they would like the guidance for the field mapping process to work, e.g. “I wish the instructions were on the screen”, “an easy procedure, step 1, step 2, step 3, etc.”. The user feedback was so good that we didn’t even need to do much design, we just needed to listen to what they were suggesting.

Record keeping is a lead feature: initially the Field Focus app boasted advanced crop analytics features as a leading feature, but it quickly became apparent that there was a more valuable feature for farmers: keeping better records with associated costs. Once farmers had framed a field boundary it made sense to keep notes on what activities they had conducted within that boundary, when they had occurred, and what the costs associated with each activity were. People didn’t appear to have a good solution for this, but there was a real need there.

2. A prototype of new features

Understanding the problem is one thing, but having a clear design that would resolve them is quite another. This is why the 6th Grain team commissioned the [learn.ink](#) design team to create a prototype to demonstrate how updates to Field Focus could resolve the challenges outlined. Our team created a click-through prototype that could be quickly tested by both 6th Grain and our original testers. You can check it out yourself here (or via this [link](#)).



3. Usability audit report #2

This design is all well and good, but who's to say it would work? The answer is simple, ask the testers. To demonstrate what kind of difference in results we could expect we conducted user tests with a mix of previous and new testers. We asked the previous testers whether they thought the new prototype design was better and why, and we sense-checked some of this with new testers (to help ensure our old testers weren't just being nice!). Again you can see a snapshot of these results in this video.

Our advisors were happy that the prototype design and new interface could deliver on what we wanted: a way for farmers to map field boundaries by accessing the field focus app alone. So the next part was how to get the redesigned application out to the farmers themselves.

In the next section we discuss 6th Grain's launch of the new application, and how the use of digital training on [learn.ink](#) as a key catalyst to a digital advertising campaign. Creating a scalable approach that achieved low costs per user acquired to the new Field Focus Light app.



2

How 6th Grain's learn.ink training enabled us to train and acquire users for \$1/user

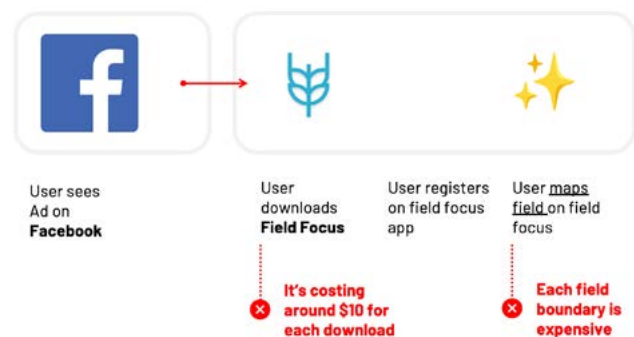
With engagement of the application development team, 6th Grain launched the new FieldFocus Light application in February 2021. It now has an Android application that could deliver results, but what good is it if nobody knows it exists? As part of the project, the 6th Grain team got the support of learn.ink to design their marketing campaign as part of their enterprise package.



Digital Ads are a great an expensive way to onboard?

Onboarding users is tough, and using digital advertising tools like Facebook Ads is appealing, since we can target countries like Kenya and construct audiences that have interests in agricultural related activities. To create a benchmark 6th Grain initially created a set of ads to try and get users to download FieldFocus directly, i.e. the link in the ad pointed straight to the app store.

A prototype user onboarding journey

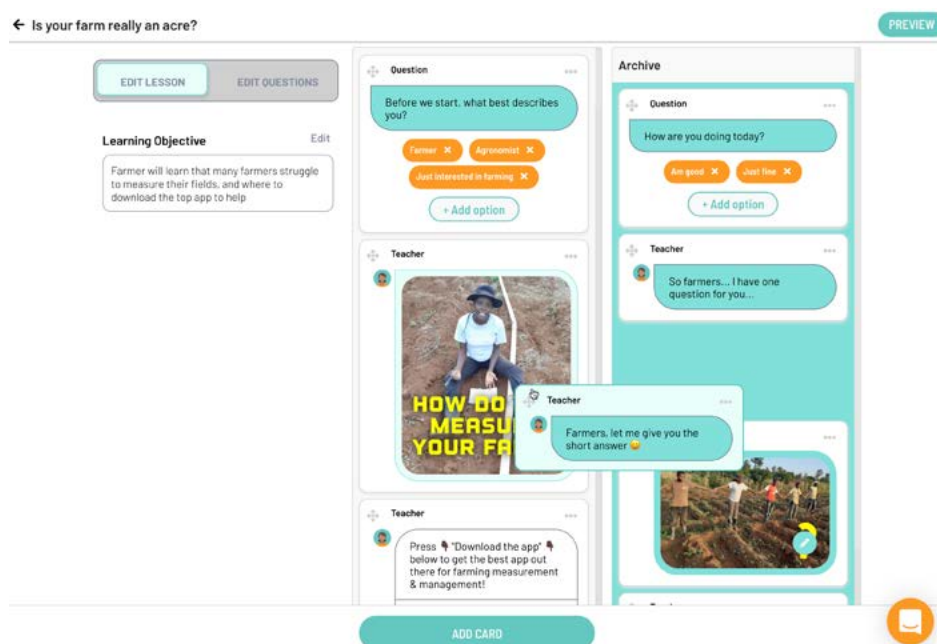


The results weren't great. We got very few downloads of the FieldFocus Light tool.

Why was this happening?

It's good to remember that trying to market your Android app directly can be challenging for multiple reasons:

- Users in Kenya typically have older Android phones with less storage available for apps, if they download your app they often have to remove another. *Why should they?*
- Explaining your app's value to the user in a picture and a single tagline might be ok for simple apps, but when your application has complex functionality, like FieldFocus Light, and needs a bit more explaining it can be hard to communicate this in an ad. *Ads are good to drive awareness but not understanding.*
- Sending users directly to the app store can be an abrupt experience, generally ads work best when sending users to a well designed web page that is easy to access and provides clear information on the purpose and benefits of the application. *It's a good idea to use web pages before driving people straight to app stores.*



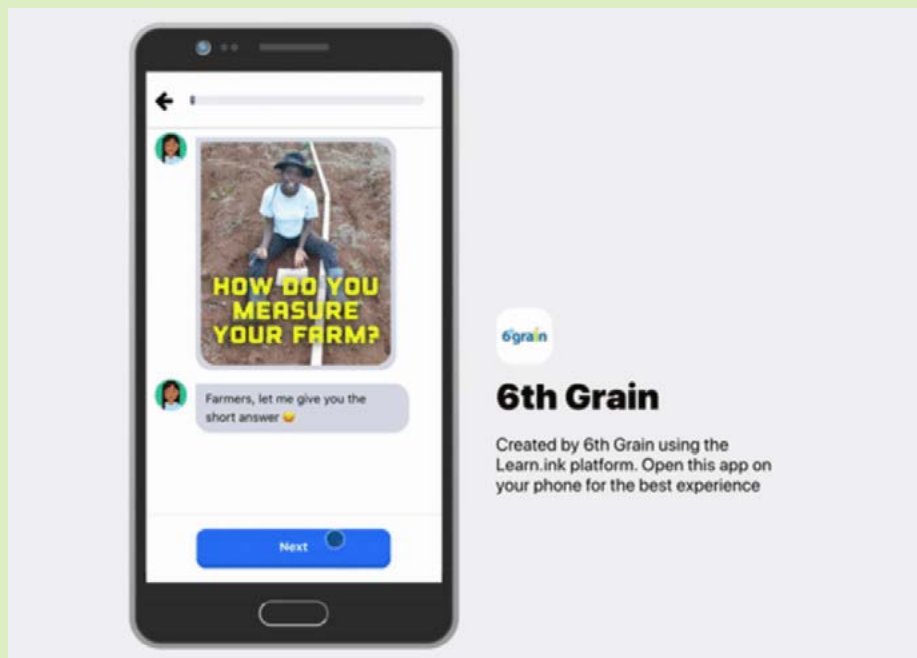
Digital Ads can be a cost effective way to onboard using learn.ink web page courses

With this benchmark onboarding data the 6th Grain team then created an initial micro-training course on the [learn.ink](#) using the simple drag-and-drop web editor.

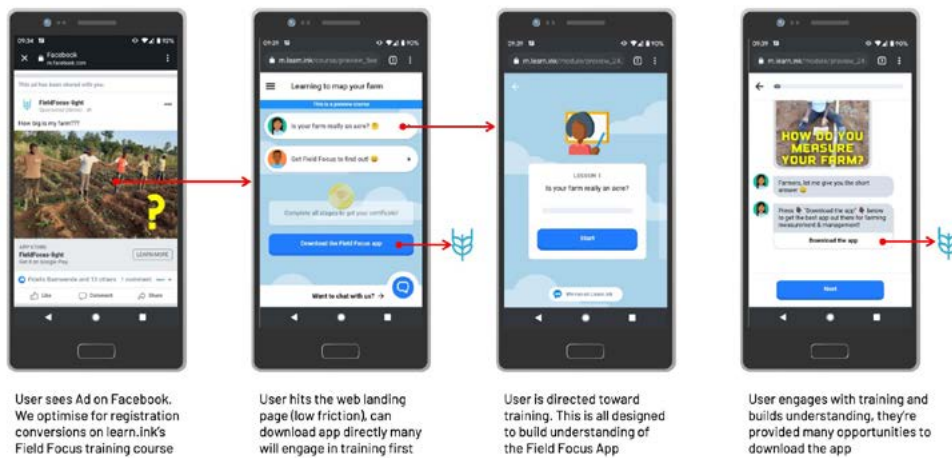
This course had some straightforward requirements:

- must be short and engaging for farmers, and easy to create for 6th Grain team (60 minutes work).
- include multiple call to actions at every stage to encourage users to download the FieldFocus light app from the app store.
- provide instructional material to help build the farmer's understanding of FieldFocus Light's value and how to actually use it.

6th Grain use digital training to drive user understanding before they point them toward app download



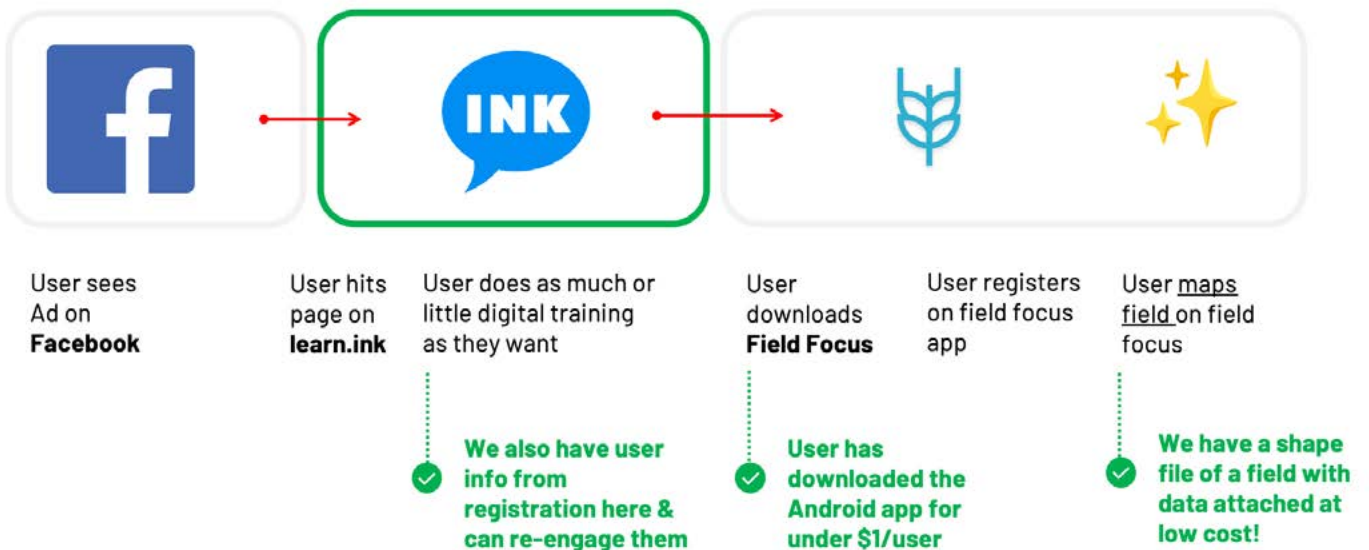
Using the [learn.ink](#) course builder we were able to construct and release a digital training within a week, you can see for yourself how this resulted in a fun and informative experience on a smart-phone that helped build the farmer's understanding of FieldFocus Light.



Now instead of onboarding users straight to the play store from an ad, which wasn't driving good results, 6th Grain were able to send users to their [learn.ink](#) digital training, which included multiple opportunities to prompt users to download the app.

By adding web based digital training as an intermediary to the enhanced Field Focus app, we'd now built a purely digital onboarding strategy for driving users from digital ads, to digital training to downloading an app to mapping a field.

An improved user onboarding journey using learn.ink



In the next section we discuss how we scaled up this model and explored how we could keep the cost per mapped field boundary low even as we extended the tool to more farmers. You can read more about the results from the learn.ink courses [here](#).



3

6th Grain's scalable approach to reach thousands of farmers and map over 350 fields in Kenya

We used our new framework to launch a Facebook campaign. The campaign focused first on engaging with growers about knowing the size of their fields. Then we launched a campaign around record keeping.



Facebook campaign for recruiting farmers

The 6C Advertising Campaign set out with the objective to create a scalable model for increasing the number of FieldFocus Light (FFL) application downloads and use. Facebook Ads was selected as a cost-effective way of advertising digitally to growers. With the help of Facebook Ads granular ad audience and targeting tools, these ads can be shown to users in almost any country. The hypothesis was if the advertising campaign were successful for growers in Kenya using Facebook Ads, we could then scale this advertising model to tens of thousands of users per target market. With 10,444,000 Facebook subscribers in 2020, Kenya is a large audience for Facebook ads. The ad campaign, The budget goal was a cost of \$1.00 per registered user on [learn.ink's](#) platform.

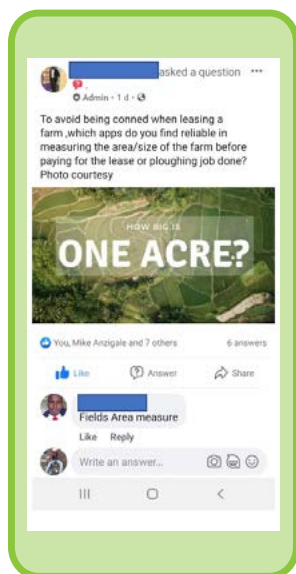
Serving Facebook ads is the quickest and simplest way to remotely put FFL in front of growers in Kenya. With the right ads, we have increased FFL awareness in Kenya, increased FFL app downloads and create a community of FFL users.

Test ad campaign:

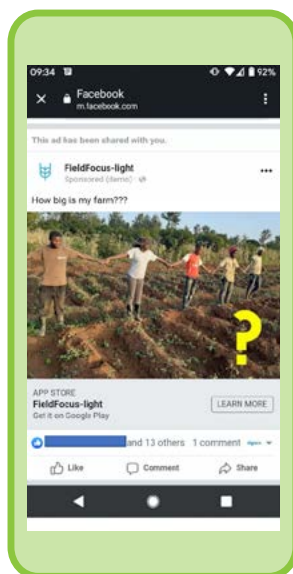
February 22, 2021 – March 16, 2021

Prior to launching the primary FieldFocus Light Facebook Ads campaign, we implemented a small test campaign with a budget of \$122. This test campaign's ads linked to the Facebook Light app Google Play Store page, with a call to action to download the application. What we quickly discovered was that few people downloaded FieldFocus Light during this test campaign. We believe asking interested visitors to download FieldFocus Light outright is too large an ask, particularly when mobile devices have limited storage. We ended the test campaign and switched strategies with the new primary ad campaign by using [learn.ink](#) as an intermediary landing site. Users then take the lesson to learn the benefits of FieldFocus Light and how to use the application effectively.

Primary Ad Campaign Messaging



EXAMPLE OF EXISTING FACEBOOK POSTS ON TOPIC OF 'IS YOUR FARM REALLY AN ACRE?'



EXAMPLE OF FACEBOOK AD WE CONSTRUCTED FROM IMAGES SHARED BY CATHERINE

To increase reception of our ads, we created ad messaging focused on the direct benefits FFL provides. Focusing on how FFL caters to a grower's needs is important in raising the number of clicks on the ads. To achieve this, we created two central themes for the primary ad campaign that explain how FFL helps growers:

- > Field Mapping – "How Big is Your Field"
- > Record Keeping – "Is Your Field Profitable"

"There is a hot debate right now on social media between farmers as to whether their field is really an acre..."

- Catherine



“How Big is your Field?”

Many growers in Kenya do not know the true size of their field, which means they may be over or under-utilizing crop inputs, and may not be getting the optimal yield, or even causing unneeded environmental damage with surplus inputs leaching into the environment. We use this issue as a focal point for this group of ads during the primary ad campaign. Field mapping is FFL Light's one of FFL's core functionalities, and our ads reached out to growers with the field mapping phrase “How Big Is Your Field?” as the central message.

The Field Mapping ads consisted of combined FFL UI images and field images, to highlight the digital — physical link between the app and the actual field. The goal of the ad was to show an example of how the app looks when in use, as evidence to ad viewers that FFL is a real product that can help map their fields for free.

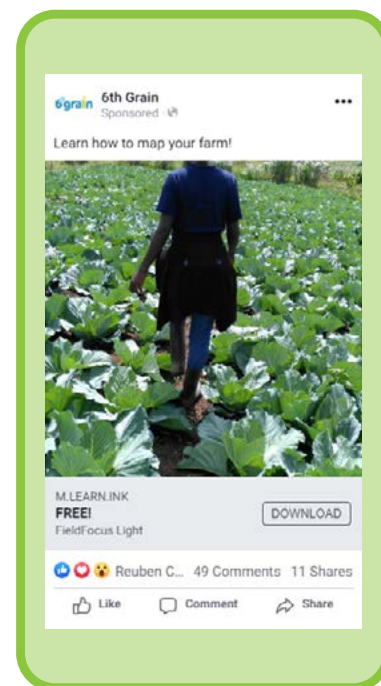
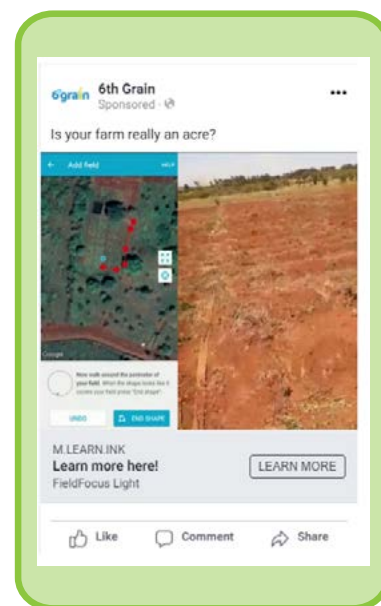
The ad to the right is one of the ads used to highlight FFL's mapping functionality to growers.

We supplemented the FFL UI/Field image ads with ads consisting of images of our super user Cathy and friends hard at work in the field. By showing bountiful crops and growers walking through their fields, we were able to garner a great deal of interest both in terms of FFL app downloads, learn.ink registrations and Facebook comments.

To the right is an example of an ad with a grower walking through a lush field. We chose images such as this to visually associate field mapping with productive fields without stating so explicitly.

With all Field Mapping Ads, we used different images that Facebook mixed and matched with a bank of headlines, text, and calls to action, shown below. Simple messaging is key to catching a viewer's attention, as people scroll down Facebook quickly.

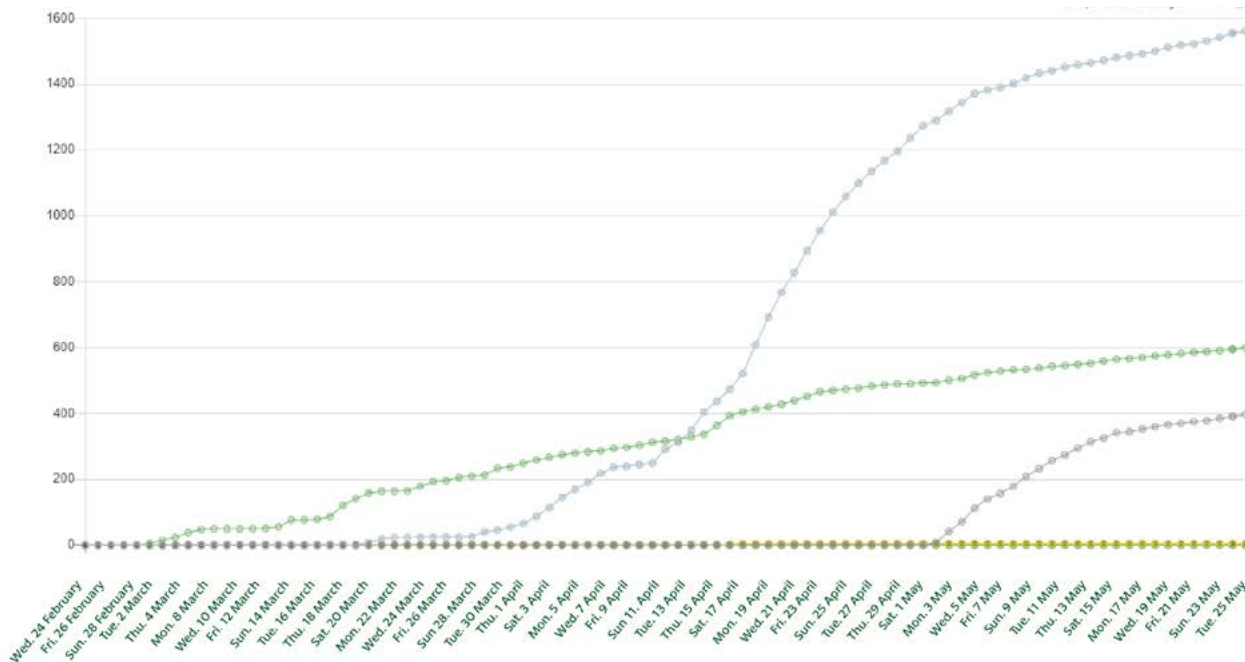
The “How Big is Your Field” group of ads performed very well, as shown in the chart above, represented by the blue line. With over 1500 cumulative installations of the FFL app over the course of the “How Big is Your Field” ad campaign, the primary ad campaign greatly increased our number of FFL installations.



“Is Your Field Profitable”

Launched on May 1, 2021, our record keeping ad campaign “Is Your Field Profitable” ran concurrently to our “How Big Is Your Farm” field mapping campaign. This new ad campaign is designed to advertise the record keeping functionality of FFL to growers. FFL's field-specific record keeping helps growers increase their field profitability and income by knowing how much they are spending on each field.

To create these new ads we selected a mix of images that focused on Cathy and friends photographed with crop input supplies, store items, and handling money during physical transactions.



Based on comment content on our 6th Grain Facebook page, we have found that engagement with record keeping is less than with field mapping. We believe a core issue with advertising the record keeping functionality of FieldFocus has been that users are already keeping track of their expenses in some format. While mapping one's field with digital technology is exciting and eye-catching, listing expenses, even via an app, is a more difficult to illustrate this benefit in an attractive manner. Despite this lower level of direct engagement on Facebook, record keeping played an important part in increasing our FieldFocus Light downloads and registrations.

Comparative analysis of marketing campaign success

Our goal in Facebook ad image selection is to use images that quickly resonate with growers in Kenya and peak their interest in FieldFocus Light. Thanks to our super-user agronomist Cathy, we learned about Kenyan grower habits and challenges before starting the ad campaign. By developing the ad campaign with a user-centric design, supported by real user evidence, our ads helped increase FieldFocus Light downloads and learn.ink registrations at a greater than expected rate.

It is well accepted that user-centric user interface and user experience design for digital apps is key to successful user adoption. It is important to make sure the marketing of the application is equally as user-centric. Cathy informed us of the difficult issue of knowing one's field size, which growers in Kenya face on a daily basis. We took this information and crafted the "How Big is Your Farm" ad campaign. We crafted the "Is Your field Profitable" off similar evidence.

To help make our ad campaign as relatable to growers in Kenya as possible, Cathy supplied us with images of her and other growers. We provided Cathy with the field mapping and record keeping central themes of our ad campaign, and she provided us with appropriate images. These authentic, Kenya grower images are central to the success of our ad campaign. When growers in Kenya see other growers in Kenya on our ads, the connection between ad and viewer grows and increases the likelihood on a click on our ad.

Examples of the most successful ads

The popularity and success of an ad can be surprising. While the most successful ads are always important to the overall campaign, much can be learned from the ads that flounder. The only way to find out the right combination of ad copy and media is by serving them to their target audience.

We found that ads that incorporated screenshots of FFL in use were the most successful, leading to the most learn.ink registrations. We believe that the user interface images provide evidence to the grower viewing the ad, instead of an ad with merely promises of a useful app. The juxtapositioning of the FFL image with an actual field helps strengthen the connection that FFL maps a field in real time for a user, which increases the chance of the ad being clicked.

Image 2 was popular and successful in helping boost the number of registrations on learn.ink. We learned that ads such as this one, with growers doing work in the field and bountiful crops are effective. Based on the ads we have already placed, it seems the presence of verdant, plentiful crops is more likely to get a grower to click on the ad. Our belief behind this rationale is that growers want to improve their crop yield, so seeing a real grower with an attracting field or harvest speaks to this desire for better yields.

Our most successful ads do not depend solely on the right image. Calls to action, titles, and subtitles can make a difference in ad success, even between two ads that share the same image. These two similar ads are successful in increasing learn.ink registrations, as well as direct engagement with Facebook ad viewers. The ad on the left has significantly more visitor comments and shares, while the ad on the right has fewer comments and zero shares.

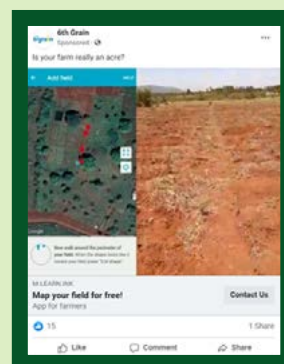


IMAGE 1

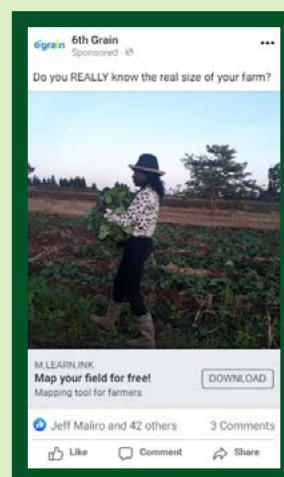


IMAGE 2



IMAGE 3

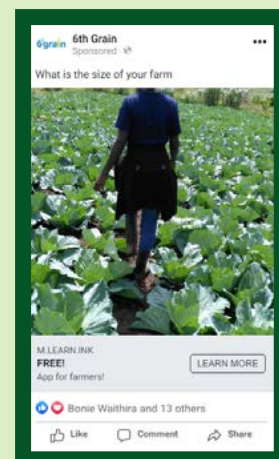
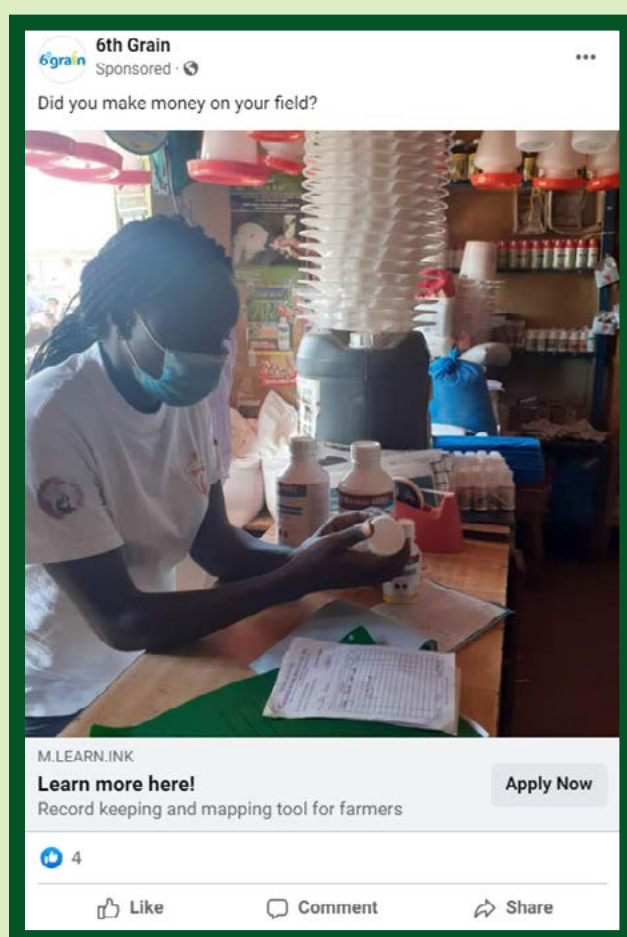


IMAGE 4

- The titles of both ads are drastically different, with the title on the left exuding a more engaging and cheerful tone. Due to a lack of punctuation, the title on the right falls flat on delivery. We chose this title to see how differences in title word choice and tone would affect ad success. While it is difficult to isolate if the titles themselves made a significant impact, we believe the more a title speaks to the visitors in a happy tone, the more engaged the visitor will be.
- We believe the ad on the left also has superior popularity due to providing a download-specific call to action, as opposed to the opportunity to learn more. Both call to action buttons lead the viewer to the learn.ink registration page, which also contains a button to download FFL directly. The winning call to action promises an actual mobile application, as opposed to a more ambiguous call to learn.
- The app on the right has a subtitle that mentions an app for farmers, which does not explicitly state the name of the application, which may be off putting to some viewers. We learned that ads which are optimistic and promise some benefit to the viewer are more successful than those with less clear messaging and calls to action.



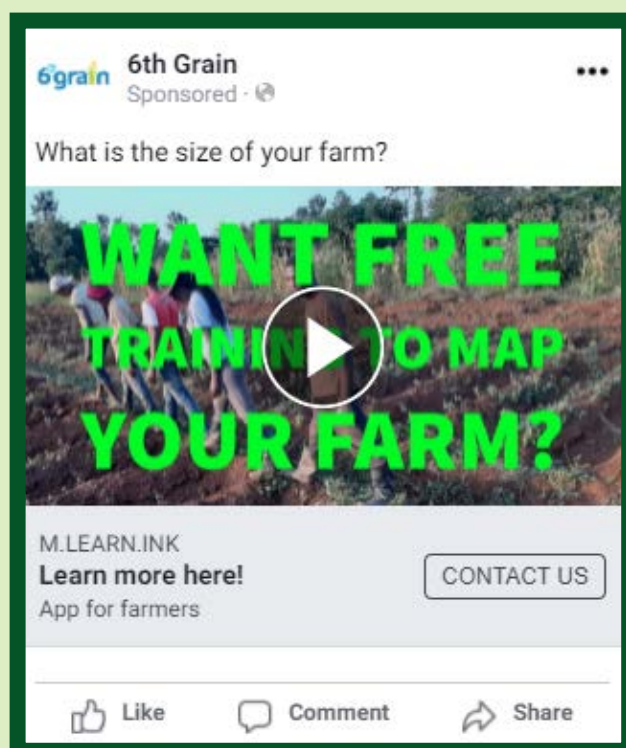
For the record keeping “Is your Field Profitable” ad campaign, we switched from images of growers with crops and fields to growers making transactions and interacting in store settings. Images such as this one of Cathy in a store setting, surrounded by crop input products, received the most comments and shares of all the record keeping ads.

An interesting finding is that Facebook visitors asked about the products in this and other store-related ads, and if 6th Grain had a physical store to buy these products. Because of these comments, there is a possibility that the popularity of this ad and other similar ads is because visitors believe we are carrying these products for purchase.



Examples of the least successful ads

During the entire ad campaign, our video ads stood out as the least successful or popular. We used short two to three-second clips with slogans scrolling across the page. This did not resonate with Facebook visitors, and our learn.ink registrations did not increase at the expected rate with the video ads. Several features of these ads played a role in their failure, most prominently the animated, colorful slogans. We think the bright colors may have put off visitors by being childish or garish in comparison to the natural color pattern and seriousness of the ads. The animated nature of the scrolling words may have also appeared cartoonish. Once we switched our ads to images, the number of learn.ink registrations, ad comments, ad shares, and overall engagement increased.



Ad creation is a fascinating exercise in human emotion, aesthetic, and messaging. We are on the right track to increasing our learn.ink registrations and FFL downloads, and there is always more to discover about the Kenyan grower audience.

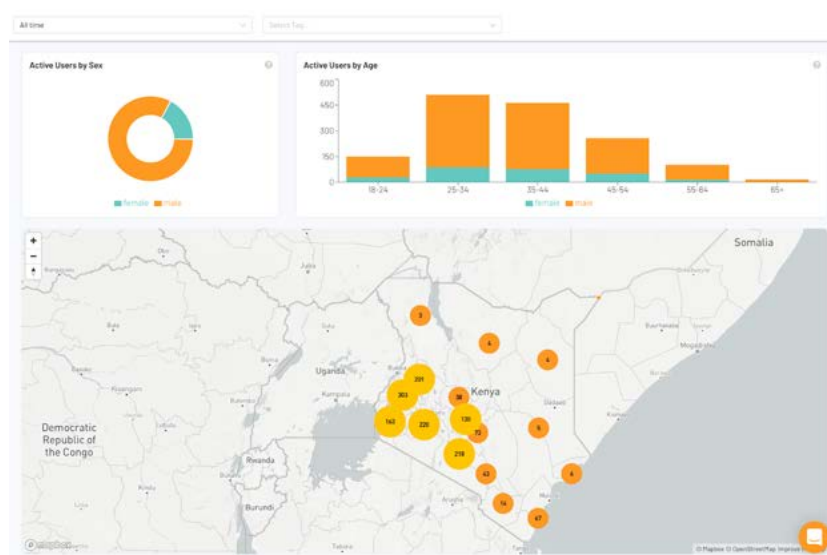


SMS campaign to get learn.ink registered users to download FFL

To help get users on learn.ink to download the FFL app, we launched a short lived SMS reengagement campaign with the following SMS messages:

- "The long rains are here! Now is the time to take control of your farm record keeping with FieldFocus Light. You have free access to the app, get it here <link> – do not delay!"
- "Hello, thanks for recently taking the digital course on farm mapping, you have been provided special access to the app, try it here <link>"
- "Hi the FieldFocus Light team have sent a tutorial in your inbox on how to map your farm, please download the app to access <link>"

The results of the SMS campaign raised engagement only slightly, which leads us to believe that SMS may be a useful tool in the near future but we need to make a more engaged and extended campaign to bear positive results. Below is a summary of the [learn.ink](#) FieldFocus Light community recruited through Facebook.



Outcomes of facebook advertising campaign

Prior to the "How big is Your Field" field mapping campaign, people were downloading and installing FFL through other means, such as word of mouth and seeing the app in the Google Play Store. Represented by the green line, these FFL installations increased over time, but at a lower rate than the field mapping campaign, reaching just over 600 installations. This data shows us that even outside of our targeted ad campaigns, FFL is being found, downloaded, and installed.

The field mapping "How Big Is Your Field" ad campaign added over 1500 cumulative installations, with a steeper increase in installations over the "Is Your Field Profitable" ad campaign. The ad images in the field mapping campaign which used UI elements were popular with the grower audience, as shown in this chart and in the interactions with Facebook users on the 6th Grain Facebook page and ads.

Advertising statistics

Starting on March 26, 2021 and ending on May 25, 2021, we achieved the following awareness with farmers in Kenya. Facebook is a unique and useful tool to engage with smart-phone-owning farmers in East Africa. Although these growers are typically more well-off than an average farmer, they are younger, technically literate and are often involved in groups or educational activities that they find out about via Facebook. In 2020, there were the following facebook subscribers in countries:

- > Kenya: 10,444,000
- > Tanzania: 5,223,000
- > Uganda: 3,328,000
- > Zambia: 2,543,000
- > Zimbabwe: 1,303,000

As a result of the \$2473 investment over three months on Facebook, we were able to provide the results summarized in the table below. The total ad spend for the primary Facebook Ad campaign was \$2352, and an additional \$122 for the pre campaign test.



Advertisement results

| Resources Invested | Results achieved | Explanation |
|---------------------------------------|----------------------------------|--|
| \$1.04 per registered user | 2,026 | When a visitor sees an ad from the campaign and click on the link, they are directed to the learn.ink registration page and asked to register. Only by registering on learn.ink can a person take the FieldFocus Light lesson modules. |
| \$0.28 per download clicks on the app | 8760 application download clicks | The number of times the link to the FFL Google Play store was clicked by a learn.ink user. The link is the one used throughout the lesson and course. |
| \$0.05 per click | 48,960 unique link clicks | Unique link clicks show the number of viewers that have click on a learn.ink link on one of our ads, not counting multiple clicks. |
| \$0.001 per impression | 1,784,320 ad impressions | An ad impression is a count of the total number of times a digital advertisement is displayed on a viewer's screen on the publisher's network. |

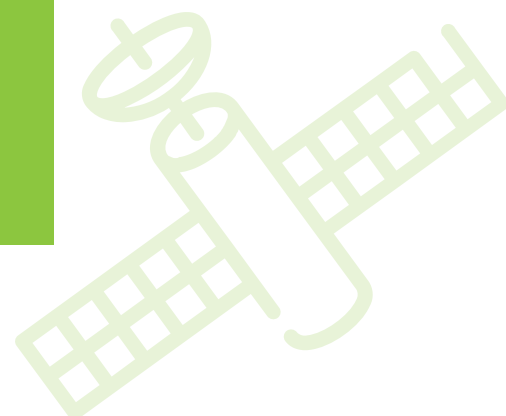
The \$1.04 per learn.ink registered user is a critical statistic because we can continually re-engage these users through an SMS platform, promote additional training on the importance of record keeping, understanding yield and production, and offer agronomic advice and other information. The cost of SMS sent to a learn.ink registered user is \$0.01. In those messages, we will include new links to trainings and simple messages about the value of knowing the size of the cultivated area. We intend to continue to engage with these registered farmers in the next few months.

Connecting the \$2473 spent in Facebook to FieldFocus Light usage is the next step. In our framework, the user clicks on the ad, goes to [learn.ink](#) and then after learning about what the application does and why they would want to use it, they can download the application. Thus below is another table showing the same Facebook investment but resulting in the downloading and use of the application.

FieldFocus downloads and field mapping

| Resources Invested | Results achieved | Explanation |
|---------------------------------|---|--|
| \$1.53 per app download | 1612 total FieldFocus Light application downloads during the three month period | Total downloads of FieldFocus Light application from the Play Store |
| \$ 1.89 per FFL registered user | 1308 registered FieldFocus Light users | Cost of download FFL app AND register on the app. Users must download the mobile FFL app before registering. |
| \$6.88 per digitized field | 359 total mapped fields in FFL | A field is considered mapped when the user completes walking around their field using the app and getting a mapped field confirmation from the FFL app. 193 users mapped at least one field. |
| \$22.08 per record in FFL | 112 fields mapped with crop type selected by user | Records include crop type, variety, planting and other details provided by the user |

The next section evaluates the data from the geospatial perspective.



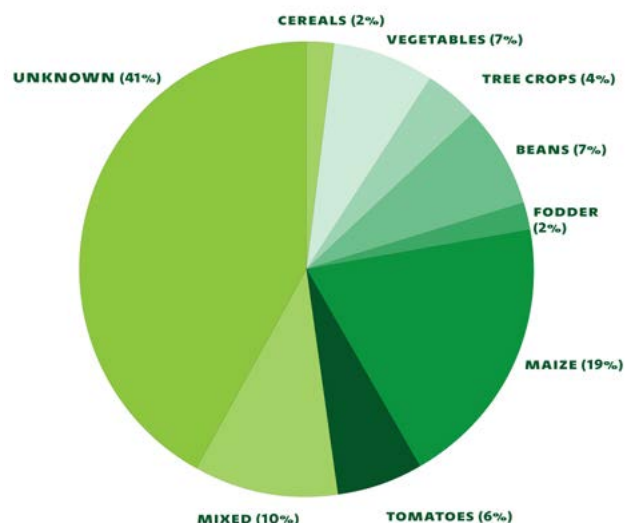
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Using field data as part of a remote sensing-based analysis

The objective of this project was to create a high quality, repeatable process that would allow for the generation of low cost, high quality ground-truth datasets that could be shared with the broader community. Here we used an Android application coupled with Facebook advertisements to promote the tool and gather ground data at a fraction of the cost of gathering the data directly. We also aspire to collect field management data that can be used to develop yield models and new cropped area maps from satellite data. Farm.ink used its online learning platform to redesign and then train Kenyan farmers on how to use FieldFocus Light. We then gathered field boundaries that can be transformed into anonymized analytical decision support products for the international community.



We found that FFL users digitized fields with 28 different crops, including mixed gardens with multiple crops or vegetables being cultivated in the space. The figure below shows the proportion of the total fields in different categories. Over 40 percent of the fields did not have any indication as to what was planted in them, since the user was interested only in obtaining the field area in response to the advertisement focused on 'How Big is Your Field?'. Our tool is designed to allow the user to obtain this information without providing crop type, crop area or planting date.



Evaluating spatial accuracy of self-mapped fields

How accurate were the field boundary data? A 'field' is defined as an area on the ground that has the same crop planted across the area, that has been managed in the same way and harvested at the same time. Here we evaluate whether two users could digitize the same field twice and get similar results, given differences in understanding of how to use the application, accuracy of the Android phone and GPS chip within each.

We identified forty users that downloaded FieldFocus-Light in Kenya and that digitized fields. We sent our Kenya collaborator to these fields to re-digitize them to:

- Assess the accuracy of boundaries when two different phones and users digitize the same field using the 'follow me' function;
- Ability of users to determine if their field has been accurately digitized; and
- Identify areas where we need to strengthen and enhance the User Journey to improve field boundary accuracy.

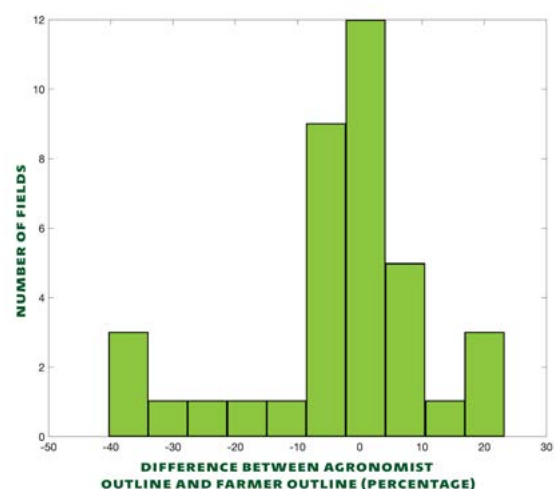
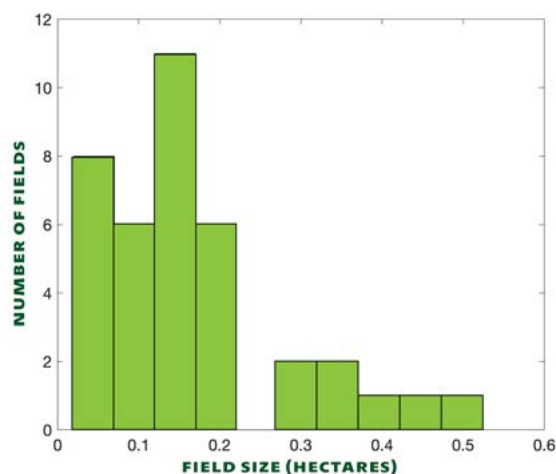
It was found that when fields were digitized by an untrained small grower and an agronomist with Android phones, they can reproduce field boundaries to within 103% of area and an average centroid distance of 2.6 m of each other, well below the geospatial accuracy of Sentinel 2a/b.



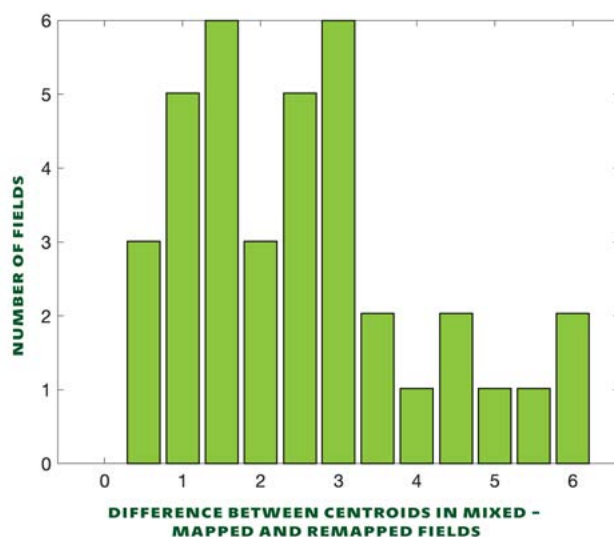


The image above shows two digitized outlines near Kabiye, Kenya (0.39369,35.06395) showing the original outline of the grower (in red) and the white outline of the agronomist (in white). The field size was 0.183 hectares.

Examining all 37 fields that were remapped, the mean field size was 0.17 hectares, with the largest being 0.5 hectares. The difference between the mapped and remapped fields is shown in the figure to the right in percent. The variation ranged from 40% to 30%, with equal number of fields being slightly larger when the agronomist remapped them and slightly smaller when the agronomist remapped them. The bias was 3%, which means that when the farmers mapped the fields themselves the fields were slightly smaller than when the agronomist mapped them.



The mean difference in centroids across the 37 remapped fields was 2.6m. This low difference provides confidence that when we register additional farmers via advertising and they download and use the FieldFocus Light tool, we obtain high quality boundaries that can be used by other researchers with confidence. The figure below shows the distribution of difference in centroids between the original field and that re-mapped by our agronomist, with 91% of the fields showing less than 5m difference, which is below the geospatial positioning error of the Sentinel 2a/b sensor. No systematic differences were detected in the errors between fields that were smaller vs those that were larger.



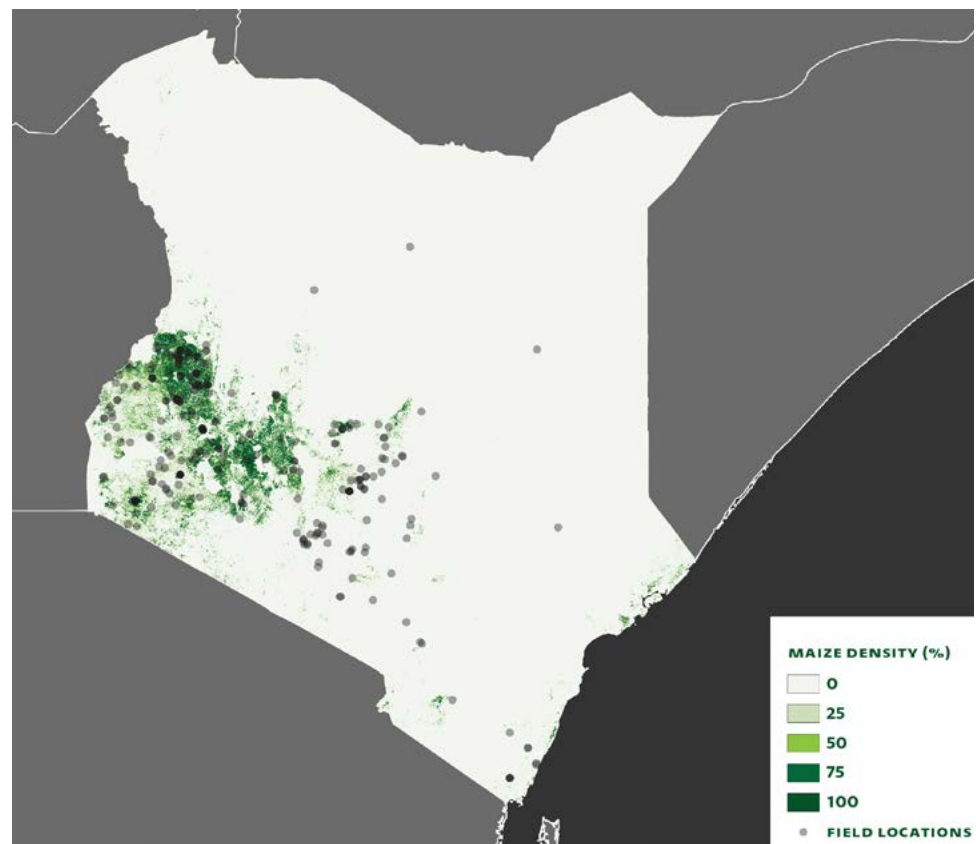
Although the digitized fields can be put on a geospatial image, these fields are typically too small and too new to be digitized without the 'Follow Me' function provided by the FieldFocus app. Examining the fields digitized by Kenyan farmers, only a small percentage are visible in the high resolution imagery. A good example is shown below on the left, where three fields have been digitized by a grower using the 'Follow Me' function, and then re-digitized by the agronomist. The image on the right is the location of these three fields near Mirira, Kenya (0°45'06.9"S, 37°13'44.2"E). Although clearly an agricultural area, the fields are not visible on the Google Earth image and would be impossible to see or digitize using a standard map interface remotely. Because we've advertised the tool to growers to digitize their fields to determine their size, this has resulted in a significant number of farmers who have used the tool to determine the size of new fields, recently cleared. Fields that have not been recently cleared are small portions of larger fields that are cultivated in a specific crop, such as strawberries, tomatoes or capsicum. These field portions are critical for calculating input expenses, yield and profitability for the farmer, but the differences cannot be seen from space in a single very high resolution image given the small field size.



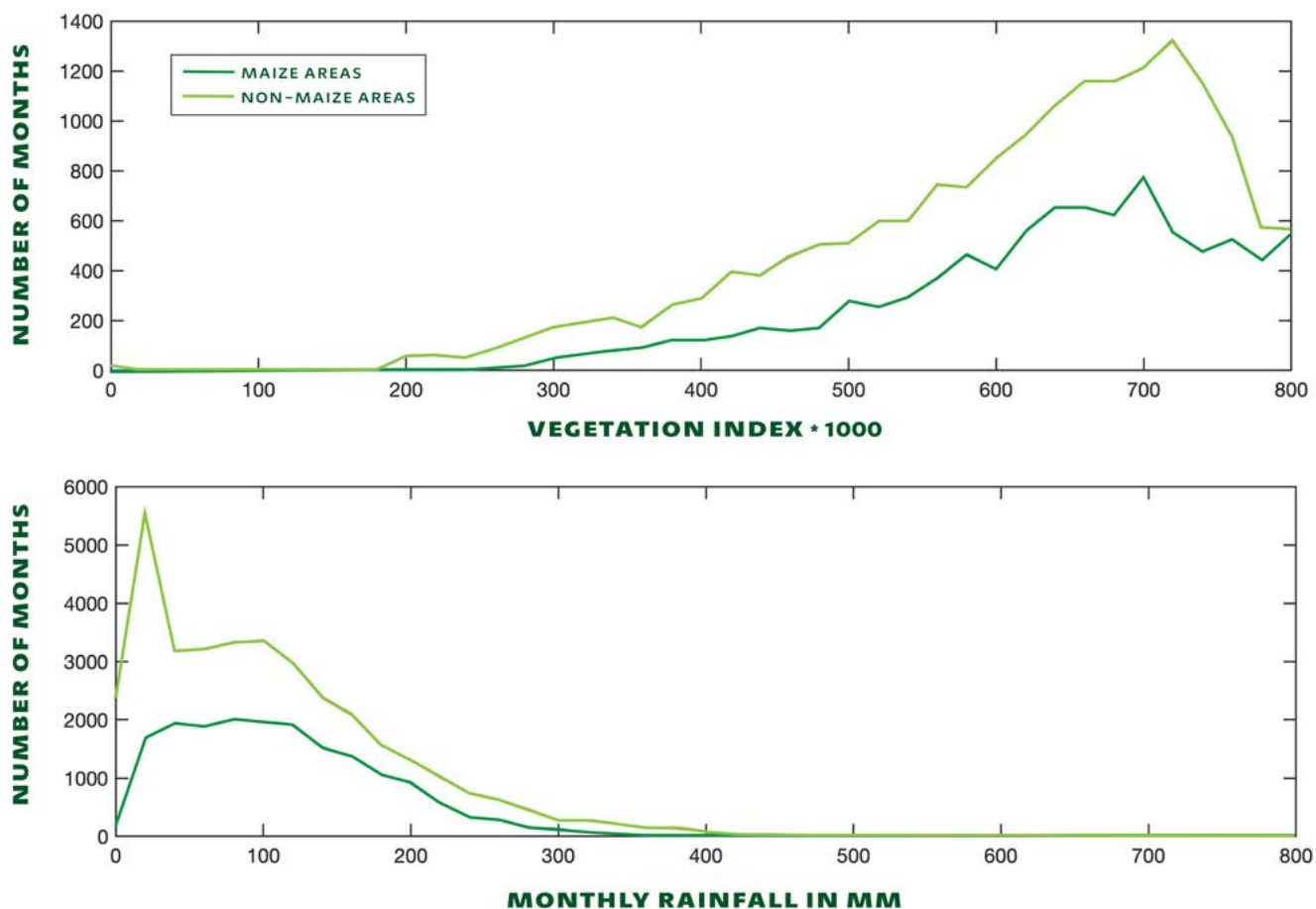
Remote sensing of cropped area and productivity

The ever-growing archive of new and historical satellite-derived Earth observation data provides an opportunity to underpin metrics that demonstrate which investments enhance global food security. Satellite remote sensing data can be used at each stage of the agriculture value chain to estimate productivity and plant health, but to provide information for decision making it must be connected with high quality, spatially explicit, regularly updated field data obtained from growers that captures agricultural activities. Although we are in a 'golden age' of satellite-driven Earth observation, transforming these datasets into information that can be used to change food security outcomes has proven challenging.

Metrics focused on raising yields must be able to capture climatic, economic and social outcomes of investment and changes of policy through time, and show clearly how new agriculture management strategies, technology and interventions can counter these pests while still reducing poverty and food insecurity. Information from FieldFocus Light can be transformed into improved advice, recommendations, market engagement and opportunities from the market. Big data approaches provide the opportunity to combine satellite remote sensing with legal, economic and food security outcomes in new and novel ways, particularly leveraging improved computing power and machine learning techniques.



The map shows Kenya with the locations, indicated by red dots, of digitized fields of farmers who have downloaded and used FieldFocus Light since the launch of the application on the Google Play Store on February 15, 2021. In addition to the Kenya fields, we also had one field digitized in Uganda (shown) and two in Nigeria (not shown). The map under the dots show the proportion of the area being cultivated in maize in 2019. Below is a graph showing that fields in regions with lower maize proportion have a higher biomass (upper graph) as measured by vegetation index, and higher rainfall over the past thirty years. Regions with higher productivity are used for the other crops that were digitized, including spinach, French beans, potatoes, cabbage, strawberries, capsicum, tomatoes, groundnuts, avocado, tea, coffee, and banana among others. FieldFocus Light is not only used for row crops as it can measure the area of any garden



In the next section we will summarize the work's contribution and the next steps in the project, which is to accelerate update and use of the tool through local agents and agronomists.

5

Lessons Learned

This project demonstrates an end-to-end process where funds invested in advertising will lead to digitized fields with information on crop type, without any on-the-ground or in-person engagement. We invested in modifying the Android application to create FieldFocus Light to create a very data-light, stable, and easily downloadable package. The application UX was simplified for a linear experience, and included video tutorial that ensured that the GPS chip was on and functioning for maximum ease of digitizing a field. We then constructed an advertising campaign with the help of our expert farmer, who engages with farmers across East Africa to ensure our messaging was compelling and of interest.





Our experience has shown:

- This was an experimental pilot, where we wanted to prove we had a scalable model to create a set of self-mapped fields from small-scale Kenyan farmers. This has been an overwhelming success, as we've built a 100% digital approach that can now be scaled up to map more fields in any geographic region using an innovative combination of 6th Grain and [learn.ink](#) technologies.
- We were able to deliver this project 100% remotely. The user testing, app interface redesign, app development, digital training development, digital campaign design and digital campaign delivery were all conducted without any of our operational team traveling to Kenya.
- Coupling a motivated development team, a mature geospatial application and rigorous usability testing, we have created a tool that has the potential for high uptake among smartphone-owning farmers in East Africa.
- A rigorous user testing approach was critical to developing a native Android smartphone application interface that enables the target user, in this case a small-scale farmer in Kenya, to map a field boundary and add crop data to it unaided.
- Advertising via social media is effective and scalable in promoting the use of an application to digitize a field to determine its size, with an impressive response to our campaign once we identified the best strategy for engagement.
- However, advertising with social media was only effective when directing the audience to a web-based, chat-bot style digital training to generate awareness and understanding of the Android application. This is critical, as the method of using digital advertising to directly onboard users to the Android application was far less effective (well over 10x the cost), even when the Android app had been redesigned.
- Although we were able to promote the use of FieldFocus Light to digitize a field to find out its size, only 59% of these users provided any information on what was grown in the field and only 43% used the in-app tools to identify the crop, variety and planting date, which is the first step in farm record keeping.
- Of the digitized fields, most were of high value crops such as banana, strawberry, tomato or other vegetable that could be sold in the market, with few fields dedicated to maize.
- Engagement of an agronomist or agent to recruit farmers who work with them will help us design UX features that will motivate farmers to keep records and better understand their farm profitability.

Our experience with this project brings confidence that with a focus on usability and the motivation of the user, we can design a system that will not only provide high quality, annually updated field boundaries, but also be scalable across East and Southern Africa.

6

Why field boundary data collection at scale in Africa is needed and next steps

High quality, accurate, annually updated information on total grain production for each field combined with field size is necessary to estimate yield. These data need to capture not only crop type and variety, but also management strategy, such as information on fertilizer timing and quantity, planting density, weeding protocols, and pest and disease prevalence. Given the hundreds of millions of small growers around the world, the large number of varieties available, and the need to continuously update the information, keeping the cost per data point as low as possible is essential. High quality yield estimates underpin financing which then provides access to additional technology, as well as insurance products needed by millions of farmers facing increasingly uncertain weather. Using insurance to transfer the risk of buying high quality seeds and inputs to the private sector allows for the expanded use of inputs. This transfer of risk also provides information to evaluate whether these inputs provide substantially higher yields year over year.



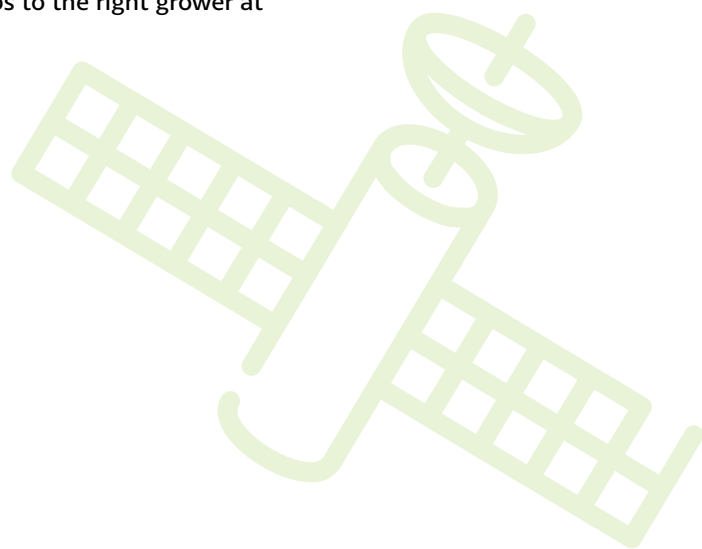
The first step in estimating yield is knowing the size of the planted area for a particular crop. Here we have shown the feasibility of a mobile application on a smartphone, social media advertising and innovative mobile chatbot technologies. The private sector can train a large base of smartphone-owning farmers around the world to create field boundaries to estimate field size. New yield models are needed to estimate the likely impact of weather shocks on outcome. Small growers can digitize their field by walking around it, capturing GPS points which are sent to a server, together with crop, variety and date planted information.

Next steps

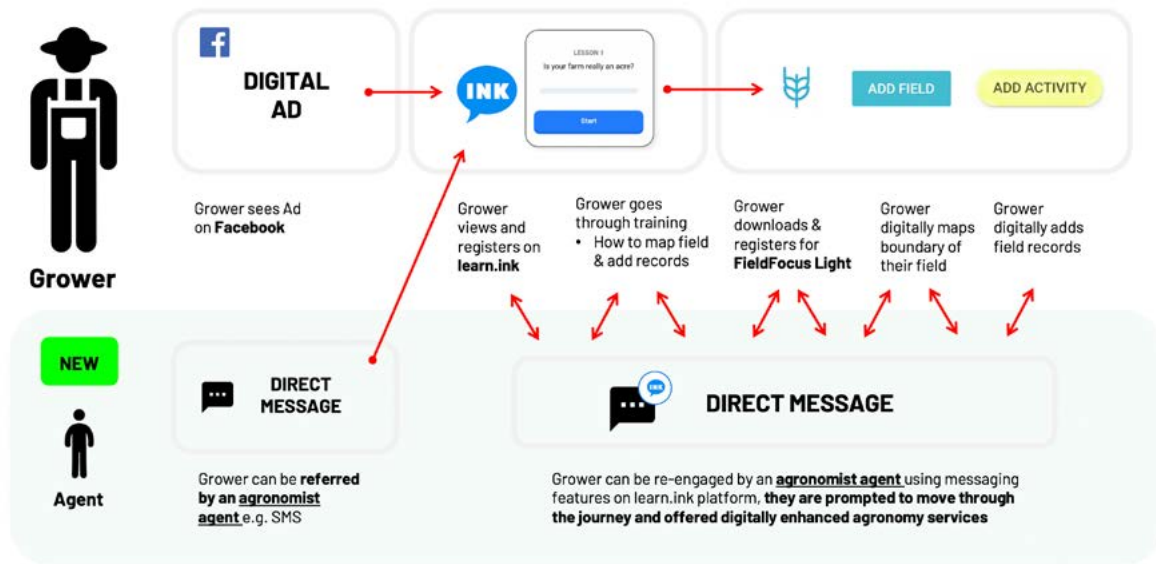
We have found that advertising a simple, singular idea such as 'How big is your field' is ideally suited to the suite of tools that we have implemented. However, we have found that a larger, more complex idea of the benefits of record keeping and management of investment in agriculture is far more complex. This more complex idea is more difficult to convey in a simple advertisement.

We therefore propose to drive both knowledge of the FieldFocus Light tool and the use of the record keeping by engaging with agronomists. The reason why a farmer who previously kept records in their head, or on a notepad, would use an app for this is primarily to share these records. An agronomist, particularly one connected to financial, technical or information outside of the circle of a farmer would motivate a farmer to create and share her records with them to get access to advice. The engagement of a local expert would be a substantial incentive to use the app.

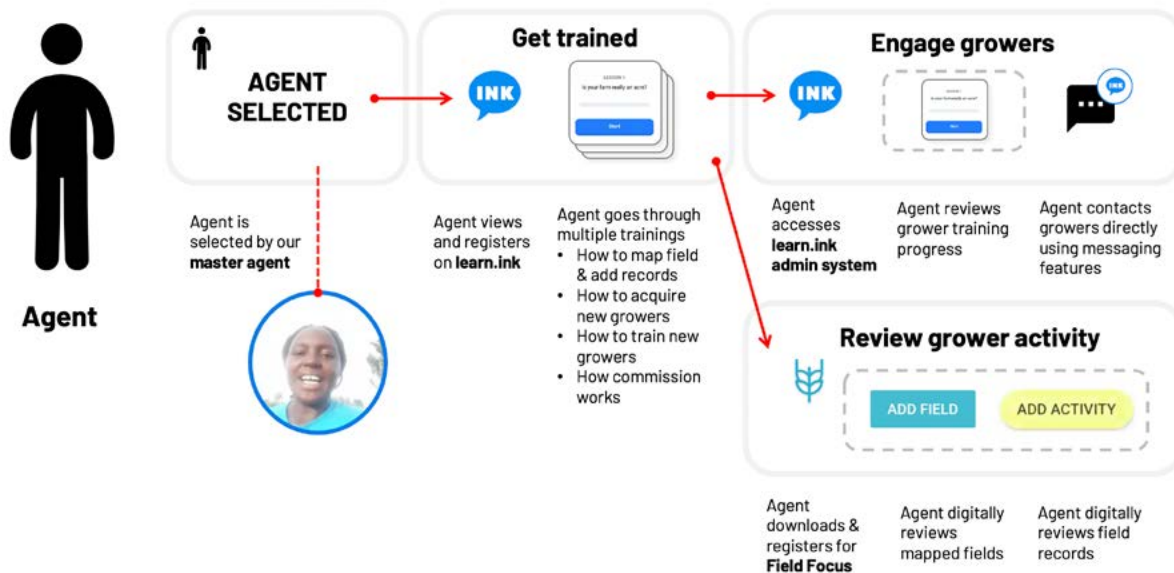
We can also recruit and train new agronomists and agents into working with us as 'expert farmers'. By leveraging the [learn.ink](#) platform, we can engage with smart and well-connected growers across the agricultural community. These growers can learn about new opportunities, inputs, agricultural technologies and hazards as they occur and then convey them to their network of farmers who have digitized their fields. Agents can then direct specific information about specific crops to the right grower at the right time.



Updated grower user journey



Agent user journey



User journeys below describe at a high level of detail exactly what steps different users take to complete a specific task within a system, application, or website.

This figure shows the current (as-is) user workflow, and reveals areas of improvement for the workflow. Here we use this concept to improve the experience of smallholder farmers in Kenya when using the FieldFocus Light app to map their field and to keep records. By extending this improvement journey to agronomists, we will bring the same level of detail and focus on improving the user experience to agents and agronomists. This newly created network can then enhance and accelerate the movement of high quality input advice and recommendations from input providers, off takers, and financial service providers through to growers with smartphones and without ever visiting the country.



**Enabling Crop
Analytics At Scale**

Unlocking the Potential of Satellite-based Data and Analytics for Smallholder Farmers

The Enabling Satellite-based Crop Analytics at Scale (ECAAS) Initiative is a multi-phase project that aims to catalyze the development, availability, and uptake of agricultural remote-sensing data and subsequent applications in smallholder farming systems. The initiative is funded by The Bill & Melinda Gates Foundation and implemented by Tetra Tech.

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Final report

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