



UPSCALE

UPSCALING THE BENEFITS OF PUSH-PULL TECHNOLOGY FOR
SUSTAINABLE AGRICULTURAL INTENSIFICATION IN EAST AFRICA



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D8.8:
**Adaptation of the e-Granary App
for integration of push-pull farmers**

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Abstract:	<p>Push-pull technology (PPT) offers smallholder farmers important benefits as it involves a combination of crops, with each crop contributing to the system. Compared to the usual mono-cropping or many current indigenous farming practices, farmers who practice PPT reap multiple benefits. Proper dissemination is therefore important for farmers to uptake and apply PPT appropriately. The Eastern Africa Farmers' Federation has developed a digital platform dubbed e-Granary that allows smallholder farmers in different value chains to register, as well as request and receive relevant farming and/or market advisory services. Through Short Messaging Services and Outbound Voice Recordings, the platform regularly notifies registered farmers on best agronomic practices and relevant services. Additionally, farmers can request inputs through the platform, while reports relating to specific services are generated by the e-Granary. This report describes and demonstrates how the e-Granary platform has been adapted within the UPSCALE project to disseminate and gather information, and for report generation, as an output of the project action toward ensuring widespread and sustained uptake of PPT by farmers. The e-Granary platform was customized with add-on features that support registration of new farmers and bulk messaging to registered farmers, including a user-friendly farmers' feedback interface. An overview of the platform, customization and integration with the UPSCALE Knowledge Exchange Hub (KEH) as well as the dissemination plans and campaigns/messaging schedules are outlined in the report. Project partners will generate relevant PPT information in farmer-friendly formats, and determine the frequency of information sharing to the farmers. PPT dissemination through the customized e-Granary is expected to increase adoption, technical capacity, and profitability among farmers.</p> <p><u>Keywords:</u> Dissemination, Digital platform, Push-pull technology</p>

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List of Abbreviations and Acronyms

PPT	Push-pull technology
KEH	Knowledge Exchange Hub
CAADP	Comprehensive Africa Agriculture Development Programme

1 Introduction

The e-Granary platform is a mobile and web-based digital platform and an innovative solution established as one-stop shop that brings together economic services for farmers while tackling the challenges faced by farmers including access to markets, affordable financial and extension services.

The innovation stems from the following:

- Use of mobile technology to gather information at the farmer level.
- Use of a mobile platform to aggregate services in a virtual form, to attract partners providing an array of different agri-services
- Linkages to the business partners like input and output service providers while de-risking farmers through well-structured bundled services with insurance product components.
- Concept development, ownership, and management of the initiative by existing farmers' organizations.

The functionalities of the app provided through a dashboard interface include: Value chains, Farmer profiles, crop-related data, digital connectors/enumerators involved in registration, payments, and extension services. The platform has been used to register farmers, service access and reporting. Coupled with USSD code application, the app offers opportunities for farmers to explore relevant information and services.

Currently the e-Granary app is implemented in Kenya, Rwanda and Uganda. Complementary apps such as E-Kilimo¹ are used in Tanzania, whereas currently no similar app is in use among farmers in Ethiopia. The work on e-Granary presented in this report is proposed as a blueprint for integration into the E-Kilimo app to support further dissemination among Tanzanian farmers. In UPSCALE, the e-Granary has been adapted for push-pull farmers to support and boost their integration in mainstream agricultural infrastructures, as well as to support widespread dissemination of the push-pull technology (PPT) among farmers not yet aware or practicing it. The present report describes the functionalities of the app and what adaptations were performed towards this aim, as well as the strategic plans for leveraging the potential of the adapted app for PPT dissemination and training among smallholders.

2 E-Granary app description and functionalities

2.1 Main components of the e-Granary app

2.1.1 Farmer listings

The app allows farmers to register and become users of the platform (Figure 1). The registration entails capturing farmers' biodata, location and value chains. Upon registration, the data from the backend can be disaggregated by country, value chain, age and sex. Data on production among the different groups can be generated, compared and represented in different forms. Contact data of farmers are maintained confidentially on the e-Granary server and any sharing of data within the UPSCALE consortium occurs following anonymization according to the General Data Protection Regulation (GDPR) of the European Union (see also UPSCALE Deliverable 10.2 Ethics).

¹ https://play.google.com/store/apps/details?id=com.bigwa_fdc.e_kilimo&hl=en&gl=US&pli=1

The screenshot displays the e-Granary app platform interface. On the left is a navigation sidebar with options: Dashboard, Value Chains, Farmer Profiles, Crop Collateral, Crop Production, Crop Aggregation, Crop Planting Inputs, Crop Enumerators, e-Extension, e-Payments, Money In, Money Out, SUPPORT, Users, and Settings. The main content area is titled 'FARMER LISTINGS' and includes a search bar, 'IMPORT' and 'FILTER' buttons, and a summary dashboard with 12 cards for various metrics: TOTAL FARMERS (262,543), KENYA (206,849), TANZANIA (0), ETHIOPIA (0), UGANDA (35,965), RWANDA (19,729), TOTAL ACREAGE (3,363,363), YOUTH (220,070), ADULT (42,473), MALE (143,275), and FEMALE (119,069). Below the dashboard is a table of farmer entries with columns: # Id, name, phone, email, national id, itax, gender, yob, organization, country, province, district, and location. The table shows 10 entries, with the first four detailed below.

# Id	name	phone	email	national id	itax	gender	yob	organization	country	province	district	location
# 247043	zziwa vincent	+256 781 003617	[X]	009556815	[X]	♀	1955	[X]	uganda	central	mubende	kassanda
# 179774	zziwa steven	+256 781 864280	[X]	17509662	[X]	♂	1990	FOODNET	uganda	central	kyankwanzi	kyankwanzi
# 180391	zziwa labison	+256 778 256536	[X]	[X]	[X]	♀	1965	FOODNET	uganda	[X]	[X]	twezimbe
# 1377	zziwa laopheth kvevune	+256 701 090273	[X]	cm79023107813l	[X]	♀	1979	FOODNET	uganda	[X]	[X]	luweero

Figure 1. Farmer listings and overview of the e-Granary app platform interface

2.1.2 Message texting services

The e-Granary app's messaging functionality is used to share messages directly with farmers and has been applied to date among registered farmers in Kenya, Uganda and Rwanda (Figure 2). The app is designed to allow blasting of messages in bulk for extension of information to smallholder farmers. The messages are outbound and are sent at different periods depending on the relevance of the message. For example, messages on application of fertilizer and postharvest handling are sent during planting and harvesting, respectively. Economic services such as loan repayment by farmers, information on access to inputs and other useful information like Covid 19 awareness have been extended to the farmers using the platform. Information racking on the services can be generated and used for decision making and advice on critical factors within the farming chain.

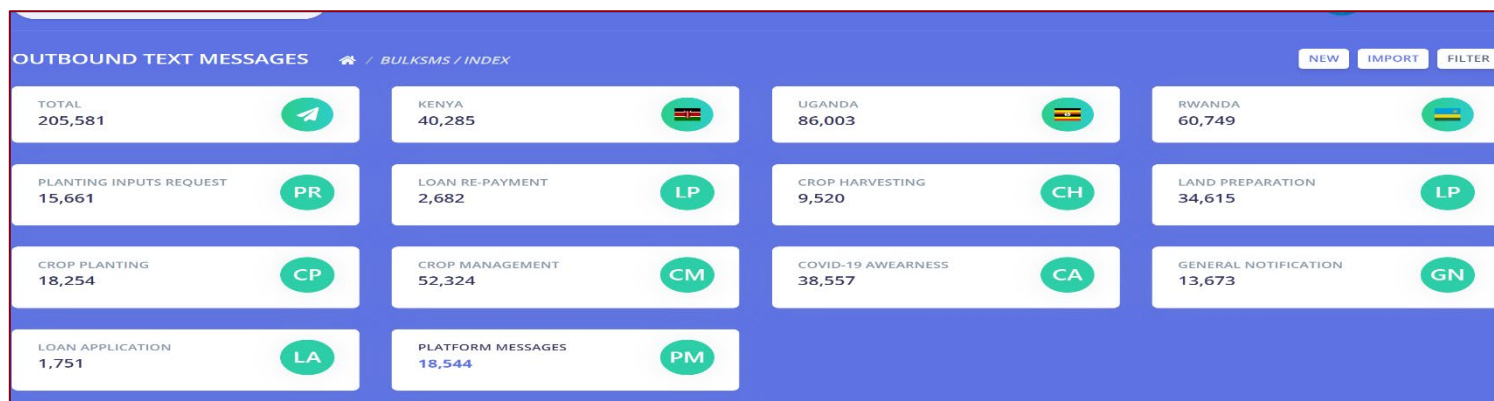


Figure 2. Message texting services

2.1.3 Voice recordings

In addition to written messages, the app allows outbound voice recordings where videos of different technologies can be sent to farmers.

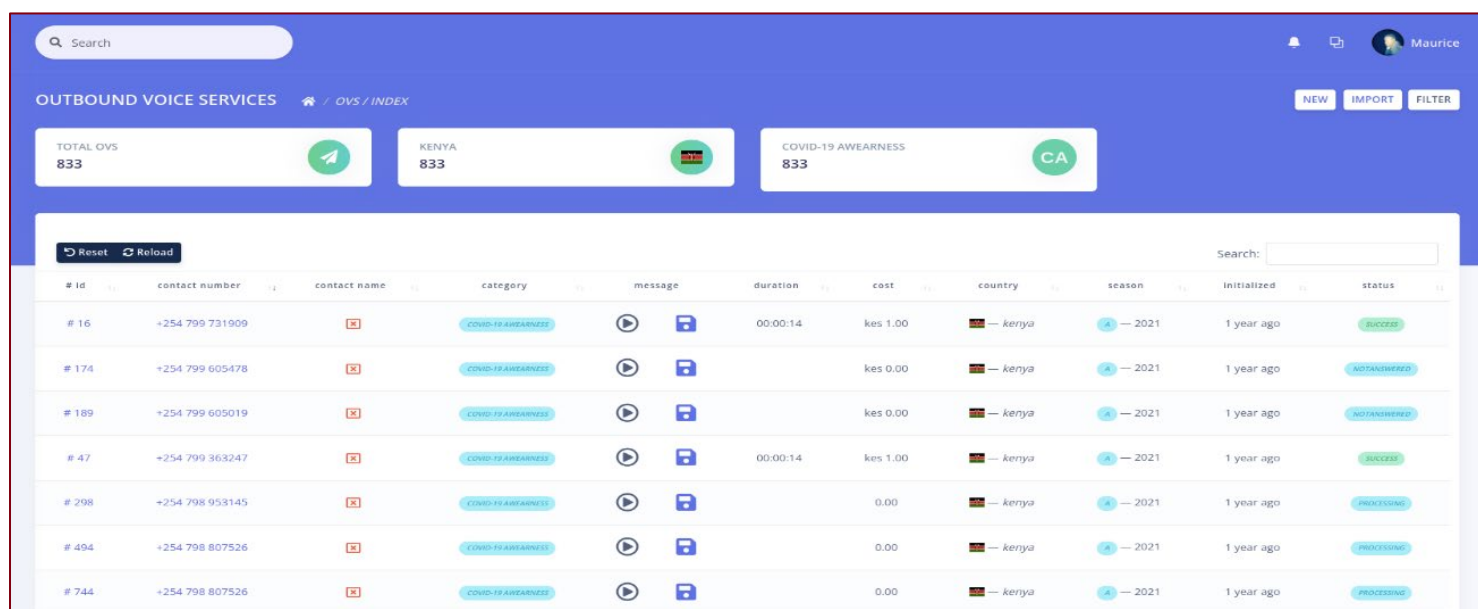


Figure 3. Voice recordings

2.1.4 E-Granary dashboard

The platform generates reports where different variables can be compared and represented graphically. Reports can be generated on number of inputs accessed by farmers (in total or for individual input products like fertilizers); planting reports (for example, statistics of number of farmers

planting soybean/maize/common beans/green-grams, the planting dates, access to planting information like windows among farmers, germination percentages, instances of pests and diseases; harvesting reports (e.g., data on number of farmers whose produce has been harvested, quantities harvested, aggregated produce for groups or cooperatives, quantities of marketable produce, quantities of storage inputs (pesticides, bags) required. Reports from different countries can also be generated and a comparison done in relation to different factors such as productivity, input usage, service requests like mechanization, farmer demographics, etc. Owing to the cooperative model taken by the Eastern Africa Farmers Federation, registered farmers indicate the name of their cooperative or group during the registration. As such, reports can be generated to compare the groups. The cooperative approach supports economic service provision among the farmers due to ease of aggregation, reduced operation costs for services like mechanization, subsidized credit facilities and group guarantee for farmer group membership which builds confidence for financial institutions to lend (makes farmers bankable).



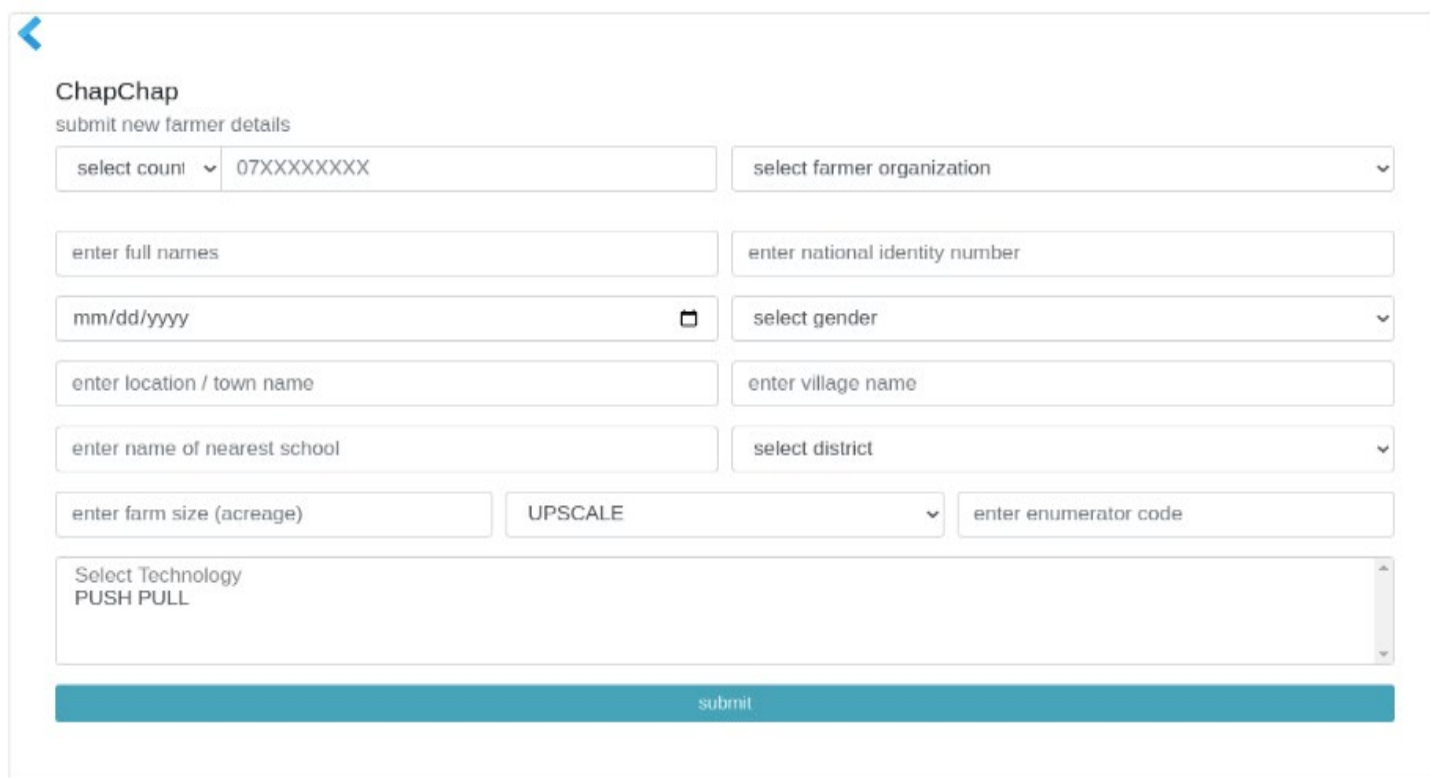
Figure 4. The e-Granary Dashboard includes a graphical representation of each data component

Farm operation category analysis done through the e-Granary platform informs on different aspects of the categories. Crop management for example, includes information on pest and diseases management, top-dressing fertilizer, quality of produce as relates to market requirements among other aspects.

All the data-related analyses inform on decisions and course of action for enhanced agricultural productivity.

2.1.5 Input chapchap

Input chapchap is an app that provides an in-built form where farmers can subsequently request inputs by entering the specific input requirement and the quantity. The application is user friendly and can be accessed through a link that allows the farmer to request inputs. Input requests, when submitted at the end of data entry by the farmers, appear on the backend in real-time. The app has been trialled in Kenya and Uganda with success. However, the use of the input chapchap app by farmers for input request is a second stage after registering on the e-Granary platform; this means only farmers who are registered can request inputs. The app captures the farmer details and the input required.



The screenshot shows the 'ChapChap' app interface for submitting new farmer details. The form includes the following fields and controls:

- select counl** (dropdown menu) with the value '07XXXXXXXX'.
- select farmer organization** (dropdown menu).
- enter full names** (text input field).
- enter national identity number** (text input field).
- mm/dd/yyyy** (date input field) with a calendar icon.
- select gender** (dropdown menu).
- enter location / town name** (text input field).
- enter village name** (text input field).
- enter name of nearest school** (text input field).
- select district** (dropdown menu).
- enter farm size (acreage)** (text input field).
- UPSCALE** (dropdown menu).
- enter enumerator code** (text input field).
- Select Technology** (dropdown menu) with the value 'PUSH PULL'.
- submit** (teal button at the bottom).

Figure 5. Input chapchap: an easy-to-use app that is used by e-Granary to collate farmer input requirements

2.2 Adaptations of the e-Granary App for integration with push-pull technology

2.2.1 App changes in support of dissemination

The platform has been customized to accommodate push-pull farmers, collect information, disseminate PPT-related information and determine the level of farmer knowledge on the technology.

The customized app has two levels of data collection; (i) farmers already registered on the platform and (ii) non-registered farmers. Information from the two groups will be collected through a different assessment tool. Registration campaigns will be organized to bring new farmers on board including in the course of dedicated push-pull dissemination events (see UPSCALE Deliverable 8.2). This will be done in a hybrid approach, physically and through the digital platform. Trainings are tailor-made based on the level of understanding of the farmers to the technology.

The changes include categorizing farmers based on their knowledge of PPT to ensure the right messages are disseminated to the right group, e.g. for farmers that are already practicing push-pull. Information on other alternative crop combinations, management advice and the availability of desmodium seed and markets for companion plants form the basis for the engagement and dissemination to already practicing farmers, whereas potential new adopters are targeted with information on how the technology works, its benefits and where to obtain information and inputs.

The changes enhance the app to send targeted information and videos about the technology. It also facilitates reporting by enabling quantitative analyses of different dissemination, adoption and production components. The app allows farmers to register when campaigns are launched to ensure bulk registration and information dissemination to interested farmers.

2.2.2 Adaptations of the e-Granary input chapchap for push-pull integration

The e-Granary input chapchap app has been adapted to gather and disseminate information on PPT practice by farmers. Using a set of questions designed for input either upon registration (new farmers) or posterior to registration (already registered farmers), the app has been customized to capture data both on farmers who already adopted PPT and on new adopters. At the initial stage, farmer data will be collected in relation to their use and awareness of PPT in order to sort them into categories; thereafter, tailored messages and recordings will be sent to the different categories of farmers in the context of PPT dissemination campaigns (see Section 3).

The adapted input questions are presented in the screenshots below (Figures 6-9). They can be accessed at the following registration URL: <https://upscale.e-granary.com/platform/initialize>.

1) Have you heard about push pull technology?

Yes
 No

NEXT >

2) How did you learn about push pull technology?

YouTube & online tutorial
 Neighbors & family
 Manuals
 Farmer to farmer
 Expert advisors
 Demonstration plots
 Seed providers

Add other comment
Itaque accusamus ut

< PREVIOUS NEXT >

3) Have you received training on push pull technology?

Yes
 No

< PREVIOUS NEXT >

4) Which training did you receive?

How the concept works
 Plant management in season
 Plant integration
 Harvest management
 Soil fertility

Add other comment
Doloribus optio do

< PREVIOUS NEXT >

5) Who facilitated the training?

Government entity
 NGO entity
 Private company
 Education institution
 Research organization

Add other comment
Consectetur nesciunt

< PREVIOUS NEXT >

6) Whats the frequency of the training?

One time training
 Every 3 months
 Every 6 months
 Every 1 year

Add other comment
Qui in praesentium n

< PREVIOUS NEXT >

Figure 6. Input chapchap post-registration questions on awareness and training of PPT

7) Are you practising or have you practised push pull technology?

Yes
 No

< PREVIOUS NEXT >

8) What Constrains did you target, with push pull technology?

Striga
 Fall armyworm
 Stemborer
 Vegetable pest
 Soil fertility
 Fodder
 Seed providers

Add other comment
Amet pariatur Quia

< PREVIOUS NEXT >

9) Which crop combination do you use with push pull technology?

Maize
 Sorghum
 Disodium
 Napier grass
 Brachiaria
 Vegetables
 Legumes
 Trees & shrubs

Add other comment
Autem excepturi cum

< PREVIOUS NEXT >

10) How long have you practised push pull technology?

Less than 1 year
 1-2 years
 More than 2 years
 More than 3 years
 More than 4 years
 More than 5 years

< PREVIOUS NEXT >

11) If you are no longer practising push pull technology, why did you stop?

No more pest
 No more striga
 Not in cultivation season
 Labour intensive
 Technology failed

Add other comment
Anim fugit minim ac

< PREVIOUS NEXT >

12) Has push pull technology, benefited you since adoption??

Yes
 No

< PREVIOUS NEXT >

13) How has push pull technology benefited you?

Low
 Average
 Good
 High

Add other comment
Quas fuga Expedita

< PREVIOUS NEXT >

Figure 7. Input chapchap post-registration questions on practice of PPT

Figure 8. Input chapchap questions on general farming practice

Figure 9. Overview of adapted input chapchap questions for integration of PPT in e-Granary dissemination

The back-end dashboard for administrators of the adapted e-Granary app is built similarly to the original (Figure 4 above). It includes additionally the data provided by the above questions to be filled in by farmers when logging in or registering to the adapted version of the app (Figure 10), as it is rolled out by participating partners during forthcoming dissemination activities and events (see Section 3 below).

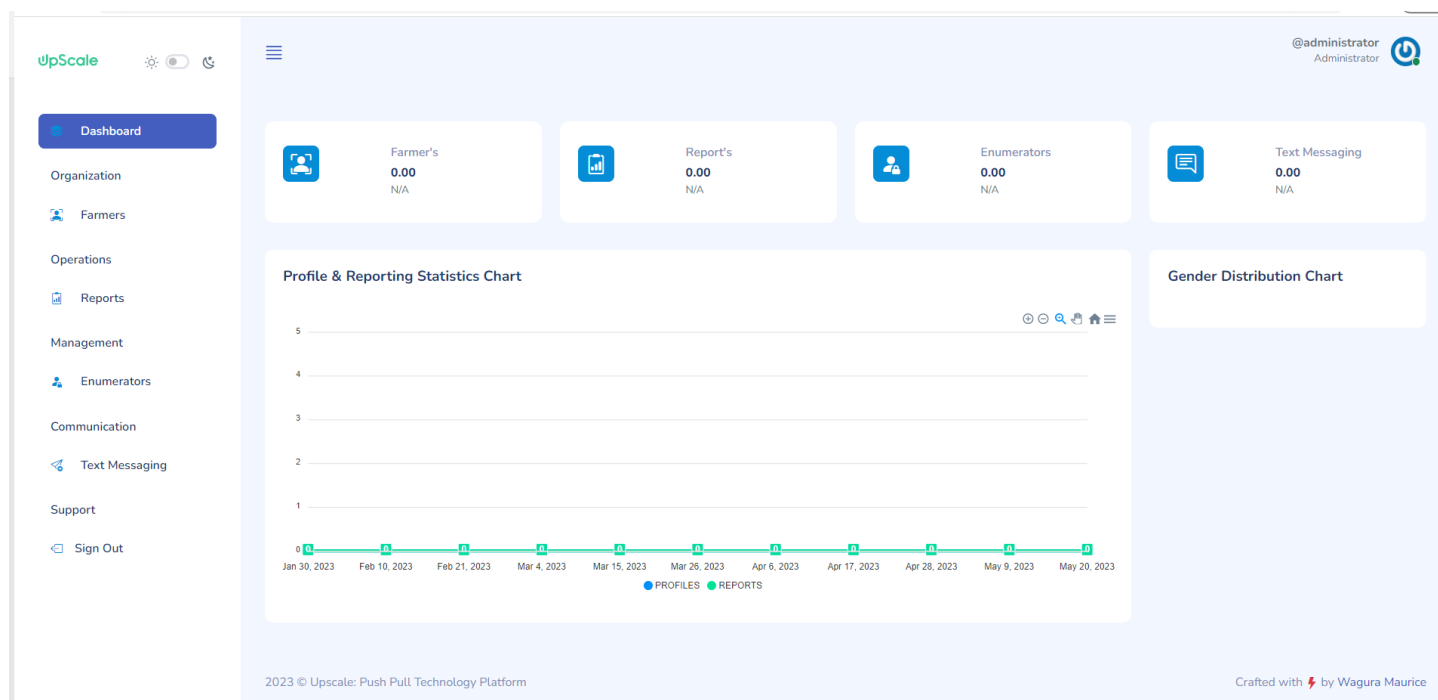


Figure 6. E-Granary adapted Dashboard before entry of push-pull farmer data

2.2.3 Linkage between e-Granary and KEH

2.2.3.1 Overview

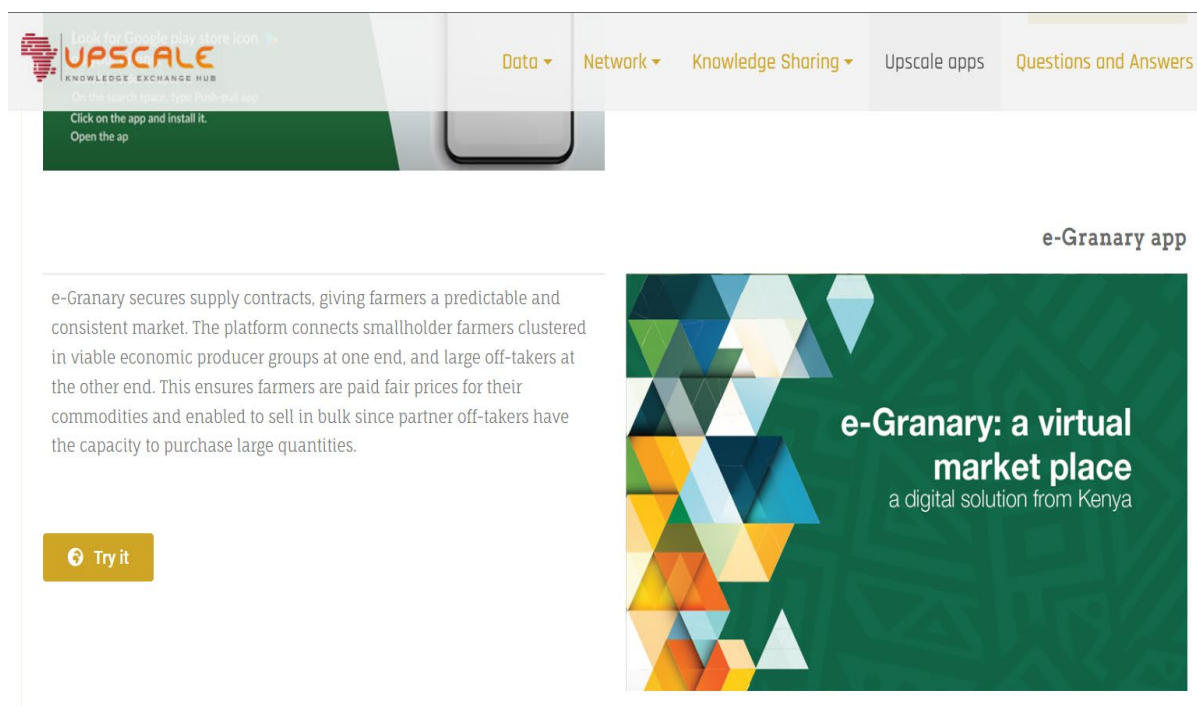
The customization supports a linkage to the UPSCALE Knowledge Exchange Hub (KEH) for enhanced access to well-packaged push-pull information, videos, messages, and other materials generated. The linkage between e-Granary and KEH is done in two ways:

1. A shared API for the KEH to directly link to e-Granary and access the materials and information.
2. At the same time, messages sent to farmers through the platform will bear a short link to the KEH that provides farmers with access to a brief description of the PPT and how to access further information.

The data exchange process proceeds with regular update of content foreseen at the start and end of each cropping season.

2.2.3.2 Linking user interfaces

On the KEH, a promotional banner is inserted on the page 'UPSCALE apps' (<https://upscale-hub.eu/upscale-apps/>). The banner leads to the e-Granary web platform for registration (<https://e-granary.com/chapchap>). This action promotes the application and it is easy to implement by users already familiar with the KEH. Furthermore, e-Granary will also be listed in the KEH section under development 'Find contacts near you' (<https://upscale-hub.eu/network/>) which will include interactive map listings of push-pull Knowledge Centres and input suppliers in addition to the value chain infrastructure provided through e-Granary.



The screenshot shows the UPSCALE Knowledge Exchange Hub website. At the top, there is a navigation bar with the UPSCALE logo and menu items: Data, Network, Knowledge Sharing, Upscale apps, and Questions and Answers. Below the navigation bar, there is a search bar and a section for the e-Granary app. The e-Granary app section features a green background with a colorful geometric pattern of triangles. The text on the page reads: "e-Granary secures supply contracts, giving farmers a predictable and consistent market. The platform connects smallholder farmers clustered in viable economic producer groups at one end, and large off-takers at the other end. This ensures farmers are paid fair prices for their commodities and enabled to sell in bulk since partner off-takers have the capacity to purchase large quantities." Below this text is a "Try it" button. To the right of the text is a graphic with the text: "e-Granary: a virtual market place a digital solution from Kenya".

Figure 71. E-Granary presence within the UPSCALE Knowledge Exchange Hub (<https://upscale-hub.eu/>)

2.2.3.3 Data collection

Data collected through the e-Granary, after anonymization and aggregation to remove sensitive personal data, is uploaded to the UPSCALE database and is available for download to registered users only (see also the UPSCALE data management plan, Deliverable 9.3), while the metadata is freely available for viewing. On the KEH, a link to all the datasets is provided through the Statistics page (<https://upscale-hub.eu/data/statistics/>) with data from the e-Granary found directly in the database (<https://www.upscale.biozentrum.uni-wuerzburg.de/Download/ShowXml.aspx?DatasetId=10400>).

	variableName	typeOfVariable	unit	description	accuracy
1	Order	integerNumber	none	the original row order of this record	definition
2	Country	character		country where this farm is in	definition
3	County	character		administrative county of this farm	definition
4	Village	character		Village name	definition
5	AgeGroup	integerNumber		Age group, based on pre-defined classes	definition
6	Gender	character		Male or Female	definition
7	FarmSize	realNumber	square meters	Areal extent of cropland	measurement
8	SeedVarietyMaize	character		Maize variety planted	measurement
9	SeedQuantityMaize	realNumber		Quantity of seed planted on the cropland	measurement
10	FertilizerType	character		Name/ type of fertilizer used	measurement
11	InsecticideType	character		Name/ type of insecticide used	measurement
12	HerbicideType	character		Name/ type of herbicide used	measurement
13	GrainYieldGRADE1	realNumber		Quantity of maize grains sorted as GRADE 1 quality	measurement
14	GrainYieldGRADE2	realNumber		Quantity of maize grains sorted as GRADE 2 quality	measurement
15	GrainYieldUNGRADED	realNumber		Quantity of maize sorted as UNGRADED quality	measurement
16	NoOfBagsHarvestedMaize	realNumber		Total number of bags of maize harvested	measurement

Figure 82. Metadata structure of the e-Granary records uploaded to the UPSCALE database (<https://www.upscale.biozentrum.uni-wuerzburg.de>)

3 Strategy for leveraging the adapted e-Granary in support of knowledge creation, dissemination, and capacity-building

3.1 Context of technology information delivery mechanisms/scaling up approaches

The African Union's Comprehensive Africa Agriculture Development Programme (CAADP) Pillar IV emphasizes not only the generation of improved agricultural technologies but also systems, approaches and capacities that can enhance their utilization and impact. Among them is the empowerment of end users, especially smallholder men and women farmers. It focusses on:

- a) enhancing the rate of adoption and effective utilization of most effective agricultural knowledge, information, and technology with particular attention to reduction of costs and risks of adopting new technologies and practices;
- b) institutionalization of delivery and promotion systems that quickly bring innovations to farmers and agribusiness;
- c) efficient and effective generation or adaptation of new knowledge and technologies; and
- d) empowerment of farmers through their associations and networks and transforming them into more potent actors in the agricultural system.

Adoption of agricultural technologies like PPT attracts considerable attention because it provides the basis for increasing production, incomes, and food security in sub-Saharan Africa. Access to quality

information is critical for adoption to take place and the final decision of an individual farmer to adopt a new technology primarily depends on his/her ability to acquire, process, and to decode the information related to the farming practices and the technological innovation itself. Providing information to producers changes their perceptions by reducing uncertainty about the technology, which is very important in the adoption decision. This, however, depends on the appropriateness of the approach(es) used to deliver the information. There is a strong relationship between dissemination approaches and technology adoption. An approach can be considered effective if it can shift farmers' perception towards adopting the technology to yield its benefits. The impact of the information source on adoption seems to be related to the technology in question. Some technologies may diffuse naturally within the social system, but for knowledge intensive technologies like PPT, more intensive information sources are likely to be required.

3.2 How the adapted App will be used in training and dissemination

The adapted e-Granary mobile phone App will be used to evaluate how different training and dissemination approaches influence not only the adoption process, but also the speed of uptake and the continued use of the PPT. This understanding is critical to develop an effective technology transfer strategy that promotes maximum adoption of the technology.

The demand to reach a greater number of geographically dispersed farmers or farmer groups in East Africa has made it necessary to complement existing PPT dissemination pathways (printed material, mass media, field days, farmer field schools, farmer teachers, public meetings) with mobile phone technology as a possible cost-effective solution for optimum push-pull dissemination.

The use of the mobile phone App will enhance the scope for immediate feedback in collecting field data, farmer mobilization and providing farming advice, monitoring, and evaluation of technology implementation activities, and providing real-time information on sources of farm inputs. Moreover, the use of the App has the potential to increase the amount of information provided to a greater range of stakeholders at a reduced cost relative to other channels used previously, and has a great potential to complement other existing dissemination strategies.

The mobile phone App will contribute to scaling and sustainability of the adapted PPT variants. It will be used to:

1. Enhance active participation of private business stakeholders (off-takers, agri-processors, input suppliers, etc) by providing them a communication platform to reach farmers and obtain feedback on the demand and performance of their products, services, as well as additional value-addition opportunities.
2. Facilitate integrated seed supply systems by matching seed sources (networks of approved seed merchants, smallholder producers, wholesalers, retailers) and the farmers who need the seeds.
3. Facilitate communication between technology developers and farmers in the context of village knowledge centres.
4. Facilitate farmer-to-farmer extension services and social networks among farmer groups (e.g., WhatsApp smallholder production groups), and
5. Facilitate access to micro-credits. Mobile financial services are among the most promising mobile applications in the developing world. We will explore on how Mobile money could become a general platform to transform payment systems along the entire value chains.

The Mobile App will also be used to disseminate the PPT, follow-up on its adoption, and obtain feedback from farmers. Farmers and their support groups will use the App to seek information from

technology developers, exchange information on upcoming events, agronomic best practices, and market opportunities. Besides tracking the diffusion rate and spatial reach of PPT among the farmers, the mobile App will provide a low-cost method to directly respond to farmers' need for more information on the technology, where to obtain specific information and planting materials such as desmodium seeds, and information on upcoming events such as field days. The App will also be instrumental in creating social capital through personal contact among farming communities, and closer interaction with technology developers.

The use of mobile phones has come in handy due to its innovative ownership and payment models for communication. A mobile phone belongs to a single person; however, it is often informally shared between people in the community due to the culture of sharing in African societies. Information communicated using phones can as well be shared. This feature will also enable Participatory Monitoring and Evaluation to be conducted using mobile phone communication. The farmers who are unable to communicate in public freely can be reached through the phones and in this way their opinion can also be heard and considered. With the rapid growth of the mobile phone applications, industry and its convergence of features such as using text, graphics, audio and video, together with its portability, the mobile phones can be used to do a range of tasks such as providing farmers with real time and feedback information from farming information needs to real time videos on extension messages.

3.3 Plans for messaging and farmer-registering campaigns

Due to the complexities of factors that affect scaling up of PPT, vertical and horizontal processes will be applied. In the vertical approach, the intent is to influence policy makers while in the horizontal process the aim is to spread the technology across communities and institutions and geographic boundaries. In both processes the efforts is to institutionalize PPT in extension and development to get policy makers, extension workers, development workers and farmers to forge their efforts jointly to address the factors that influence going to scale. Specific messaging and farmer-registering campaigns will be facilitated by the mobile phone App. In this regard, the project proposes to work with the following group of stakeholders:

- At the policy level, the project proposes to work with county governments by training the respective officers who would then facilitate the institutionalization of Push-pull in the agricultural sector. The App will help channel county-level messaging and farmer-registering campaigns to access county government services.
- Direct training of farmers as trainers with the goal being that the farmers trained will in turn provide training to their fellow farmers in each locality. Training of project partners and NGO projects who work at the grassroots level to in turn train farmer in their own project areas. Local farmer-registering campaigns will help mobilize farmers for these interactions.
- The farmer-registering campaigns will help create a critical mass of mobile App users and providing mass scale access to announcements of Farmer-to-farmer exchange visits, public media channels and events (local radio, TV programs, documentaries, field days, agricultural shows, etc.) meant to expose more farmers to Push-pull.

The up-scaling plan intends to leverage farmer-farmer approaches (e.g., Farmer teachers) as one of the most preferred dissemination approaches by farmers to increase the adoption of the technology as well as to reach out to new areas where previous efforts have not taken place. Further, the App and related linkages will be used to intensify the use of Field Day trainings in new catchment areas as

one way of promptly promoting technology adoption. In addition, the program proposes to test the viability of using Farmer Field School Approach as one of the model approaches to convey push-pull innovation. These approaches have been used while embracing the strength of Farmer Groups, which are a key entry point in delivering new technologies to farmers. Such participatory approaches have proven to be effective in enhancing adoption in addition to encouraging equal participation of women.

The mobile App will be used to obtain feedback on the relative technical efficiency of technology transfer pathways. The feedback will be useful in testing and evaluating the diffusion of Push-pull technology among farmers who are accessing information and knowledge from different approaches. Different factors affect the spread and accumulation of agricultural knowledge across members of different socio-economic setup. It will be important to evaluate this while disaggregating the data by gender to understand the differences in perceptions between women and men. Although information is critical in adoption, the quality of information offered by a certain pathway matters more than the number of information sources.

3.4 Schedule for messaging campaigns

Mobile messaging campaigns will be aligned with the stakeholders' communication needs. The following matrix outlines the schedule for messaging campaigns (Table 1).

Table 1. Audience, content and time frame of e-Granary messaging campaigns for PPT

Target Audience	Information content	Frequency/ Time frame
Primary Direct participants: mainly farmers	<ul style="list-style-type: none"> •Development context of PPT. •PPT options, components, functionality, best agronomic practices, benefits vs constraints, management, and integration. •Farmer community mobilization and awareness for training events, farmer-registration campaigns for access to inputs, services, and markets. •Feedback channels on technology performance, effectiveness of dissemination channels, challenges, opportunities, products, and services 	At onset of planting season for inputs and services; and mid-season just before harvest for markets and value chain linkages.
Primary Direct participants: mainly project partners	<ul style="list-style-type: none"> • Partner engagement announcements, e.g., MAC meetings, workshops, information sources, electronic resources e.g., relevant websites; new opportunities for farmer engagement 	Continuous, per project roll out calendar
Primary indirect participants: value chain actors	<ul style="list-style-type: none"> •Opportunities in input and output value chains. •General awareness of Push-pull events, agribusiness opportunities. 	In tandem with farmer communication campaigns, at onset of planting season for inputs and services; and mid-season just before harvest for markets and value chain linkages.

Secondary participants: Policy makers; other complimentary regional initiatives	<ul style="list-style-type: none"> •General awareness of Push-pull development context. 	At critical project milestones that require policy intervention, e.g., leveraging county government programmes for mass reach to registered farmers; and need to communicate information extracts from relevant complementary initiatives like INNOVAfrica, EPIAgri Practice abstracts.
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4 Outlook

The platform will utilize the existing network of the input and output service providers related to the supply and market of farm inputs. Agro-dealers and off-takers of the crop components within the push pull, who at the same time are involved in the production of other food crops will facilitate implementation of the technology. The service providers are categorized based on service and occupancy on the production chain (Table 2).

Table 2. Types of service providers to be integrated through e-Granary in PPT dissemination and value chain integration

Category of Service Provider	Description
i) Input service providers	<p>Seed merchants, fertilizer providers, agrochemical dealers and machine suppliers</p> <p>The seed merchants' engagement considers those involved in supply of maize seed, fodder seed/planting material like Napier and desmodium seeds and other legumes like Lucerne.</p> <p>Also those involved in alternative crop combination inputs that could lead to push pull benefits are also considered.</p> <p>Examples: Kenya Seed Company, East African Seed, KALRO, KEPHIS on certification of products.</p> <p>Agrochemical: For provision of pest and disease management operations within the push pull agri-system. The companies include: Bayer crop science, Arystal, Syngenta.</p> <p>Fertilizer –To facilitate the provision of plant nutrients in case of supplementation. Include ETG, Toyota Tshusho</p> <p>Machine operations-Both in land preparation, postharvest handling and storage, e.g., tractor service providers like hello tractor, chaff-cutter, maize shellers and driers</p>
ii) Output service providers	<p>Market and financial related services to be considered.</p> <p>Upon the dissemination of the push pull technology, better productivity will be realized for the crop components. Production requires a reliable market that supports the investment in the technology. Organized market space where aggregation will be done and quality standards of produce ensured that lead to better profit margins.</p>

	<p>Push pull uptake increases when farmers have access to credit to procure inputs inform of mechanized services at scale, seed purchase, and other management services.</p> <p>Insurance services derisk farmers when they invest on the technology. Planting dates advise by insurance increase the chance of good crop establishment and better yields.</p> <p>Engagement of these stakeholders supports the technology indirectly.</p> <p>Partners-ETG, Commercial dairy firms, microfinance institutions, commercial banks that provide agri-products, Acre Africa Insurance.</p>
iii) Extension Service Providers	<p>Both government and private extension agencies are key in supporting the technology uptake.</p> <p>They are required in farmer mobilization, training and continuous technical support, so that farmers can own the technology.</p> <p>Dissemination tools like demo plots, workshops and model farm establishments bring together farmers to learn where the extensions explain and introduce farmers to the technology as well as the benefits. Platforms like DigiFarm, DigiCow, and other platforms can be integrated.</p>
iv) Research	<p>Generate and integrate the technologies for better alternatives that support push pull e.g. alternative crop combinations for programs that work well like the push pull technology.</p>
v) Other Partners (ICT, Media and Communication)	<p>Partnerships with other service providers like Farm Radio, KTN Farmers, SmartFarm media programs and other technology firms provide more dissemination channels.</p> <p>The partnership could be utilized in campaigns on farmer sensitization on push pull technology.</p>

Furthermore the customized platform is projected to be linked to additional existing extension mobile platforms in other countries at the national level. For example, E-Kilimo in Tanzania is envisaged to be linked by i) sharing of information to be uploaded to the national platforms, ii) sharing an encrypted file of the customized e-Granary app accessible when farmers log into national apps.

The existing partnerships with agriculture institutions, government, private sector stakeholders and farmer-related organizations will support the identification of the existing knowledge extension apps for further interlinkage with customized digital platforms. Extension service through interlinked apps is expected to support the scaling up of push-pull as they will be co-extended alongside other technologies promoted by the apps and advised on to farmers.