LASER PULSE

Long-term Assistance and SErvices for Research (LASER)

Partners for University-Led Solutions Engine (PULSE)

Embedded Research Translation Report

Exploring the Use of Blockchain Technology to Promote the Production and Consumption of African Indigenous Vegetables in Western Kenya

By Nurvitria Kristofikova, Irene Muskoke, and Jessica Agnew

SUPPLEMENT TO AGREEMENT NO. AID-7200AA18CA00009

AOR Name: Kevin Roberts

August 2021

USAID FROM THE AMERICAN PEOPLE | PURDUE UNIVERSITY | VIRGINIA TECH | EGERTON UNIVERSITY | AgUnity Connecting the last mile

AgUnity
Surfer's Paradise, Queensland
Australia

Virginia Polytechnic Institute and State University
College of Agriculture and Life Sciences Global Programs
Blacksburg, VA 24061

About the Project

Exploring the Use of Blockchain Technology to Improve Food Security Through African Indigenous Vegetables in Western Kenya is one of the first projects undertaken to investigate how blockchain technology (BCT) can be deployed in horticultural value chains with the express purpose of improving food and nutrition security among all value chain actors. The project also focuses on understanding how digital platforms using BCT will secure the place of women and youth in the value chain. This report documents the impacts of this twelve-month project. Additional information can be found on the project website. This project was made possible through a LASER PULSE grant, funded by USAID.

About LASER PULSE

LASER (Long-term Assistance and SErvices for Research) PULSE (Partners for University-Led Solutions Engine) is a five-year, $70M program funded through USAID's Innovation, Technology, and Research Hub, that delivers research-driven solutions to field-sourced development challenges in USAID interest countries. A consortium led by Purdue University, with core partners Catholic Relief Services, Indiana University, Makerere University, and the University of Notre Dame, implements the LASER PULSE program through a growing network of 2,500+ researchers and development practitioners in 61 countries.

About this Publication

This publication was made possible through support provided by the Center for Development Research, U.S. Global Development Lab (Lab), U.S. Agency for International Development, through the LASER PULSE Program under the terms of Cooperative Agreement No. 7200AA18CA00009. The opinions expressed herein are those of the author(s) and do not necessarily reflect the views of the U.S. Agency for International Development. This report was peer-reviewed by the LASER PULSE Research & Publication Working Group.

Recommended citation: Kristofikova, N., I. Muskoke, and J. Agnew. 2021. *Embedded Research Translation Report: Exploring the Use of Blockchain Technology to Promote the Production and Consumption of African Indigenous Vegetables in Western Kenya.* AgUnity, Australia.
https://vtechworks.lib.vt.edu/handle/10919/111503

Executive Summary

AgUnity worked with Virginia Tech and Egerton University on the LASER PULSE-funded project entitled *Exploring the Use of Blockchain Technology to Promote the Production and Consumption of African Indigenous Vegetables (AIVs) in Western Kenya*. AIV value chains are characterized by transactional and informational inefficiencies that contribute to inconsistent supply and mismatched demand in Kenya. This research program explores how digital applications built on blockchain technology (BCT) can be deployed in AIV value chains in western Kenya, in a way that improves food and nutrition security for all value chain actors. Specifically, there was interest in understanding how the BCT-based smartphone application could assist groups of individuals who typically face constraints in accessing economic or nutritional benefits from value chain upgrading (i.e., smallholder producers, women, youth, low-income consumers).

This project was one of the first times the AgUnity app was not deployed in a centralized supply chain context (i.e., with a union or cooperative supplied by hundreds of farmers). We have found that in decentralized supply chains, there is a particular need to ensure that the system supports the users' values and needs for conducting their respective value chain activities. When this is achieved, trust that is garnered through the use of the technology shall translate directly into more cooperative and coordinated value chains. Both the value chain app adaptation and configuration and the technology service design were built around this premise, using embedded research translation (ERT) processes to ensure that it was achieved in the target population and value chain.

This report outlines the steps taken by AgUnity to translate Virginia Tech and Egerton University's research into the adaptation and deployment of our proprietary BCT-based smartphone application. It is directed toward readers interested in understanding the product and service design of the AgUnity application, the use of BCT in digital platforms designed for last-mile users, and those interested in successful examples of ERT. It walks the reader through the value chain mapping and community immersion processes, the steps needed to adapt the technology to fit the local value chain context, and the development and selection of app functionalities for the target users and value chain. The report may be of interest to researchers, farming associations, and cooperatives or agricultural non-governmental organizations interested in the AgUnity solution as well as stakeholders involved in strengthening agricultural market systems, AgTech, or FinTech.

Table of Contents

Table of Figures and Tables

List of Abbreviations

AgChampions	Agriculture Champions for AgUnity
AIV	African Indigenous Vegetables
BCT	Blockchain Technology
CBO	Community Based Organization
ERT	Embedded Research Translation
ICT	Information and Communications Technology
KSH	Kenya Shilling
LASER PULSE	Long-term Assistance and SErvices for Research Partners for University-Led Solutions Engine
USD	United States Dollars

Introduction

AgUnity partnered with Virginia Tech and Egerton University to evaluate how blockchain technology (BCT) deployed through a smartphone application can impact food security in Kenya. It was hypothesized that BCT would help to improve the functionality of the value chains of African indigenous vegetables (AIVs), leading to improved food security by improving the income of value chain actors and increasing the availability, desirability, and affordability of AIVs. These nutritious leafy greens have significant food security and cultural value in the country.

AgUnity served as the embedded research translation (ERT) partner for the *Exploring the Use of Blockchain Technology to Improve Food Security Through African Indigenous Vegetables in Western Kenya* project. ERT is "an iterative co-design process among academics, practitioners, and other stakeholders in which research is intentionally applied to a development challenge" (LASER PULSE, n.d.). AgUnity used research conducted by Virginia Tech and Egerton University to iteratively adapt its V3 Super App built on blockchain technology and its service delivery model to address the pain points in the AIV value chain that constrain farmer income and consistency of AIV availability, desirability, and affordability in Kakamega markets. This public-private partnership has produced important lessons on how academia can support the development of private sector innovation to accelerate product life cycle development and time to achieving scale in a low- and lower-middle income country context like Kenya.

AgUnity V3 Software and App Overview

AgUnity offers a suite of digital solutions that provide a means to connect last-mile producers (those who typically receive services last or struggle to access viable markets), establish reliable and efficient trade between value chain actors, and resolve transparency and provenance issues in food chains through a remotely managed, secure, and accountable online platform. The platform leverages a powerful ecosystem of technology including a rugged smartphone, digital ID cards, a proprietary operating system, and a "Super App".[1] These components have been specifically designed to resolve common issues faced by rural agrarian populations in low- and middle-income countries, where value chain actors (i.e., producers, traders, retailers) have not historically had consistent access to technological advances and digital services.

The AgUnity V3 Super App platform is designed to provide a contextually-grounded user experience, BCT-powered record-keeping, and complementary solutions (e.g., a marketplace, weather information, a learning center) while also providing security, connectivity, and

[1] A "Super App" is a smartphone application that can provide multiple services to the user, including payment and financial transaction processing.

guarantee of digital identity. It is intended to be simple to use, accessible to individuals with low literacy, and usable in the local language. The BCT-powered record-keeping applet allows the farmer to build a transaction history, track revenues, and monitor repayments of debts. The transaction record-keeping feature also enables a user to easily keep records which promotes cooperation between farmers, co-operatives, and other stakeholders in the supply chain, mitigate the potential for exploitative behavior by bad actors and help facilitate business planning by value chain actors. An additional value proposition of the V3 Super App is the linkage between the embedded digital identity proofs and the distributed ledger that records transactions and farmer revenue. This could eventually enable access to financial services like banking, microloans, and insurance.

Figures 1 and 2 present the user interface of the V3 Super App. Figure 1 shows the 'handover' process between the giving and receiving parties on the grade, type of commodity, and volume of the handed-over goods and/or cash. Figure 2 pictures different applets and describes their functions. For this project, BCT-powered record-keeping is the core applet of interest (i.e., "Give Harvest").

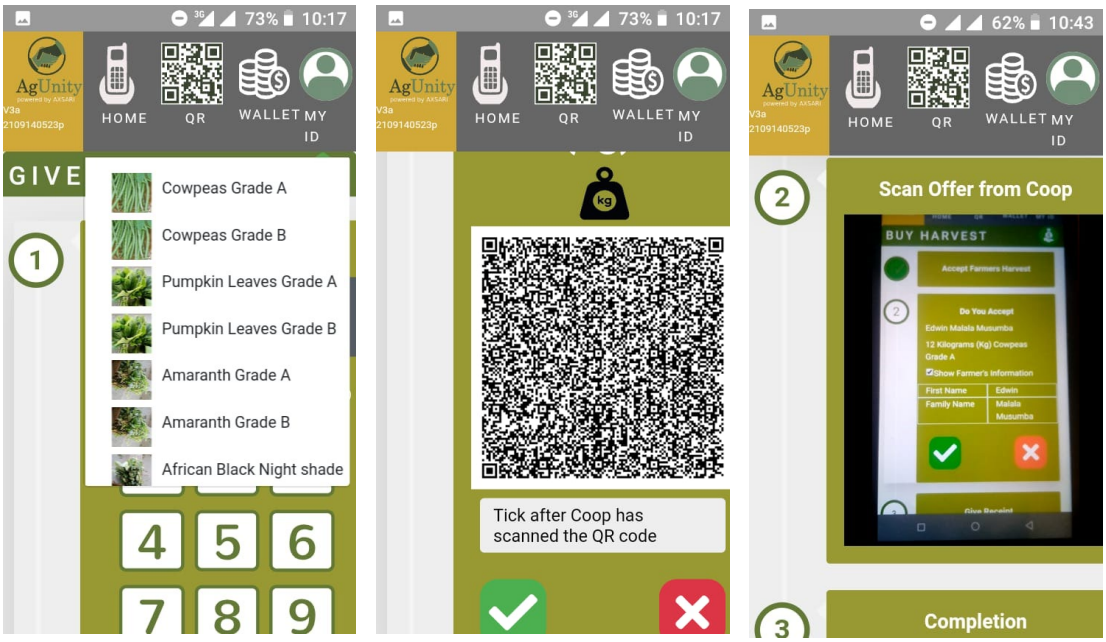


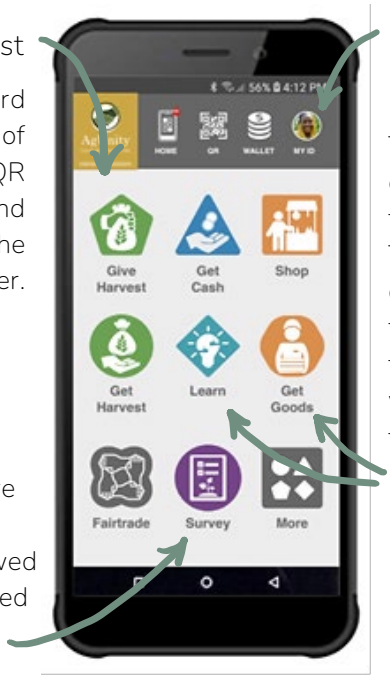
Figure 1. Example User Interface – Producer Handover Process

Give Harvest

BCT-powered transaction record interface that records blocks of transactions using a unique QR code generated after price and quantity are agreed upon by the seller and buyer.

Survey Applet

Reliable field data is captured through this feature to measure project progress and verify outcomes, without risk of skewed or lost data (normally associated with manual methodologies).



Digital & Transaction Identity

The digital user ID links to the distributed ledger that records transactions and farmer income. This allows the user to build a credit profile, enabling access to financial services. It also improves trust between actors through verified, user-identified transactions.

Marketplace and Learn

Provide capacity building and access to relevant products and services for the community. The marketplace facilitates access to inputs for farmer groups, community based organizations, and cooperatives.

Figure 2. AgUnity V3 App

The AgUnity App as a Development-Solution

The AgUnity V3 Super App has potential applications in numerous value chains and agricultural development contexts. It is easily customizable to suit the needs of any user, implementer, and value chain, tailoring the features they would like to use and when, providing quality data to measure the return on investment or impact of projects, and providing a range of digital solutions complementary to the blockchain-based functionality. Working with researchers helps to customize the app to various contexts and to address the unique pain points in different agricultural value chains. The V3 Super App, in return, provides users, including target beneficiaries as well as implementers, with a way to understand and manage the cost and risks of strengthening value chains in an emerging market.

Additionally, since the AgUnity V3 App is a super app, it can synchronize service offerings to farmers and align them with other key business players in the agribusiness value chain, such as commodities buyers, extension services, financial institutions, NGOs and government bodies, cooperatives and associations, and industries. Thus, AgUnity's solution offers platformization to the agricultural sector in low and lower-middle income countries.

Embedded Research Translation Process

AgUnity uses value chain analyses to create a business process map in order to create the backend configuration of the V3 Super App and service delivery design. The business process map encompasses the actors that participate in the production, transportation, processing, and marketing of the selected commodity or agricultural product, the activities conducted at each stage, and the way transactions are conducted. Virginia Tech and Egerton University worked closely with AgUnity to map the AIV value chain in Kakamega county, located in western Kenya, and to translate this into a business process map. The pain points of the target beneficiaries and inefficiencies in the AIV value chain were also identified in the value chain analysis, which is integral to the AgUnity design process. AgUnity provided input into the design of the qualitative and quantitative data collection so they could capture the data points needed to configure the app and service delivery design for the Kakamega AIV value chain (Agnew et al., 2021).[2]

A preliminary analysis of existing literature provided AgUnity with enough information for an initial adaptation plan for the V3 Super App. Focus group discussions were conducted with 108 participants and questionnaires were conducted with 322 AIV value chain actors. This further defined key business processes in the value chain including the nature of transactions, flow of goods and information, and vertical coordination arrangements for male and female value chain actors. The results of both quantitative and qualitative research informed the configuration of the technology and prompted the development of new functions so the V3 Super App addressed the pain points of AIV value chain actors. The final version of the V3 Super App was developed and deployed to 53 purposively selected value chain actors for an impact evaluation.

ERT Processes for Improving App Design and Service Delivery

The ERT process is iterative and involves co-design processes. The research methods described in Table 1 were used to iteratively improve the AgUnity app and service delivery through the project life cycle.

[2] Activities that AgUnity has developed for its other projects that incorporate the principles of user experience and human-centered design were included by Virginia Tech and Egerton University in the formative data collection.

Table 1. Methods to Collect Participant Insights

Stage	Method	Participants	Use of Insights
Pre-Deployment	Questionnaire; Focus Group Discussions	Sample of value chain actors (300+) in Kakamega County (producers, traders, retailers, consumers).	• To configure and tweak the app so it fits the local value chain context. • How to be strategic about resource mobilization during training and implementation (including during the potential promotion of future scale-up). • To get insights on payment methods, aspirations for the eventual use of e-wallets, and group financial schemes (savings, deposits, etc.).
Training	Informal Interviews; Training; Feedback	~53 Users	• To improve training design and deployment approach in scaling part of the project.
Implementation	Weekly meeting with Field Officer	~53 Users	• To troubleshoot problems and re-train people as needed.
Post Implementation (6 months after implementation)	Questionnaire; Focus Group Discussions	53 Users for Questionnaire (baseline and endline) FGD - sample of ~20 value chain actors from 3 regions	• To understand remarks on usability, and benefits for daily value chain activities. • Insights for future product and service development. • Insights for scale-up.

AgUnity App Adaptation for AIV Value Chains

AIV Business Process Map

The AIV business process map is pictured in Figure 3. Actors in the AIV value chain include the individual smallholder farmers – i.e., farmers that are registered with a local community-based organization (CBO) and those who are not – middle people (traders, CBO), retailers who sell to the final consumer, and consumers (urban, peri-urban). Minimal processing and value addition occur as the vegetables are traded between actors. Washing off the dirt from the vegetables is either required of producers or done by the middle person or retailer. Some retailers shred the vegetables and package them into bags before selling them to the consumer. A more in-depth gender-sensitive value chain analysis is provided in the *Transaction and Information Pain Points in African Indigenous Vegetable Value Chains in Western Kenya: A Gender-Responsive AIV Value Chain and Market Analysis* report (Agnew et al., 2021).

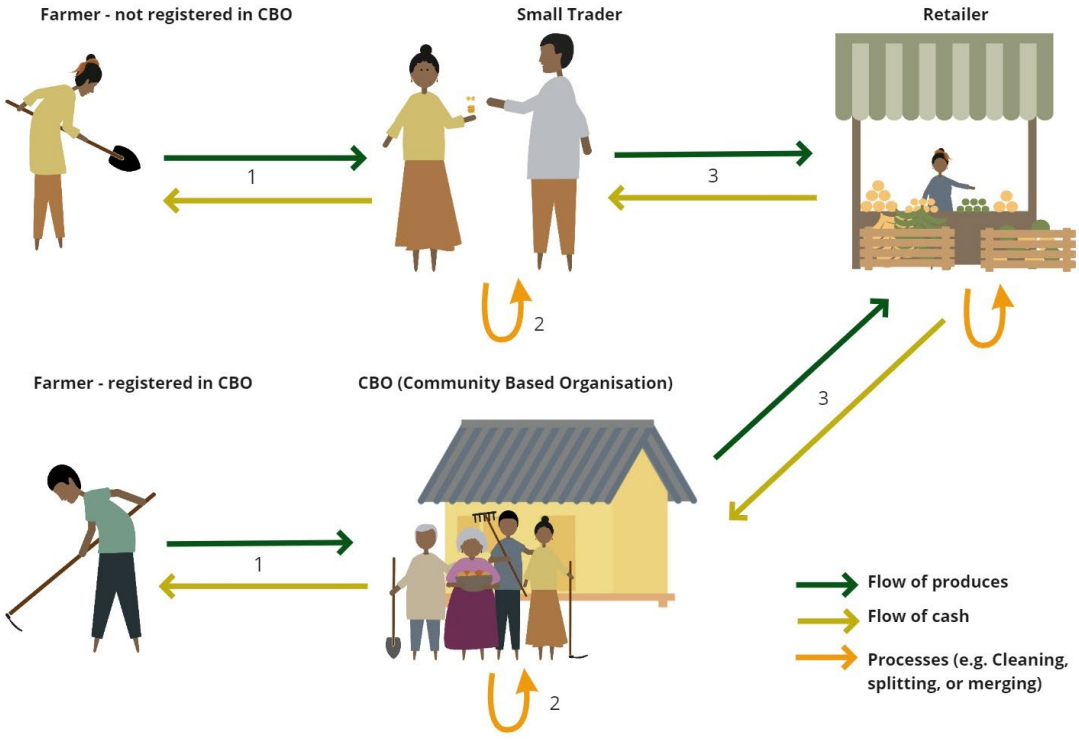


Figure 3. AIV Value Chain Business Processes in Kakamega County

Business Process Legend

1. AIV handover occurs between farmers and traders or the CBO, depending on the sub-value chain.
    a. This step commences with the farmer stating the quantity (kg) and the grade (A or B) of the AIV variety (e.g., amaranth, African black nightshade, spider plant, Ethiopian kale, jute mallow). The trader then bundles the vegetables by hand and states the price per bundle they are willing to pay.
    b. The farmer hands over the produce and the trader hands over the cash as agreed. At times, traders may pay at a later time. Producers do not generally keep records of debts.
2. Traders, when selling to retailers, first *merge* the produce purchased from several producers, then *split* the aggregated AIV varieties to sell to retailers. The handoff of AIVs usually occurs in open-air markets, very early in the morning (Figure 4).
    a. Bundles are determined by hand and priced by the trader.
    b. Payment tends to occur on the spot; however, some retailers will pay traders after they have sold the vegetables for the day.
3. Retailers *split* the various AIV varieties into small bundles, wrapped with a piece of banana leaf or fiber from a gunny bag for selling to consumers. Bundle sizes are determined by eye.
    a. Consumers tend to buy several bundles of AIVs, either of the same or different varieties.
    b. Produce handover takes place in the market. Consumers tend to pay on the spot, though some retailers may extend credit.

In the case of farmers registered with a CBO, the cash payment is delayed upon the CBO selling the goods to the final buyer.

Figure 4. Larger Traders in Mumias Market, Kakamega

Pain Points and Service Delivery Design

The V3 Super App was adapted to include features to help streamline and enhance the AIV value chain in Kakamega through increased coordination between actors, increased trust and transparency, and seamless digital transactions. Table 2 summarizes the primary categories of pain points that were deemed as the highest priority to address in order to achieve improved value chain functionality and ultimately value chain actors' income and food security.

Table 2. Pain Points and Responsive Ideated Services

Themes	Pain Points	Ideated Service & Anticipated Outcome	Mode
Lack of record-keeping	Value chain actors have limited visibility into AIV profitability due to a lack of records. Credit collection is not accurate or timely due to a lack of records.	Blockchain-enabled records are immutable and trustworthy. Sales become predictable, the buyer-seller relationship is loyal and trustworthy. Each user knows what has been bought and sold. Users have documented revenue from AIV sales.	On App
Lack of standardization in the value chain	Inability for the value chain to improve due to uniformed grading regardless of quality.	Require entry of variety, grade, and kg being transacted. Post-harvest loss is reduced; incentives for improved quality exist; improved data is available.	On App
	Vegetable weights are set by hand, not by Kg.	Training of standardization benefits. AIV revenues increase from consistency.	Offline technical assistance
Uniform pricing for AIVs	Inability to charge a premium for higher quality AIVs despite efforts to leverage inputs and quality of produces.	Training on quality identification and price premiums for higher quality vegetables. Producers are incentivized to improve the quality and safety of their vegetables.	Offline technical assistance
Inexperience with digital solutions for agriculture	Only a few value chain actors have used a smartphone for the digital marketing of AIVs. Lack of awareness of how to use a smartphone and digital solutions for agriculture in their daily lives.		Offline technical assistance
Lack of trust and	Farmers act as individuals and do not organize their	Value chain actor profile and identity verification.	On App

Themes	Pain Points	Ideated Service & Anticipated Outcome	Mode
transparency between value chain actors	production/ marketing activities, even in the CBO. Transacting parties do not have limited visibility into one another's business decisions or actions, leading to a lack of trust and/or loyalty between actors.	Transacting parties will have more confidence in their business relationships with more information on the people they are doing business with. It will help to facilitate coordination by identifying parties each actor can do business with.	
Post-harvest loss	Significant post-harvest loss because of the perishability of produce. Lack of inventory management leads to higher losses. Producers are largely unable to plan. Search costs for buyers are high and contribute to loss.	Phone and user profiles can be used to coordinate purchases. Post-harvest losses will be reduced because AIVs will not be harvested until a buyer is identified.	Phone
Negotiation and information transmission	Lack of standardized pricing. Asymmetric information between upstream and downstream. Lack of awareness of the value of AIVs at the consumer level.	Blockchain-based record-keeping functionality will provide a proxy for market data. Negotiating power of the producer will increase because of transaction records.	On App
Lack of access to credit	Producers especially do not have transaction history or collateral for credit.	Transaction records are secure and immutable. Access to microfinance and formal loans will increase. Village Saving and Loans schemes will be supported and effective.	On App Offline Technical Training

App Adaptation and Configuration Summary

AgUnity needed to adapt its existing V3 Super App with a new configuration of the relationship between transacting farmers according to the business process map. Originally the app was developed for value chains where there was a cooperative acting as an aggregator of commodities like coffee or cocoa. AgUnity changed the backend configuration so that each value

chain actor (producer, trader, retailer) could engage in the 'double handshake' process. The *double handshake* begins with both parties scanning the QR code generated on their transacting partner's phone. It is called a *double handshake* because both parties have certified the accuracy of the transaction (i.e., price, quantity, variety, and grade).

For the V3 Super App system configuration, we divided farmers into two types:

1. Registered farmers – The CBO acts as a group and an aggregator of the leafy vegetables.
2. Unregistered farmers – These farmers are not part of a formal farmer group or CBO. Payments are provided on the spot by traders or retailers or collected at a later time.

The first version of the V3 Super App allowed each farmer to supply only one trader. For this project, the app was adapted to allow each trader to purchase AIVs from multiple farmers and each retailer to purchase AIVs from multiple traders. Once we received confirmation of the value chain linkages from the participating value chain actors, the above configuration was set in the AgUnity user management portal. Table 3 shows the number of each category of value chain actors initially onboarded.[3] The next version of the app will allow each farmer to sell to multiple traders, and one trader will be able to trade with multiple retailers. This project includes several sub-chains that have different arrangements of value chain actors (Figure 5).

Table 3. Project Participants

Value Chain Actors	Registered with CBO	Not Registered with CBO
Farmers	10	24
Traders	1	6
Retailers	0	13

[3] Some of the enrolled participants were unable to attend the initial onboarding session. The remaining participants were onboarded in August 2021.

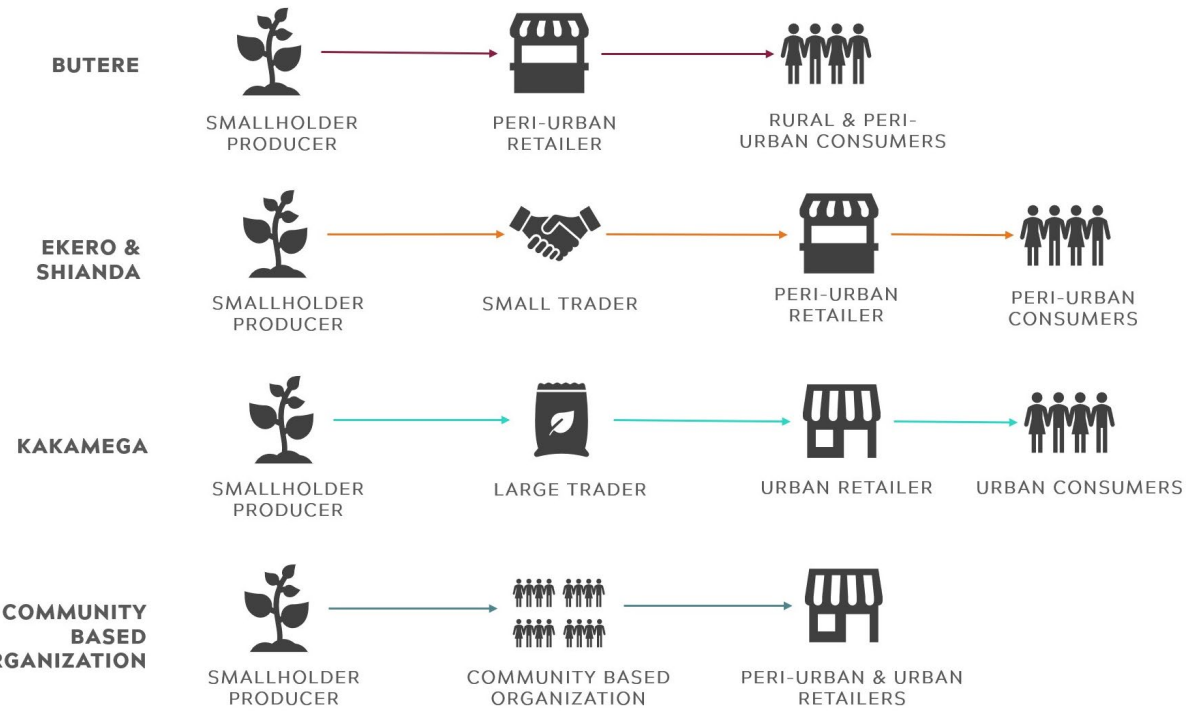


Figure 5. Sub-Value Chains in Kakamega County

During the value chain analysis, the consumers indicated that vegetable safety is important to them when making their purchasing decision. Seventeen percent of respondents (n=13) indicated they would be willing to pay for organic vegetables. This information can be transmitted along the value chain using the V3 app, so we decided to test the willingness to pay for different quality vegetables and the ability of actors to track and trace different vegetable types by differentiating between two grades of vegetables.

1. Grade A Vegetables – No inorganic fertilizers or pesticides are used, the vegetable leaves have a natural green color, are free from damage from pests or disease, and are not wilted.
2. Grade B Vegetables – Some inorganic fertilizers or pesticides may be used, there may be some discoloration, pest, or disease damage, and/or some wilting.

This graded approach was used to ensure that farmers who are not able to grow organically would not be penalized in the market. Grade A vegetables are offered to the consumer at a slight price premium and are differentiated by the retailer into separate piles in the market.[4]

[4] The vegetables were graded using a grading tool developed by Egerton University faculty member, Joseph Mafura, professor of agronomy and horticulture specialist.

Prior to being traded, AIVs are sorted by the respective farmer. During the handover (e.g., vegetables are given by the farmer to the trader or retailers), the vegetables are assessed according to the agreed-upon quality assurance standards. Traders and the CBO repack, bundle, and grade the harvest into Grades A and B before reselling it to the retailer. Retailers follow the same procedures before selling to the final consumer. In the journey, the CBO value chain will be configured in a way that simplifies the process and will later be upgraded to better reflect their business processes. Each transacting party will engage in a *double handshake* scanning process.

Each of the farmers and the traders still trade with actors who are not enrolled in this project. For these other transactions, AgUnity devices have a survey applet that will be used to capture farmers' income and trading patterns when they transact with individuals who do not have an AgUnity device.

Tradeable Assets & Their Transformation

For this project, tradeable assets consist of the most commonly sold and purchased AIV varieties according to Grades A and B. The AIV varieties include African black nightshade, amaranth, spider plant, cowpeas, Ethiopian kale, pumpkin leaves, sunn hemp, and jute mallow. The process of transformation includes unbundling, re-bundling, and merging received produce by traders, the CBO, and retailers.

Functional Overview

An overview of the functionality of each of the V3 Super App's features is provided in Table 4, describing how each of the features works to produce the desired outcome. The functionality details demonstrate the customizability of the app to the user's respective needs.

Table 4. Functionality Overview

Req.ID	App User	Feature	Function
ON SMARTPHONE			
CU001	Farmer	Give Harvest	The Farmer can give specific types and grades of AIV to a Trader.
CU002	Trader CBO	Receive Harvest	A Trader can choose to accept the offer or decline.
CU003	Farmer	Wallet	A Farmer can receive a payment voucher from a Trader or CBO through the digital wallet and the transaction is recorded.

Req.ID	App User	Feature	Function
CU004	Trader CBO	Wallet	A CBO or Trader provides a payment voucher to a farmer and the transaction is recorded. A CBO can issue a receipt for products received to a Farmer for any transaction initiated.
CU005	Retailer	Wallet	A Retailer can make a payment to a Trader through the Wallet, which provides a receipt of the transaction/payment.[5]
CU006	Trader CBO	Merge / Transform / Split	A CBO or Trader can merge several harvest items of the same kind and grade, from the same or two Farmers. The merging function enables a CBO or Trader to add two or more received harvests in one batch digitally. For example, when the Retailer needs a bulk sale of quantities larger than what was received by the CBO or Trader from one Farmer. A CBO or Trader can transform a received harvest to another grade. A CBO or Trader can split a received harvest into different quantities according to the needs of the Consumer or Retailer (a Consumer or Retailer can specify these quantities to the Trader).
CU007	Trader CBO	Give Harvest	Upon both parties' consent on quality, volume, and price, a Trader or CBO can sell a harvest to a Retailer.
CU008	Retailer	Receive Harvest	A Retailer can receive a harvest from Trader/CBO on specific processed and graded conditions as required.
CU09	Farmer Trader/CBO Retailer	User Identity Verification	The unique identity of the Farmer, Trader, CBO, or Retailer is recorded.

[5] Currency is not actually transacted through the app. Users transfer cash or m-Pesa transactions outside the app and the payment is recorded on the AgUnity ledger.

Req.ID	App User	Feature	Function
CU010	Farmer Trader/CBO Retailer	Language Settings	A user can select a language they prefer. The local language (Swahili) is supported.
CU011	Farmer Trader/CBO Retailer	Reset Password	A Farmer, Trader, CBO, or Retailer with a user account can reset their password.
CU012	Farmer Trader/CBO Retailer Trader Farmer Retailer	Refresh App	A user can refresh the App to push or receive new data uploaded when offline – i.e., send an invoice receipt/voucher automatically for any transaction completed. A User can reset their pin as required. Upon a new App release, users can refresh the App.
CU013	Farmer CBO/Trader	Receive Cash	A user can receive the cash expected from the party that received a harvest.
CU014	Retailer CBO/Trader	Give Cash	A Buyer can provide the cash expected from the party that sells a harvest.
NOT ON SMARTPHONE			
CU015	Project admin	User and Asset Management	Assigned personnel can add a new AIV/other asset transacted. Assigned personnel can add new user and value chain links.
CU016	Farmer Trader CBO Retailer	Reporting (CSV)	Various transaction reports are recorded for value chain actors in the form of a CSV (for dissemination by AgChampions via a Field officer and Egerton University students).

Smartphones

Thirty Konka phones were procured from China, and 30 Tecno Phones from inside the country. It is beneficial to test a readily available phone model in the country for potential scaling up activities in the future. The cost of each phone (including importation costs and tax) was 75 USD for the Konka Phone, and 54 USD for the Tecno Phone. Technical specifications of each phone are described in Figure 6.

Konka RE 1 Phone	Tecno F1 Phone
	
Specifications	Specifications
RAM Memory: 2GB	RAM Memory 512MB, 513MHZ
ROM Memory: 16GB	Internal Storage 8GB
Memory Card: Max 128GB	Memory Card: Max 32GB
DUAL SIM PHONE	Dual Sim Phone
Battery: 2150mAh	Battery:2000mAh
OS: Android 8.1 Oreo	OS: Android 8.0 Oreo
Processor type: 1500.0 MHz (4-core)	Processor Type: Quad-Core 1.30 GHz
Display: LCD (16M) 720X1440px (5.45") 295ppi	Display: 5.0" In FWVGA 854X480px
Bluetooth: Yes 4.0	Bluetooth: Yes
Network: GSMFDD-LTE TDD-LTE	Network: GSM/WDCMA/EDGE
Size: 144.2×70.4×7.8 mm	Size: 145 x 74.2 x 9.7mm
Main Camera: 13MP camera	Main Camera: 5MP with dual flash
Front Camera: 8MP camera	Front Camera: 2MP with Flashlight

Figure 6. Functional Specification

Training and Deployment of Phones

Training for both users and administrators ('super admins') is a key component of the AgUnity deployment process. All users and *super admins* of the software must be aware of how to configure the V3 app, work with the software, and trigger the service features intended to address value chain actor pain points. Prior to deployment, potential bottlenecks to phone deployment and app use were identified and addressed in the training design to ensure that the beneficiaries can seamlessly use the services offered on the platform. The AgUnity training process equips users with complementary digital knowledge and skills to increase the likelihood of sustained adoption and improved business operations.

Development of Training Material

To facilitate on-the-ground training, the AgUnity team prepared poster-size training materials (Figure 7) and step-by-step guides (Figure 8) on how to use the V3 Super App.

Figure 7. Poster Size Training Material

Figure 8. Step-by-Step Training Leaflet

Training of Trainers

Training of the trainers was conducted remotely with Egerton University faculty and students in February 2021. Each student and faculty participating as a trainer was given a smartphone to become accustomed to the V3 Super App. AgUnity also provided the trainers with a handbook, step-by-step instructions, and practice drills. During the community training, the AgUnity field officers and Egerton trainers were tasked with identifying the participants who were quick to understand the V3 Super App, the process, and digital skills. These identified candidates were nominated as so-called 'AgChampions'. If the participants accepted this role, they were made responsible for helping other Farmers, Traders, and Retailers resolve simple queries that might arise throughout the project. They also were asked to work hand-in-hand with the AgUnity Kakamega field officer to disseminate training and obtain feedback from participants.

Pre-Deployment Preparation

Some 53 longitudinal project participants were selected for recruitment by first identifying retailers in local markets that primarily serve low-income consumers. Of the retailers who agreed to participate, the traders and farmers who supply these retailers were then identified and recruited. A local CBO and 10 of its farmers also agreed to participate so that we could work in different configurations of the AIV value chain. We also aimed to enroll an equal number of men and women and to enroll youth in the project as well. The objectives of the research project were described and participants had the opportunity to agree to participate at enrolment and then confirm this participation during training and deployment. Participants were informed that

the project would operate until November 2021 when an endline survey would be conducted. They were also informed that they would be able to use the AgUnity app past the end of the project and that they would be able to keep the phone as compensation for participating in research activities (e.g., baseline and endline surveys, focus group discussions). Further details on the impact evaluation methodology and results will be forthcoming in the project's final report (expected early 2022).

A field plan was developed to deploy the phones. The AgUnity/Egerton team visited the nominated Farmers, Traders, Retailers, and the CBO to connect with the identified participants. These interactions allowed the team to understand the actors' respective activities and to build a relationship. The AgUnity/Egerton team was also able to re-confirm that the nominated Farmers, Traders, Retailers, and the CBO transact with one another in the AIV value chain and that they were still willing to participate in the project.

Figure 9. A Project Beneficiary's AIV Production

Figure 10. AgUnity/Egerton Team Visit at the Ministry of Agriculture Offices in Kakamega

On April 28, 2021, the AgUnity/Egerton team visited the Kakamega county Ministry of Agriculture, Livestock, and Fisheries (MoALF) to introduce the project (Figure 10). MoALF officials welcomed the AgUnity/Egerton team and were eager to support the project from pilot to market scale. They indicated there is potential to replicate the approach with other producer crops including cereals and food crops for both local and domestic markets. They plan to support the mobilization of Farmers, Traders, and Cooperatives as well as Retailers to ensure that AIV value chains in Kakamega are strengthened and that the project benefits the people of Kakamega.

Phone Binding

On April 27, 2021, 53 mobile phones were bound by the Egerton University team with remote guidance provided by the AgUnity team. Binding assigns each phone to a specific individual participating in the project. This process is essential since each mobile phone has a unique ID that is connected with each user, which prevents identity theft. Since each user is assigned to a unique mobile phone with a pin password, a user cannot login to their account on another person's app (even if they know the PIN code).

For the binding process, the students were oriented on the requirements (e.g., the phones needed to be fully charged) and the V3 App was downloaded and installed on each beneficiary's phone.[6] With ready and bound phones, the team was able to start training the beneficiaries throughout the targeted AIV pilot value chain.

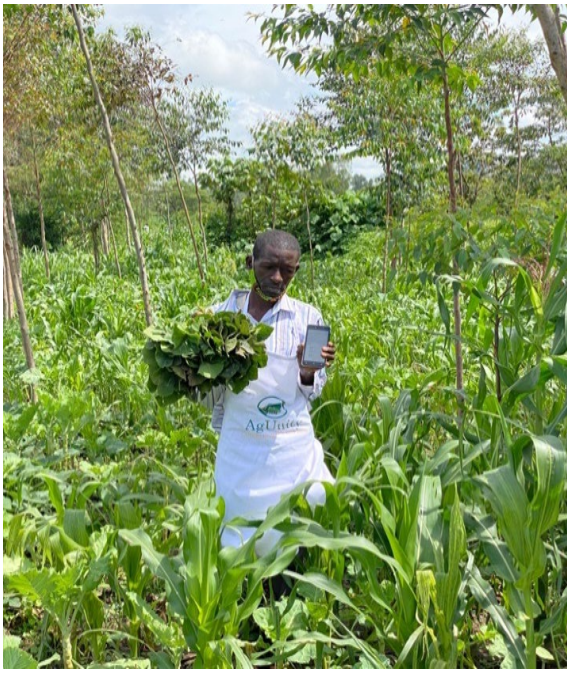


Figure 12. A Project Beneficiary with an AgUnity Phone

Figure 11. A Project Beneficiary's AIV Field

[6] For more information see the *AgUnity Trainer Guide* (AgUnity, 2021).

Deployment Summary

Training of Beneficiaries

The community training was conducted from April 26 to May 10, 2021. The activities included logistical preparations, mobilization of participants, training activities, and a baseline survey.

According to the value chain analysis, approximately 65% of the value chain actors previously owned or used a smartphone (Agnew et al., 2021). To ensure that all participants were equally comfortable with using a smartphone, the training plan included basic technical skills to ensure all participants understood how to use the V3 Super App as well as the phone on which the App was installed.

Figure 13. Egerton University Staff Member Conducts Training with Participants

The training team consisted of field officers (i.e., Egerton University faculty and students and AgUnity technical field officers) who facilitated the training with the participants. Field officers were paired with groups of value chain actors who were grouped according to their role in the value chain – e.g., Farmers, Traders, or Retailers. Each group received specific training that was based on how they would be using the App in practice. Table 5 summarizes the number of beneficiaries that participated in training activities.

Table 5. Training Beneficiaries

Organization Participants	Number of Participants	Number of Males	Number of Females
AgUnity	3	1	2
Egerton University	8	5	3
Traders	3	1	2
Retailers	13	1	12
Farmers	32	15	17
Ministry of Agriculture, Livestock, and Fisheries	1	0	1

The Egerton University faculty and students, together with the AgUnity Kakamega field officer, AgUnity team, and AgChampions continued to support the beneficiaries throughout the project.

Summary of Key Deployment Stakeholders

AgUnity is an Australian tech organization that enables low-income farmers to lift themselves out of poverty with a mobile blockchain-based digital platform that improves communication, trust, and efficiency of food supply chains. The technology enables the sale and supply of fresh, safe, and quality food. Leading the program deployment in the field was Monicah Rapando (AgUnity Field Officer). She is a community development specialist, a local, and lives in Kakamega. Also present in the field were Irene Musoke (AgUnity Senior Business Analyst) and Collins Ziraba (IT Support) both based in Kampala, Uganda.

The New Vision CBO will focus on utilizing the technology in the sale of fresh AIVs in existing markets together with various existing Farmers, Traders, and Retailers. New Vision's coordinator is a local advocate not just for the CBO, but also for other less established AIV farmer groups. New Vision supported the training and use of the phones in the AIV value chain in Kakamega and helped facilitate training sessions.

Egerton University is the local research partner for this project. Along with conducting evaluation activities in partnership with Virginia Tech (the lead research partner), Egerton University provided technical expertise for value chain actors in the form of training on App as well as other complementary training required. Paul Kahenya, the ICT Specialist at Egerton University, was trained by AgUnity to provide on-the-ground support. Joseph Mwangi, project co-PI, provided technical support, working closely with eight students and other university faculty.

Ministry of Agriculture, Livestock, and Fisheries (MoALF) worked with the New Vision CBO to provide extension services on different matters such as composting and good agricultural practices (GAPs) to Kakamega farmers.

Deployment Activities

Table 6 outlines the activities and processes that were included in the deployment of phones among project beneficiaries.

Table 6. Summary of Training Session Processes

Time	Activities and Processes	Checklist
	Needed	• 8 phones unbound

Time	Activities and Processes	Checklist
		• 8 standard vegetable bags for farmers • 4 bags for traders (big bags) • 4 crates for retailers • Sample Vegetables
15 min	Go through training sequence Test walkthrough for each sub-chain	• Binding phones • Flow 1. Farmer hand-over to Trader • Flow 2. Trader merge bags • Flow 3. Trader hand over to Retailer • Flow 4. Farmer get cash • Flow 5. Trader get cash • Flow 6. Sales log (manual for now) Group 1: 2 farmers → 1 trader → 1 retailer Group 2: 1 farmer → 2 traders → 1 retailer

5 min	Bind and set up phones
	
	Navigate around the main menu
		• Send V3 APK version 2209 to 8 different phones
		• Install
		• Check all times on the phone are correct (local time)
		
		• Find the app, show it on screen
		• Enter pin, show on screen
		• Find Profile ID, show on screen
		• Find Wallet
		• Home button
		• Settings button
		  ○ Language (later: Swahili)
		  ○ Refresh (only when instructed)

3 min 12 min	Flow 1. Farmer hand over to Trader	• Drill without instruction. From the menu – Farmer: *Give Harvest*, Trader: *Get harvest*. Do 4 uninstructed drills • Get questions/feedback • Answers and explanation

Time	Activities and Processes	Checklist
	Drill Exercise	Group 1. • Farmer A sells 50 kg of cowpeas grade A for 5000KS • Farmer A sells 35 kg of Kale grade B for 3000 KS • Farmer B sells 41 kg of cowpeas grade A for 4500 KS • Farmer B sells 56 kg of Kale grade B for 4000 KS • Check Wallet • Score, review Group 2. • Farmer sells 50 kg of cowpeas grade A to trader A for 5000KS • Farmer sells 35 kg of Kale grade B to trader B for 3000 KS • Farmer sells 56 kg of cowpeas grade A to trader A for 5000 KS • Farmer sells 34 kg of Kale grade B to trader B for 2000 KS • Check Wallet • Score and review
2 min	Flow 2. Trader Merge Background Explain how Break out session	• Merge detail can only be seen on the backend, the wallet cannot show where it comes from once it's merged. You can only merge 1 specific asset (e.g., you cannot merge Kale grade A with Kale grade B; you can merge Kale grade A from several farmers at once). Recommended to check the dates of the goods, and not merge two from different dates. • Go to Wallet > Highlight 2 lines of assets of the same type

Time	Activities and Processes	Checklist
		• Click on the Merge button (from the three-dots on the right)
15 min	Drills	Group 1. • Trader: Merge two Cowpeas supplies into one (total 91 kg) • Trader: Merge two Kale supplies into one (total 91 kg) Group 2. • Trader A: Merge two Cowpeas supplies into one (total 106 kg) • Trader B: Merge two Kale supplies into one (total of 69 kg) • Check Wallet • Score, review • Feedback
	Check wallet Score and review Replicate Back to room	Groups 1 and 2 Please each make new transactions of the same size (farmer -> trader) so Group 1. Trader has 4 merged items Group 2. Each trader has at least 2 merged items Questions to Review E.g., should we have a max kg per bag recommended? Marker to mark the bag with the kg. Trader brings 1 bag per asset.
8 min	Flow 3. Trader hand over to retailer "Give harvest via wallet" "Split"	• Entry point to *Give Harvest*: *Wallet* or *Give Harvest* • Check the *Give Harvest* via wallet button

Time	Activities and Processes	Checklist
	Breakout	• For lesser than batch volume, use the "Split" function • Find Split function Drill Group 1 • Trader: Hand over 80 kg cowpeas for a total of 1000 KSH • Trader: Hand over 80 Ethiopian kale for a total of 8,000 KSH Group 2. • Trader A handover 90 kg cowpeas for 12,000 KSH • Trader B handover 69 kg Ethiopian kale for 8,000 KSH • Check *Wallet* • Score, review • Feedback
5 min	Flow 4. Get Cash	Drill • Farmer cashes out some money. • Trader cashes out some money.
5 min	Flow 5. Sales log	Drill • Participant (Farmer and Trader) reviews the sales log individually in their account. • Participants compare recorded transactions.
TOTAL 70 min		

Summary of Deployment Outcomes

The energy of the participants and their commitment to learn and adopt new digital processes to improve their businesses, even in light of COVID-19 limitations, was very encouraging. Although the project only distributed 53 phones, the potential for scale-up is promising. During the training, we collected feedback and insights on the training and the overall product impressions. Most of the beneficiaries attested that they would recommend the smartphone platform to colleagues and business partners whom they felt would benefit from the project. All stakeholders believed that there are more farmers and other value chain actors who would

benefit from the AgUnity V3 Super App. Despite their limited previous exposure to smartphone apps for trading agricultural products, participants quickly acquired digital skills and maintained their high enthusiasm for digitizing their businesses.

The students that supported the deployment and trainings were very responsive and quick to support the participants in the best way possible. During the training, the Egerton University and AgUnity teams were quick to address technical issues arising from the V3 App with support from the AgUnity service desk and technical team.

The field teams offered the following recommendations after completing the initial training:

- There should be continuous follow-up and refresher training to ensure beneficiaries keep on top of the technology and new features.
- The training schedule for refresher training and close monitoring of the participants should be matched with the needs of participants.

Action Items

The following key actions are recommended based on the experience gained through the first deployment of the AgUnity platform in Kakamega County.

- The AgUnity field officer in Kakamega shall visit the different beneficiary groups to refresh participants' knowledge of the app and provide a first pass at troubleshooting problems. She will report incidents that need to be escalated to the AgUnity Service Desk.
- The AgUnity team shall prepare for the next upgrade that includes the integration of a survey applet into the platform (released June 2021).
- The Egerton University team will return to the field for an extension visit to provide refresher training, update the Apps, and collect important evaluation data (July, August, and September 2021).
- Virginia Tech University shall devise the training plan for the next training sequence that will focus on nutrition, food security, and gender empowerment.
- The project partners shall start to plan for the upcoming Hackathon (in November 2021).

Annex 1. Deployment Photos

Figure 14. AgUnity and Egerton University Team Visits the CBO

Figure 15. AgUnity/Egerton University Team Visits CBO Farmer

Figure 16. AgUnity Team Viewing Farmer Produce

Figure 17. Demo Session Between CBO Trader and Registered Farmer

Figure 18. Demo Session Between CBO and Retailer in Kakamega Market

Figure 19. Training Session to the Beneficiaries in Mumias Sub-County

Figure 20. Beneficiaries Receive Phones with AgUnity V3 Super App

Figure 21. Egerton University Students Conducting a Capacity-Building Session

Figure 22. Students Participate in Train the Trainer Session

Annex 2. Relevant Findings from the Baseline Survey

Do you own a smartphone?

- Yes: 65 (23%)
- No, but I have previously: 40 (14%)
- No: 176 (63%)

Of those who don't own a smartphone, would you be willing to buy a smartphone with an app that allows you to market and sell your AIVs? This would cost between 6,000 and 7,000 shillings.[7]

- Yes: 90 (51%)
- Maybe: 34 (19%)
- No: 20 (11%)
- Don't know/Prefer not to say: 7 (4%)
- No response: 25 (14%)

Of those who don't own a smartphone, would you be willing to pay a monthly fee in order to use the app to market and sell your AIVs? It would cost about 150 shillings per month.

- Yes: 97 (55%)
- Maybe: 28 (16%)
- No: 21 (12%)
- Don't know/Prefer not to say: 5 (3%)
- No response: 25 (14%)

Of those who do own a smartphone, would you be willing to pay a monthly fee in order to use the app to market and sell your AIVs? It would cost about 150 shillings per month.

- Yes: 58 (55%)
- Maybe: 10 (10%)
- No: 2 (2%)
- Don't know/Prefer not to say: 1 (1%)
- No response: 34 (32%)

[7] This question relates to one service offering of the AgUnity app and may not be operational in the scope of this project

Annex 3. New Timeline

ID	Milestone Name	Status	Anticipated Completion Date	Actual Completion Date	Owner	Comments
1	Report		June 15, 2021	June 15, 2021	NK, IM	
2	Prototype/User Guide		June 30, 2021	To be shared	NK, IM	
3	Training in App Use and Deployment		30th March 2021	10 May 2021	JM	
4	Data Collection Instruments (including IRB revision approval process)		June 30, 2021	June 30, 2021	JM, NK	
5	Training of Data Collectors and Implementers		April 16, 2021	28 April 2021	NK, JA, IM	
6	Data collection: 2nd Phase		July 16, 2021		MR, IM, PK	
7	Field Visits		May, June, August, October, November		JA, IM, CZ	Ongoing
8	Quarterly Report		Mar 30, July 30 October 31, 2021		JM, NK, IM	
10	Integration of Applets		21 Nov 2021		JA	Rescheduled
11	Data Collection Instruments (Including IRB revisions approval)		October 14, 2021		JM, NK	
12	(Evaluation) Data Collection Training		October 24, 2021		JM, JA	
13	(Evaluation) Data Collection		November 14, 2021		JA, NK	
14	(Evaluation) Program Impact Report		December 14, 2021		JM, NK	
15	(Evaluation) Report on Gender and Youth		December 14, 2021		NK, JM	
16	(Scale up plan) Detailed business plan and implementation guidelines		November 30, 2021		JA, NK, IM	

Annex 4. References

Agnew, J., J. Mwangi, R.P. Hall, D. Sumner, and N. Kristofikova. 2021. *Transaction and Information Pain Points in African Indigenous Vegetable Value Chains in Western Kenya.* Virginia Tech, Blacksburg.

AgUnity. 2021. *App & Smartphone Trainer's Guide.* Queensland, Australia.

LASER PULSE, n.d. "Embedded Research Translation". Accessed July 13, 2022. https://laserpulse.org/embedded-research-translation/#:~:text=LASER%20PULSE%20defines%20Embedded%20Research,process%2C%20product%2C%20and%20dissemination.