AP(P)ICULTURE: DIGITAL SOLUTIONS FOR REAL-WORLD PROBLEMS

A CASE OF APICULTURE IN RURAL UGANDA

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EXECUTIVE SUMMARY

Executive summary

In Uganda, Apiculture is primarily practiced on a subsistence scale, with about 2.7% of total households reported to own beehives and an estimated annual honey production of about 2,600 tons (according to MAAIF/UBOS, 2010). It has a vast untapped potential, as the estimated yearly capacity is more than 500,000 tons of honey. This is changing, with many people considering the activity as a trusted commercial business, shown by the increased national production trends in all bee products. Nevertheless, the sector continues to employ a substantial number of people, attributed to the ease of operating the business and the fact that it requires less finance to start and run.

Several factors contribute to the challenges that this subsector faces. Previous studies report a need for knowledge and skills, modern harvesting techniques, sufficient financial and capacity-building support, and appropriate equipment (MAAIF annual reports, 2016/2017; 2017/2018). As a result, unevolved honey extraction methods, such as boiling honeycombs and sun heating or combed honey, are still primarily used. In addition, lack of access to affordable credit products for smallholders is a big issue. This is related to the lack of traceability, business quality assurance mechanisms and the difficulty to include beekeepers in Know Your Customer (KYC) requirements.

This study is based on one of the current projects funded by the CFYE[1] Trees x Bees. The system of digital applications introduced in the project aims to solve problems of access to finance, quality assurance, and traceability among smallholder farmers.

The study examines the usability of three digital applications that are part of a youth employment program in Uganda, focusing on coffee farmers and starting beekeepers in western Uganda. The research was carried out in partnership with TUNADO, the apex body for the apiculture sector in Uganda, and focused on three localities/communities where the project is running. The three applications used in

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[1] The Challenge Fund for Youth Employment, managed by Palladium, financed by the Ministry of Foreign Affairs of the Netherlands: https://fundforyouthemployment.nl/

the program are Farmerlink, Sevi, and Kucheza, which are used for registration, accessing credit, and gamified learning, respectively. The study explored the usability of these applications in a developing country's context and gave several recommendations to improve digitization. The study paid attention to the individual characteristics of users, the technological factors, and the influence of the social environment and infrastructure. A total of 30 respondents participated and findings point to the need of proxy users for beekeepers to interact with the digital solutions effectively. It was also found that the quality and nature of the device used to operate the digital applications matter greatly, and offline modes are necessary in rural areas with low connectivity. The study's recommendations include training, device distribution, and better offline functionality for digital applications.

User-individual aspects of usability

The study identified the following individual aspects of usability:

1. Digital literacy: The beekeepers' level of digital literacy is a crucial factor in their ability to use digital solutions effectively. As most of them had a low digital literacy rate, the use of proxy users helped overcome this barrier to participation.

2. Device familiarity: Since most beekeepers needed to possess a smartphone to use digital solutions, their familiarity with the device was important. Understanding how the device works is essential for effective use.

3. Trust: The beekeepers needed to trust the intermediary users to use the digital solutions effectively. The fact that the apiary masters represented a trusted organization (TUNADO) helped build trust among the beekeepers.

4. Access to credit: The beekeepers' previous experiences with accessing credit from conventional sources, including mobile money, is also an important factor in their ability to use digital solutions. Understanding

the process of accessing credit digitally is crucial for them to benefit from digital solutions that provide credit.

Technological aspects of usability

Usability of digital applications is not only affected by their features and functionalities but also by the technological aspects that support them. There are several technological considerations that should be taken into account to ensure their effectiveness in remote and rural areas.

5. Device specifications: Devices used to operate the applications should have sufficient storage, memory, processing power, and battery longevity to support its operations. This is especially important in areas with limited access to electricity and internet connectivity, where the devices may need to last for extended periods without recharging.

6. Screen sizes: The size of the screen used to display the application is also important, as smaller screens may hinder the effectiveness of the training. In larger groups that train in the open air, this limitation can be further amplified.

7. Offline modes: The application should have an offline mode to work in rural areas with low connectivity and network issues. This allows users to store data and save gameplay offline, and synchronize it when there is sufficient connectivity.

8. Technical support: Upgrades and updates of software in the applications can cause interferences or disturb data storage and saving, so timely technical support is necessary, especially in areas where developers are not easily accessible.

9. Language accessibility and compatibility: Language barriers can pose problems in areas where literacy in English is limited. It is advisable to offer applications in indigenous languages in remote areas to ensure their effectiveness and accessibility.

Social environment

The social environment of beekeepers greatly impacts the use of digital applications. These applications not only assist beekeepers in their work but also facilitate communication and learning within their social circles. The major considerations identified are:

1. Mediation support: It's interesting to note that some beekeepers may require assistance in accessing and utilizing technology, highlighting the potential digital divide within the community. However, the willingness of their peers to mediate and share information suggests a strong sense of community and collaboration.

2. Knowledge sharing: The sharing of learning points and information about the applications also shows how social networks can be an important source of knowledge and support. Through these interactions, beekeepers can expand their understanding of the applications and how they can be applied to their businesses.

In conclusion, the role of intermediaries is crucial to adopting and using digital applications. This happens through one-on-one interactions with trusted intermediaries (in this case, the Apiary Masters) or in group sessions and proxy use of the applications. The above shows that there is more to digital applications and their capacity to solve real-world problems than what happens on the screen. There is a system of human interactions and networks that negotiate this process.

Table of Contents

List of Tables

List of Figures

INTRODUCTION

1 Introduction

Apiculture in Uganda faces challenges with access to finance, traceability, quality assurance, and the skills and knowledge needed to make beekeeping a business in the fragmented sector. This report presents a case study of three digital solutions to these challenges, implemented by TUNADO, World of Bees, Woord en Daad, and TRIAS Uganda.

This study is based on one of the current projects funded by the CFYE[2] Trees x Bees is a youth employment program focusing on coffee farmers and starting beekeepers in central southwest Uganda. It focused on the usability of the three digital applications in the context of rural smallholder beekeepers and the project staff in the Mubende, Bunyangabo, and Mbarara regions.

First, this report introduces the apiculture sector, the digital applications, the project, and the methodology used in the case study. Then it presents the results and analysis before a discussion and conclusion, followed by recommendations for programs and policies for digital applications in rural settings.

1.1 Apiculture in Uganda

In Uganda, Apiculture is primarily practiced on a subsistence scale, with about 2.7% of total households reported to own beehives and an estimated annual honey production of about 2,600 tons (according to MAAIF/UBOS, 2010). However, this is rapidly changing, with many people considering the activity as a trusted commercial business, shown by the increased national production trends in all bee products. For instance, compared to 2015, 2016 registered increased production in honey, wax, propolis, and bee venom (12,000 to 12,200 tons, 720 to 735 tons, 5,000 to 6,500 liters, and 1.3kg to 2.8kg, respectively) (MAAIF, 2016). In the same period, honey exports and value also increased substantially from 3,000 metric tons (MT) and valued at USD 9.6 million in the financial year 2014/2015 and increased to 4,100MT and valued at 13.12

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[2] The Challenge Fund for Youth Employment, managed by Palladium, financed by the Ministry of Foreign Affairs of the Netherlands: https://fundforyouthemployment.nl/

million in the financial year (2015/2016) (MAAIF, 2016). The Northern West Nile sub-region records the highest honey production compared to other Uganda regions. The sector continues to employ a substantial number of people, attributed to the ease of operating the business and the fact that it requires less finance to start and run.

Despite the subsector's estimated capacity to produce more than 500,000 tons of honey annually (UBOS, 2010), production still needs to grow (in export value) compared to other African countries like Egypt, Tanzania, South Africa, and Kenya. Several factors contribute to the challenges that this subsector faces. Previous studies report a need for knowledge and skills, modern harvesting techniques, sufficient financial and capacity-building support, and appropriate equipment. Unevolved honey extraction methods, such as boiling honeycombs and sun heating or combed honey, are still primarily used (MAAIF, 2016; 2018).

As a response, the government has partnered with development organizations to provide much-needed solutions. At the center of these partnerships is the Uganda National Apiculture Development Organization (TUNADO), an Apex membership-based organization coordinating key stakeholders in apiculture. TUNADO's projects are spread over all four regions in the country (North, East, West, and Central).

TUNADO registers and maintains a database of individual beekeepers who form the composition of their membership. Around 90,000 members benefit from a host of services offered by TUNADO, including capacity development and affordable and reliable inputs (through the world of bee's credit facility owned by TUNADO or cash). To improve their collaboration with local beekeepers in rural Uganda, TUNADO works with World of Bees (WOB), TUNADO's commercial arm (https://worldofbees.shop/about-us/). TUNADO has trained beekeepers on site selection, apiary establishment and management, pest control, beehive production diversification, and value addition and marketing in almost all regions of the country (MAAIF, 2017). The organization has successfully promoted and extended the beekeeper-to-beekeeper extension model, benefiting beekeepers in Uganda.

1.2 Overview of the three applications

TUNADO teamed up with application developers to develop and roll out three Apps- 1) Farmerlink, 2) Sevi, and 3) Kucheza. These apps were developed to fulfill a specific purpose, as shown below.

The Farmerlink Application

This application records and documents the beekeeper's personal information (see figure 1). It uses the mobile phone camera to take a beekeeper's passport photo and GPS coordinates to locate and capture his/her location in real-time. Other information regarding the farmers' business is also captured, including the number of apiaries, hectares of land, coffee trees, the number of beehives, the amount of honey harvested (in kilograms), and other bee products such as beeswax, propolis at the end of the harvest season. The registration exercise (also known as onboarding) is usually carried out by TUNADO field staff (the Apiary Masters).
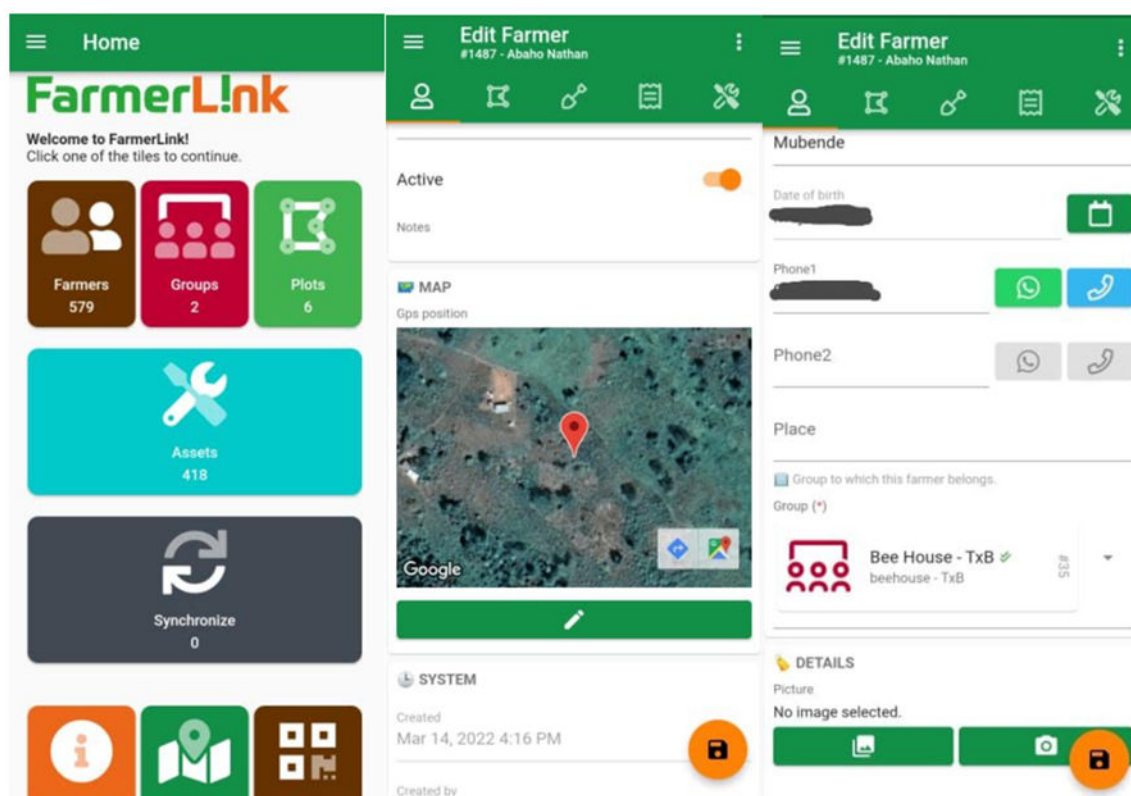
Figure 1 Farmerlink Application interface

Although the Farmerlink app does not require an internet connection, an Apiary Master must connect to an internet network to synchronize the data recorded; otherwise, this data will be lost. This means that an Apiary Master can go to a remote place (with no internet connection), register a farmer, come back to an internet-accessible place and synchronize this information.

The Sevi Application

This application aims to help farmers access beekeeping materials such as beehives, bee suits, smokers, and other harvest materials on credit or with cash. Also, the app is intended to help beekeepers access markets for their products (see figure 2). Initially, beekeepers are supposed to be trained on how to use the Sevi app by Apiary Master before the registration exercise. Upon showing interest in using the app, beekeepers are onboarded either through the Apiary Master's phone or by uploading the app on their (beekeepers') phones. One crucial requirement for successful registration on the app is the provision of a valid National Identification (ID) card.

Figure 2 Sevi App settings

Unlike the Farmerlink App, Sevi requires an internet connection to execute the onboarding exercise. Once the onboarding process is complete, the farmer can order beekeeping materials from World of Bees through the app and wait for delivery in the specified period. For those that request materials on credit, once materials are delivered, beekeepers make payments at the end of the harvest period under the conditions agreed upon prior to the transactions. Payments are either in-kind (in the form of harvested products such as honey) or money, whicheve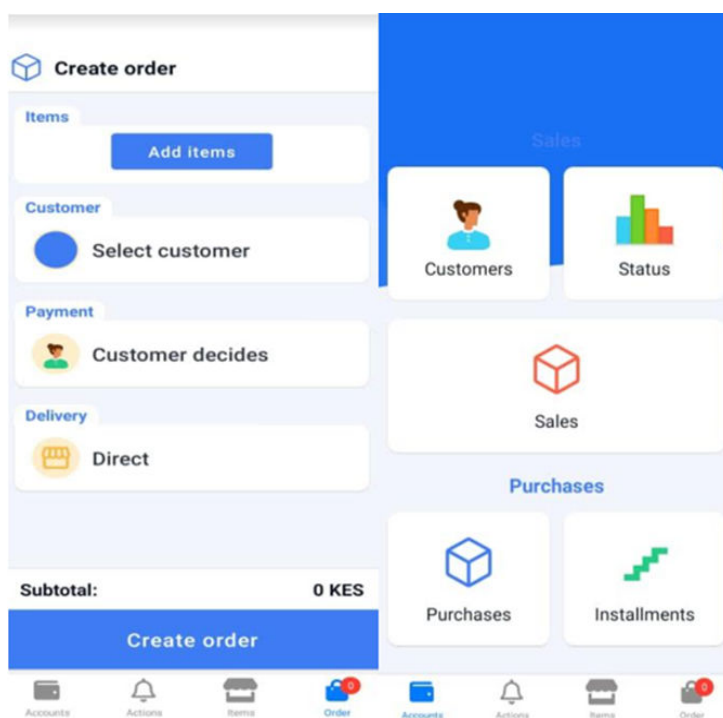r works best for the farmer. Like Farmerlink, it was necessary to interact with Apiary Masters because of their proxy role in the usability of the Sevi App.

The Kucheza Application

This gaming application is tailored to mimic the beekeepers' day-to-day activities to aid in making informed business decisions (see screenshots of the Kucheza game in figure 3). This game aims to simulate a start-up beekeeping business and learn about the decisions and best practices regarding apiary management, equipment needs, processing, and markets.

The game starts with a token (a budget cap) of Shs. 750,000, the money beekeepers use to access the required beekeeping materials to start their business. A list of equipment is displayed in the app, including the type of beehives (local or modern/the Kenya Top Bar hive-KTB), bee suit, smoker, a lure/bait to attract the bees, flowers, a queen, and a plot of land to place the apiary. The price of each piece of equipment is indicated right next to it.

It is important to note that every item selected from the list during gameplay reduces the initial amount (Shs. 750,000). After selecting the equipment (s) needed, farmers use a human-like robot to transfer them to a plot-purchased plot land (their apiary) by touching the gadget's screen. The farmers can colonize their hives by purchasing a queen, baits, or flowers and transfer these to their apiary(ies). The game then takes farmers through the harvesting process and shows them a market where to sell products like honey.

To complete all the steps, farmers had to spend the budget (Shs. 750,000) carefully since the game would stop immediately after the initial budget was depleted. To

master the game, beekeepers are required to keep practicing after their training(s). The gameplay does not require internet connectivity, and smartphone farmers get the game uploaded on their phones.
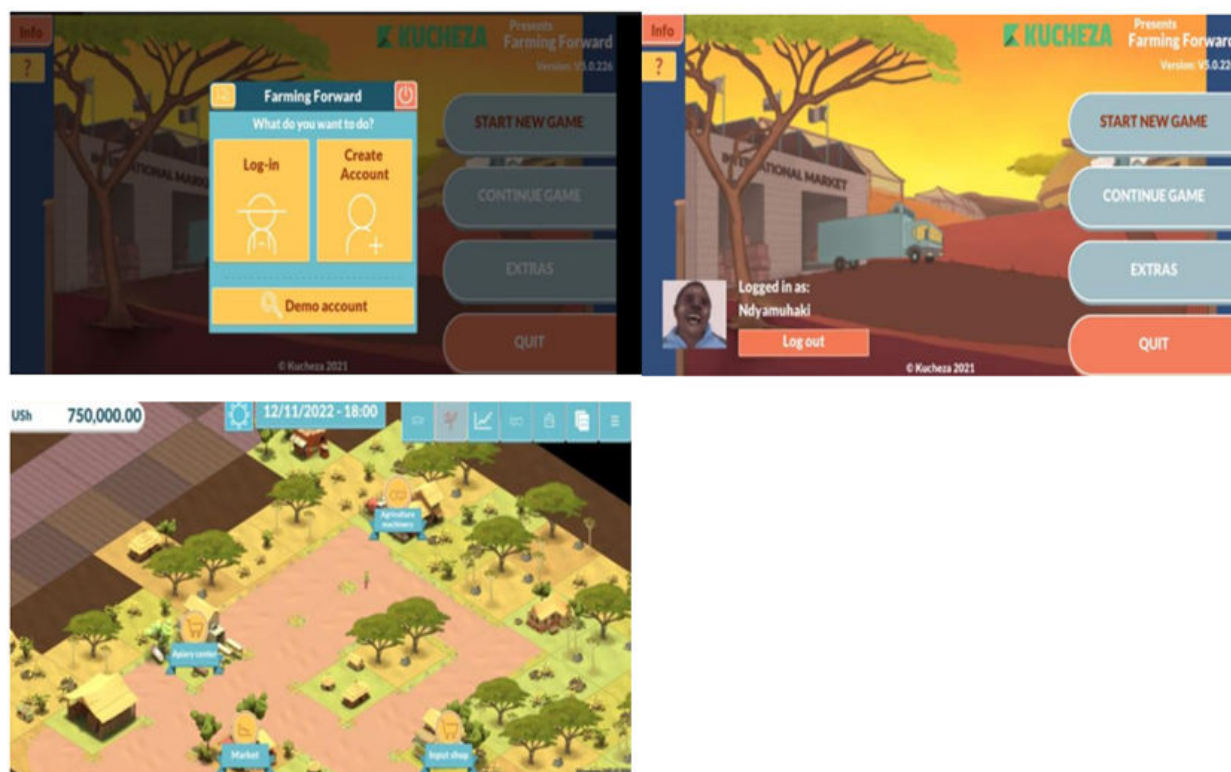
Figure 3 Kucheza Application

1.3 Objectives of the study

Our main objective was to understand users' interactions with digital applications through the lens of usability. The study was guided by the following research questions.

How do individual characteristics of users promote or restrict digital applications' adoption and usability?

a) What are the technological factors that promote or hinder digital applications' usability?

b) What impact does the social environment have on the use of digital applications?

c) What recommendations do users have for technology developers?

METHODOLOGY

2 Methodology

The study targeted users of the three digital applications in rural western Uganda at TUNADO's three Rural Transformation Centers (RTCs). The RTCs included; Bunyangabo Beekeepers' Cooperative (BBC), Delta Bees limited, and Bee House Limited, located in Isingiro, Mbarara, and Mubende districts, respectively. TUNADO was instrumental in the researchers' accessibility of the Apiary Masters and beekeepers for interviews.

The users were sub-categorized into; 1) end users and 2) proxy users. Proxy users are intermediaries necessary for the end-users to operate, understand, or access digital applications. End users represent the farmers (beekeepers) currently partnering with TUNADO in the CFYE project. In contrast, proxy users are TUNADO staff trained to extend the digital applications to beekeepers.

Research instruments (see Appendix A and B) were prepared before the data collection. The study targeted a total of 58 respondents-fifty (50) farmers (the total number of beekeepers who had been trained in the three applications at the time) and eight (8) Apiary Masters (the total number of active trainers that TUNADO had in the field in the three RTCs). A total sample of 30 respondents was reached, and of these, only 26 interviews (18 individual beekeepers, 1 FGD, and 5 Apiary Masters) were used in this report; 4 were found to be unusable.

The earlier target was unachieved because some respondents were unavailable, others were shy to give any relevant information regarding the questions in the study, and others were unreachable. On average, interviews lasted for 30-45 minutes except for one focus group discussion (FGD), which lasted for approximately one (1) hour and five (5) minutes.

RESULTS

3 Results

This chapter presents the results of this study as follows; demographic characteristics, individual aspects; the technological environment; the social environment, and recommendations.

3.1 Demographics

Tables 1, 2, and 3 below indicate the demographic characteristics of Apiary Masters, individual beekeepers, and members of a focus group discussion, respectively. Proxy users in Table 1 below are also known as Apiary Masters employed by TUNADO in the three mentioned RTCs. Although there are 10 TUNADO staff employed as Apiary Masters, we reached our saturation point at the [fourth] respondent. The proxy users were considered for this study because their role goes beyond interacting with beekeepers on behalf of TUNADO.

Table 1 Proxy users (Apiary Masters), source: primary data

SN	Gender	Age	Education level	Total No. of trained beekeepers		
				Farmerlink	Sevi	Kuchera
R26	Male	25	Diploma	400	0	15
R7	Male	29	Degree	187	0	7
R14	Male	27	Certificate	140	0	8
R15	Male	29	Degree	205	0	12

The proxies not only train the beekeepers on how to use these Apps, but they also operate the Apps on behalf of the end-users (beekeepers). All the interviewed respondents were male, aged between 25 and 29 years of age. They had all attained a certain level of education, two with a bachelor's degree, one with a diploma, and one

attained a certificate in beekeeping. Although all the Apiary Masters had been trained in using all three applications, at the time the study was conducted, only Farmerlink App had been successful with no interruptions reported. The four respondents reported that although headway had been made in understanding Kucheza, we still faced challenges while training end users to play the game. Finally, all the respondents indicated that progress still needed to be made in using Sevi App, and no end-user had been trained.

Table 2 End users (beekeepers)

SN	Gender	Age	Highest level of Education attained	Colonized beehives	Un-colonized hives	Total hives	Owner of hive(s)	Owns a smart phone
R1	Male	33	Secondary school	19	8	27	Individually	Yes
R2	Male	28	Vocational training	65	3	68	Individually	Yes
R3	Male	32	Secondary school	17	8	25	Individually	No
R4	Male	28	Primary school	4	0	4	Individually	No
R5	Male	39	Secondary school	18	12	30	Individually	No
R6	Fem	34	Primary school	4	8	12	Individually	No
R8	Male	24	Primary school	28	30	58	Individually	No
R9	Male	21	Secondary school	13	0	13	Individually	No
R10	Male	23	Primary school	10	0	10	Individually	No
R11	Male	32	Primary school	20	5	25	Individually	Yes

SN	Gender	Age	Highest level of Education attained	Colonized beehives	Un-colonized hives	Total hives	Owner of hive(s)	Owns a smart phone
R13	Male	20	Primary school	28	22	50	Individually	No
R16	Fem	17	Primary school	2	1	2	Individually	No
R17	Fem	17	Primary school	16	0	16	Individually	Yes
R18	Male	30	Vocational institute	12	21	33	Individually	No
R19	Male	24	Primary School	6	1	7	Jointly	No
R20	Fem	36	Primary school	0	10	10	Individually	No
R21	Fem	28	Primary school	0	7	7	Individually	No
R22	Male	26	Secondary school	6	4	10	Individually	Yes
R23	Fem	24	Secondary school	3	2	5	Individually	No
R24	Male	38	Secondary school	27	8	35	Individually	No
R25	Male	22	Secondary school	4	4	8	Individually	No

Table 3 Focus Group Discussion-Demographic characteristics

R12	Gender	Age	Highest level of Education attained	Colonized beehives	Un-colonized hives	Total hives	Owner of hives	Owns smart phone
R12-1	Male	25	Secondary school	160	0	160	Individually	Yes
R12-2	Male	32	Primary school	4	2	6	Individually	No
R12-3	Male	36	Primary school	2	3	5	Individually	No
R12-4	Male	19	Primary school	10	3	13	Individually	Yes
R12-5	Male	19	Primary school	11	0	11	Individually	No
R12-6	Female	23	Primary school	7	3	10	Individually	No
R12-7	Female	31	Primary school	4	3	7	Individually	No

Age

Only two (2) respondents were aged between 17-19 years of age, thirteen (13) respondents were aged between 20-29 years old, and nine (9) people were between 30-39 years old. This reflects the CFYE project targeting the youth. That said, there are other beekeeping projects that TUNADO is running whose focus is on other demographics. In general, beekeepers tend to be slightly older and male.

Education

Overall, the education level is still low, with only ten (10) beekeepers reported attending secondary school education. Of these, many did not complete the lower secondary, barely completing senior four (4) completing senior. The majority (seventeen) completed the primary level of education, and only (2) have a vocational institute certificate. Most cited the lack of school fees and other resources as the main reason for dropping out. Many needed help writing their names during a registration exercise before the interview.

Gender

Only eight (8) participants are women, and the rest (21) are men, which contradicts TUNADO's CFYE project target of 70% women inclusion. Although our sample remains small, there was an indication that beekeeping is still a male-dominated business, given the higher participation of men compared to women in our study. Our findings align with previous studies and the general understanding that beekeeping is male-dominated. However, there may also be other factors that prevented women from making time to attend the training sessions and the group events of this study. Those were beyond the scope of this study but could be informative for further study on women's participation in beekeeping in general and training or workshops in particular.

The number of beehives owned

Most of the hives were individually owned, with few instances sharing the hives as a joint venture in a group setting. Only one (1) of the respondents reported owning beehives jointly (with others). Even in a group setting, the members did not have designated roles and would help one another in any activity where possible.

The number of bee hives varied from one individual to another. Most respondents were doing the beekeeping business as a side business, contributing to the more extensive subsistence farming activities. Only a few considered this business a source of income; to many, it was a trial-and-error activity. On average, only half of the beehives were colonized, and there were instances where the previously colonized

hives eventually became empty. Although there were no specific known reasons for bees migrating, farmers pointed to the impact of predators like black ants. The beekeeping business is still a new venture for most of our respondents, and as such, bee products such as honey and wax are still produced in smaller quantities.

Ownership of a smartphone

Only seven (7) respondents reported owning smartphones, and the rest did not. When probed on the desire to have smartphones, a few reported no urgency in owning or using a smartphone, citing that it would lead to spending a lot of their productive time on social media. However, many reported their need for a smartphone and that they were saving money to buy one in the future.

Training Received

At the time of this research, beekeepers had received one training session in Kucheza App. Depending on their availability, farmers were trained either individually or in groups. For those in groups, group mobilization played a crucial role in their training as it would determine how many people in the group showed up and how practical the training would be. Further, farmers reported that the training environment could have been more conducive to effective learning. For instance, in group training sessions, a gadget with a small screen (a phone) was used for illustrations, and many could not see the screen. Also, training sessions were held in open spaces such as under a tree, in the scorching sun, and noisy places.

There was no practical (hands-on) training offered for Farmerlink as the application was operated by the Apiary Masters on behalf of the end-users (farmers). It was reported that Apiary Masters, who spoke about the app in passing, bought step-by-step training to show farmers its details. Also, at the time of this study, training still needed to be offered in Sevi to farmers who reported having heard about the app informally.

3.2 Individual aspects of application usability

The research tested the general understanding of three digital applications following the training(s) and participants' interactions with Apiary Masters. We asked questions about understanding the applications, such as their ability to remember the contents of their training, replication, and applicability. We also probed their grasp of the usability and understandability of the apps.

Ability to recall content from training

a) Farmerlink- The farmers (end users) did not directly use the Farmerlink app; instead, it was used by the Apiary Masters to collect farmers' personal information. So, to get to know their understanding of the app, our research team asked farmers about the information collected and uploaded in Farmerlink. Most of them could recall some of the information asked, such as their name, the location of their apiary(ies), and whether or not farmers owned coffee plantations. There needed to be a general understanding of why their information was being captured. For instance, some assumed that it was a general process a farmer ought to go through to qualify for a future loan facility. To others, it was done to please the Apiary Masters and their group members, while to others, they just had to provide information because it was requested.

However, a few farmers asked about the onboarding process and its importance to their beekeeping business. These reported that Apiary Masters were able to provide clarity about the importance of the onboarding application. See one farmer's response below.

> As a businessman, I do not allow people to take pictures of me. So, I asked him (the Apiary Master) why it was essential to take my picture. He mentioned that the photo was to act as evidence of registration. He said my photo would be attached to my biography as photographic evidence that I had been registered. With this explanation, I was confident that my photo was being used for the right reasons. The trainer also mentioned other benefits of Farmerlink, such as getting access to markets for my bee products like honey, easy access to other beekeeping services like loans, access to beekeeping materials like a harvesting suite, smokers, and modern beehives from TUNADO.

b) Sevi- At the time of data collection, end users had not been trained in using this application. They had received information about the application and how it would be implemented, as shared by the Apiary Masters. As such, they needed a clearer understanding of how the credit app works.

The participants only remembered a little about the details of Sevi. For a few that recalled, their knowledge was limited to the basic theoretical assumptions on how the application works. Almost all of our respondents mentioned that they still needed to receive training in the Sevi application. However, they mentioned the app in passing during other training. Most of them seemed to have a general idea of how the application works: mentioning that it is used to access beekeeping materials on credit from World of Bees and that repayments are made at the harvest period, mainly in kind (through giving up of some of the honey harvested) until such a time when the owed money is fully paid. See a quote from one of the respondents below.

> He (the trainer) told me a few things about Sevi. He mentioned I could access the materials I wanted through World of bees. He said I could access these materials through a loan and pay at harvest time. He also told me that TUNADO could help me access markets through this app.

c) Kucheza-Of all three applications, most respondents seemed to understand the Kucheza application better than Sevi and Farmerlink. Most respondents were able to recount the step-by-step training processes on how the game works

> Yes, I received training in this application. Kucheza is a game that helps one to start a beekeeping business. The app shows a farmer how to access beekeeping materials. It starts with an amount of money to spend, Shs. 750,000. We used this money to purchase the required beekeeping materials and tools. We started by buying beehives. We decided on buying the local hives because they were cheap, each at shs. 20,000. The modern hives were expensive, each priced at shs. 100,000. Then we bought a plot of land where we placed our hives. For the next step, we bought flowers. We were told that flowers are essential in beekeeping as pollination attracts bees. The following process was to ensure that our hives were colonized. We decided not to buy the option of a queen bee since it was expensive. Instead, we bought smoking material as it was a cheaper option.

Some seemed to understand the game more than others; at least most showed participation and interest in it. In group training, participants did not have a chance to play the game; they only attended the session. Whereas with individual training, participants could interact with the game. Although members had a high recall ability in both settings, learning was higher in the one-one training than in groups. One respondent from a group setting recounts as follows.

> **"**
> I did not play. I only attended a training where the trainer was the only one playing the game while giving us instructions.

Ability to duplicate knowledge (skills)

This pertains to the gamified learning application, Kucheza, primarily designed to convey best farming practices and business decisions. Many farmers found the gaming application to be beneficial to their beekeeping business. They could relate the game's visual optics to their daily operations. We asked specifics of what was learnt from playing the game and if they could relate this to their daily lives, and an overwhelming majority cited different lessons.

Farmers found that the Kucheza app taught them budgeting skills. Since the game had a cap on the amount spent in setting up a beekeeping business (capped at shs. 750,000), they had to be careful to spend this money on acquiring the most essential material. The game is set so that when one deleted the cap, he/she cannot continue playing and cannot access the next step. Most participants linked failure to complete the game to failure to plan for the budgeted money properly.

The game shows other expensive items that were above the budgeted amount. For instance, an item like a sting poison extractor was priced at Shs. 2 million, higher than the available funds (Shs. 750,000). With such items, farmers needed to focus on buying items that fit their budget. From playing the game, participants learnt that the distance between their beehives is vital for faster colonization. Two respondents put it this way-

> **"**
> I found the game beneficial. Initially, my beehives were scattered and not colonized. Nevertheless, after the game, I ensured that they were one meter apart, and surprisingly, they started getting colonized.

Trust

Although not stressed by all the respondents, an overwhelming majority indicated that they agreed to deal with TUNADO and the Apiary Masters because of the established amount of trust. One respondent put it this way-

> " We trusted Apiary Masters because they proved to us that they were from a recognized institution with a physical address. They moved on TUNADO-marked motorbikes and showed us their business cards. Playing the game taught me that there should be a meter distance from one beehive to another.

To others, trust was a process that involved continuous communities between TUNADO and the beekeepers. Apiary Masters ensured they kept in touch with the farmers after the training. They (Apiary Masters) made themselves available to attend to anyone with beekeeping challenges, and they visited beekeepers in their homes and apiaries and for community engagements. Especially providing personal information through Farmerlink and in the proxy-user system of Sevi, trust in the intermediaries is essential for adequate information, onboarding, and functioning of the credit accessibility function. In this sense, trust in the intermediaries allows for trust in digital applications.

Digital Illiteracy

Coupled with limited access to and usage of smartphones, most respondents in our sample needed help understanding how applications on the phone work. They could not open an app or install an app. On top of that, some of the respondents were unable to read and write well. Also, some of them did not know that some digital services are, in fact, digital.

For instance, when asked if they had accessed credit through digital means before (discussed earlier), these farmers could not tell those activities such as borrowing airtime or borrowing little money from a telecom company like MTN (MoKash) were all part of digital credit. The researcher first had to probe further for such an activity to be understood as digital.

Not knowing what digital technology entails, much less how it works, can be a natural barrier for farmers to participate in digital solutions – especially in the case of credit, which potentially has a significant impact on a farmer's life. This is besides the questions of whether and how the credit process may work within the application and how much more beneficial the conditions may be for participating farmers. One respondent pointedly remarks:

> I need to be more confident using digital applications to access credit because I need to learn more about them. I need to find out their payment terms too. I am used to conventional banks because I know how the loan application process and disbursement work.

Preference between conventional vs. digital credit facility

As the sampled farmers still needed to use the Sevi application to access credit, we investigated whether there was a willingness to use digital credit. Initially, we asked respondents if they had ever used digital credit outside the Sevi application. We found that for the farmers, interaction with digital credit is mainly limited to MTN and Airtel digital services and usually for small amounts of money, such as a day's airtime, free calls, and a few Megabytes.

Most of the beekeepers attested to using digital credit to access airtime and borrow small amounts of money using their telephone numbers (MTN mobile money and/or Airtel Money). This is a different use of credit than the one envisioned by the Sevi application. See one farmer's response below.

> Yes, there is one I tried. It is the MTN MoKash. I reached a point where they asked me to register for MoKash, and I did not proceed. I borrow airtime often.

Further, we asked our respondents to give their preference given two choices of accessing credit. The first option is (1) accessing credit through conventional/traditional ways. This entails borrowing from a financial institution

(formal/semi-formal/informal). The second (2) option was accessing credit through digital means. Although mixed findings were recorded on this question, the majority seemed to prefer digital applications credit.

The advantages of digital credit over conventional borrowing that respondents cited included a) low-interest rates; b) the ability to pay back in other non-monetary terms; c) a quicker way to access money with just a click of a button on the phone; d) avoids lengthy and bureaucratic tendencies; and, e) does not ask for guarantors and other proofs of previous financial position statements. Still, that does not mean that any digital credit would do, as one beekeeper recounts:

> " Look, I need help understanding how these mobile applications work. I can only commit to them after knowing what I am signing up for. I know that banks have their issues, but they are the ones I know, so I am more inclined to the traditional way of accessing credit.

3.3 Technological aspects and digital applications' usability

To understand the aspects of technology that are viable for App usability, this study sought users' (both proxies and end users) responses regarding the Apps' ease of use, the slowness (speed) of the Apps, the complexity, the quality of locally owned phones where Apps were installed, App upgrades, the difficulty/ease with which to access the upgrades, any interruptions resulting from App upgrades, internet connectivity and general network connectivity requirements. Participants' responses reveal that, indeed, there are various technological challenges affecting App usability. These are discussed below.

No and/ or poor-quality smartphones

Applications rely on the technical specifications of the devices they run on for their operations. A concern shown by both Apiary Masters and beekeepers is the quality and technical specifications of their own devices.

More access to smartphone technology must be available on the beekeepers' side. Most of them do not own smartphones. For a few that have bought [smartphones, their incomes limited them from buying high-quality phones. As such, they own "second-hand" smartphones with numerous challenges such as; a) limited storage capacity; b) limited memory, which causes their screens to freeze up most of the time; c) their batteries heat up, and d) they have short battery life.

In addition, the kind of smartphones owned cannot upload most applications. This makes it very difficult to upload a digital application that requires significant storage space or a different operating system. See below what a farmer with such a phone said-

> The app was not installed on my phone. As I told you earlier, my smartphone had a problem; it would freeze, lose network, and refuse to open sometimes. I have taken it to the mechanic to work on it. Because of these issues, I feared that an app like Kucheza

An Apiary Master put it this way-

> *Usually, the most common challenge is that when we are playing the game, it consumes power a lot of, and if the phone blacks out, that is the end of the game, yet in the field, we do not have electricity.*

Another Apiary Master narrated-

> *Kucheza does not need an internet connection when installed, except that sometimes the phone heats up and slows down, and the icons are free when you try to move the times around.*

Limited Training

It was clear that little training time was allocated to all the applications, and for some, like the Sevi app, there was no training given. For Farmerlink, most farmers were still determining why their information was requested; only a few inquired about this. Also, farmers indicated that although the Kucheza application was beneficial,

almost all of our sampled respondents indicated limited learning time. Where training(s) was offered, it lasted for less than two hours, and there was no guarantee for scheduled training sessions with farmers going forward. One respondent indicated that he witnessed photo upload fails in a few instances. See below:

> *I remember that in a few instances, the passport photos taken would not upload on the app immediately. In such instances, the Apiary Master would request to take another photo (s) of the farmer.*

Long processes

The length or duration of the interactions with the applications is also an essential aspect of usability. This puts pressure on the device regarding battery life or processing capacity (some phones heat up and lose performance when used for a prolonged time).

The Kucheza game is long and involves many steps. Besides worrying about battery life, Apiary Masters attest to never finishing the training on all the steps because each step takes time. There is fear that if the training is rushed, the farmers will forget, and learning will not occur. Indeed, when asked about the length of the game, farmers mentioned that the game involves so many steps, and they never had time to play it to the end. One Apiary Master relates-

> *The game is long. I have never completed all the steps for all the people I have trained. I always stop on the step of harvesting the honey. Nevertheless, there are other steps, like entering the sales records in some documents necessary for the beekeeper.*

A long game puts pressure on the possible duration of a training or workshop, both in terms of interaction with the technical specifications of a device and the learning progress that can be made. The game cannot be played out in full during one session. This makes it more important to have provisions for shorter demonstrations that focus on specific topics that are relevant for the beekeepers in those training sessions.

Small interface

The Kucheza game training is usually held in a group setting (groups of 4 people and above). The training gadgets currently used are the smartphones of the Apiary Masters and some of the beekeepers individually (if they possess any). A typical training entails an Apiary Master who holds a device and passes it around while explaining the steps and decisions made along the process. In some instances, individual beekeepers may also own a smartphone that allows them to run a game in parallel.

The small size of the devices used in training does not support such a community development initiative. A phone has a smaller interface – viewing anything during a training session would require that people are up-close. This is not convenient for a group learning and engaging session. Second, due to the rural nature of the locations where beekeepers live, training would sometimes be held under the trees or in the scorching sun. It is difficult to view anything on a small screen under such conditions. See one Apiary Master's experience below-

> *The phone has a small screen, and for learning to take place, the maximum that needs to train at once is two people. Although I try to train two people per meeting, sometimes I get a bigger group of more than four people.*

Working offline or with poor connectivity

Public network and internet connectivity could be better or more present in some of the areas of the study. The study focused on rural western Uganda. The further farmers are from a telecom antenna, the harder it is to access a network connection; this may be compounded by environmental factors such as rain, valleys, or obstacles. Responses from both the Apiary Masters and the trained beekeepers confirmed this challenge.

For instance, Apiary Masters gave an account of network challenges while onboarding beekeepers on the Farmerlink App. The areas that were further from masts had low frequency, which slowed the application and the onboarding process. This also means

that the onboarding process could not be completed in the field; it was done partially once the Apiary Master returned to a location with a better network connection. This makes it essential to feature an offline modus into an application required to enter and store data or function in these low connectivity areas.

See Apiary Masters' experience with the Farmerlink App during the onboarding process-

> *The app is not affected by internet connections because it can be used offline. You can go to the field without internet, register farmers, and when you return from the field, you can put back your internet and synchronize the data. However, while synchronizing the data, it takes a long time to synchronize if the network is deplorable.*

In addition to low mast frequency, poor internet connection was challenged. As such, applications like Sevi, whose entire process runs on a stable internet connection, would be rendered useless. Either the app becomes very slow or unresponsive. Indeed, as Apiary Masters indicated, one of the reasons they have not started training beekeepers is that they work in remote areas with limited access to stable internet. Regarding Sevi App, one Apiary Master recounted-

> *Most of the time, I try to input my information, but I do not complete it. The user of the app is required to register before registering other people. So, I still need to complete my registration. Sometimes it is because of a poor network, and sometimes even when you have a good network, it does not allow you to complete the registration process. Sevi has always been complicated, not only for me but also for other Apiary Masters who complain of the same.*

Upgrades

Respondents were asked about the upgrading process of the application (downloading and installing an updated version). The study probed if there were significant upgrades, the frequencies of upgrades, any interruption during the installation of upgrades, whether upgrades happen automatically, the upgrades installed process, and whether the upgrades affect the old versions.

It was essential to capture the responses to this question from those that interacted with the applications. For Farmerlink and Sevi, responses were gathered from the Apiary Masters because they interact with the application. Farmerlink gets frequent upgrades, almost monthly. Although these upgrades did not affect the farmer's onboarding process previously, this position changed when the Apiary Masters faced challenges with it. One Apiary Master recounted.

> *Initially, the upgrades would not affect the process. However, this last upgrade affected my data. It made me lose the information I had saved with the previous version. I contacted the person in charge, who promised to contact the developer. Eventually, I was locked out of the app and could not access the data for a while. This stalled my onboarding process and the target of farmers to onboard for a long time.*

Limited technical support/assistance

The example stated above also points to the necessity of troubleshooting and technical support for the users of applications. All three Apps have been developed from outside the country. As such, there is no office in Uganda to assist in rectifying a technical problem with the app faster to enable smooth usage. In case the app got corrupted in the process of registering farmers during a training session, the trainers (Apiary Masters) must first report this to TUNADO offices (in Kampala), who will then report the issue to the App developers (outside the country). Then, there is a time lag between the developers' assessing the problem and rectifying it.

Language barrier

All three applications are written in the English language. It is important to note that most of the intended end users need help to read, write and comprehensively communicate in English. The demographic data (in tables 1, 2, and 3 shown earlier) attest to this as most of them had limited levels of education. In addition, some of the trainers (Apiary Masters) do not understand the local language, making learning difficult. One Apiary Master stated that.

> *The language barrier has been a considerable challenge. I do not speak the local language, Runyankole. When training, I always have to look for a translator who understands the language. Also, sometimes, the farmers may be willing to learn, but they need to learn English, and I need help understanding their language. Also, the game is in the English language. This has been a big challenge*

3.4 The social environment and application usability

The usability of an application is also mediated by social environments. These social environments entail networks, relationships, and socio-economic factors. A digital app does not function merely within the space of user-technology interaction based on technological characteristics. In informal settings, social capital and networks play a vital role in community development. These aspects mediate the usability of digital solutions.

To understand the role of the social environment in App usability, this study probed whether the beekeepers could access a smartphone from their friends, family, or closest community members from which they would practice the Kucheza app or fulfill their other digital needs. Also, the study probed the beekeepers' willingness to share the information from training and their willingness to receive information from others.

Help to access a smartphone.

Many of our sampled respondents need smartphones. Although some showed no need to have and use one, others desired to use a smartphone. For those that showed interest in using a smartphone, we asked them if they ever get help from a friend, a family member, or anyone in their community(ies) to access a smartphone. They ask family members with smartphones to teach them before asking someone from the larger community. See the excerpt from one respondent below-

> " .... I need a smartphone, especially for my business. For instance, I may need to send pictures for construction projects. So, I have a young brother with a smartphone. Usually, I ask him to help me with his phone.

Information Sharing

Respondents were asked if they had shared any information from their training(s) with anyone in their community. The information regarded the knowledge acquired through training, skills and competencies gained. The responses varied depending on the general understanding of how the apps work and if the training was valuable. Those who found the helpful training and understood the app better were more inclined to share that with others. Some said they shared this information and encouraged their community members to attend. See the response below.

> *So far, I have told three farmers. I know that TUNADO still needs to register them, the importance of being registered with TUNADO, and the possibility of accessing loans to improve their business. They seemed interested in being registered, and I promised to invite them to other scheduled training sessions and encouraged them to attend the next.*

Others had not shared anything since they had yet to understand the applications. Regardless, they were willing to share this information if more training is offered and if there is a better understanding of the applications. Most respondents learned about these applications after joining the TUNADO project (CFYE project). They learnt about this project through their community gathering, social groups, and networks, as well as their friends. One beekeeper recounts;

> *I got to know TUNADO and these apps through one of my friends in this community. He later told me how the project works and brought the TUNADO Apiary Masters to me, which is how I ended up joining.*

CONCLUSION

4 Conclusion

This study aimed to enlighten our understanding of rural digital acceptance and usability from individual, technological, social, and environmental perspectives. The role of intermediaries is crucial if the adoption and usage of digital applications are to be achieved in the country. Apiary Masters were an essential aspect of every aspect of digital applications' usability journey in two ways 1) through their one-on-one interaction with end users, and 2) acting on behalf (proxies) of end-users to operate the digital applications. On the individual account, many beekeepers do not own a smart phone-some want to but find it costly; others are still saving up to buy one, and others need to see it as a pressing need. The high digital illiteracy explains this in the country.

On a social front, trust in a digital service provider and the beekeepers' circles drive learning and motivate farmers to participate in digital solutions. That said, trust comes with persistence, presence, understanding, and problem-solving from the digital service provider. On a technological front, digital compatibility is significant; without it, applications cannot operate. Similarly, telecommunication network reach affects the speed at which an application installs, opens, and runs. Similarly, some rural areas in the country have poor internet connection, making it challenging to work with digital apps that require internet. Operating only with an internet connection, with a low reach bandwidth, has a two-way effect and is a significant factor in the digitization process.

This shows that digital solutions are not merely digital, and focusing on the inner workings of these technologies does not do justice to the bigger question of their effectiveness in the real world. A system of individual, technological and social factors negotiates the interactions between digital interfaces and their users. This context both impedes and facilitates the usability and effectiveness of digital solutions.

RECOMMENDATIONS

5 Recommendations

Based on the findings of this study, we propose the following recommendations to stakeholders (TUNADOs' management and Apiary Masters, application developers, policymakers, and end users).

To application developers

a) There is a need to improve the settings of the digital application to be compatible with local phones (smartphones). Since most phones are not of high quality or the latest make, have short battery life, limited capacity, and heat up when frequently used, the digital settings must be made to accommodate such hurdles. Prototype the apps as often as possible to iron out compatibility hurdles before the actual roll-out.

b) A gamified application used for group training should look different from a game intended to be single-player. In the case of Kucheza, the game could be simplified into a few manageable steps. As shown by both Apiary Masters and beekeepers, it takes a long time to play the entire game. Since the game takes a long time to play, leading to battery rundown and the phone screen freezing, it may help to introduce a short version or shorter modules of the game to fit this training context.

c) Specific conditions may work or not work for certain users. For the Sevi credit application, users asked for the app to have more product options. For instance, an option to receive the loan in cash form was suggested. Farmers indicated that, at times, their needs are beyond accessing beekeeping equipment. Occasionally, they may need to transport their harvest to the market. As such, actual money facilitates this process.

d) Specific technical issues require direct involvement and technical support. A local office (or person) to work on technical queries promptly, at least at the start-up phase of implementation, would improve its introduction. This was raised from the technical challenges faced with the Sevi application that took a long time to be resolved for the app to be in use. Direct communication would have sped up this process.

e) When rolling out new versions of the same application in upgrades or updates, endeavor to synchronize data from the old version effectively, as there were a few cases of reported inaccessibility of previously recorded data on new versions.

To organisations working with digital solutions (e.g., TUNADO)

a) Sufficient training is required for the intermediaries who will be passing this on to the end users. Primarily when they also fulfill the role of proxy users.

- Trainers (Apiary Masters) need periodical training sessions to refresh their knowledge of digital applications. The one to two sessions previously (per digital app) offered has proved insufficient since Apiary Masters still have challenges operating the sevi and Kucheza app.
- Given that most of the targeted end users need to be literate (beekeepers) and do not own smartphones, it would make sense to incorporate non-digital tools in the training sessions. In that case, consider using flip charts or other training methods with the phone- or table-based training.
- Digital literacy training should be tailored and available for vulnerable community groups. For instance, provide educational toolkits and materials to Apiary Masters on how to train special groups such as persons with disabilities (the deaf, the visually impaired, the deaf, etc.) on the importance of digital inclusion.
- Training sessions could target women's and men's needs separately. Gender roles may limit women's learning abilities in male-dominated sessions. Although this was beyond the scope of the study, similar studies such as the Global Gender Gap report (2021) have proved that women's needs are different, and training sessions must be female-focused to address them.

b) There is a need for appropriate training equipment. Apiary Masters pointed out that training gadgets with bigger screens during training would be more efficient. The currently used smartphones have small screens, occasionally run out of

battery during training sessions, and work best with four people or fewer per session.

c) Carry out periodic impact reviews to assess the digital applications' performance, track performance shortfalls, and make reasonable and actionable steps. This should be in combination with support from the developers' side.

d) Encourage effective communication channels with a supportive feedback loop. When a technical challenge is identified with a digital applications' field roll-out, practical steps should be taken, and an Apiary Master should be informed promptly.

e) We recommend translating the apps into the local languages (of course, this only works if the AM knows those languages). Alternatively, source the Apiary Masters from the same linguistic area / that master the language to help mediate between the Apiary Master who does not understand the local language and the farmers for better communication purposes.

To policymakers thinking about digital innovation in rural areas

a) Building capacity- support digital innovations by subsidizing innovative local firms to either adapt or produce the digital technologies locally.

b) Digital innovation is not a standalone initiative – in the case of beekeeping, these should be embedded in efforts to protect bees and promote beekeeping.

c) The social systems that negotiate the usability of digital technology should be promoted. There is a need to increase funding for locally based development organizations like TUNADO to expand the beekeeper-to-beekeeper extension model to other regions.

d) Support mass digital literacy campaigns financially through funding to run at the grassroots level, to sensitize all Ugandans about the importance of digitization. Also, finance locally interpreted digital literacy educational materials.

e) Collaborate with telecommunication companies to build masts in remote areas for better network accessibility.

f) Continuing with the rural electrification campaign to enable rural areas to access electricity by solar or other means.

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APPENDIX

Appendix 1: Interview Guide for Bee-keepers

Summary: We are going to talk to you about three applications, that is, Farmerlink, Sevi, and Kucheza. We are interested in knowing your opinion on how these three apps have been used in rural settings in Uganda. We want to know if these apps have helped document the beekeeper's information, how they have guided farmers in making informed business decisions, and helping them to access required materials. We also want to know the challenges faced while interfacing with the three apps and your suggested solution to the mentioned challenges.

Part a) Demographic Information.

FACILITATOR says in 5 minutes; I am going to ask you to tell me about yourself. *The FACILITATOR asks the participant about the following background information group.*

1. **Participant Identification Number: _____**
2. **Date: _____**
3. **Time started: _ _ : _ _**
4. **Time ended: _ _ : _**
5. **Duration: _ _ hour(s) and _ _ minute(s)**
6. **Gender:**
   - ☐ Male
   - ☐ Female
7. **Age**
   - ☐ 15-25 years
   - ☐ 36-45years
   - ☐ 46-55 years
   - ☐ Above 55 years
8. **Level of education**
   - ☐ No school

☐ Primary

☐ Secondary

☐ Diploma

☐ Degree

☐ Other, please specify here.....................

9. RTC name.

☐ Bunyangabo beekeepers Cooperative (BBC)

☐ Delta Bees limited - Mbarara

☐ Bee House limited-Mubende

10. Who owns the beehive(s)?

☐ Individually owned

☐ Only working with the beehive(s)

☐ Jointly owned

☐ If jointly owned, kindly specify the others...........................

11. The number of beehives owned.

☐ Below 10

☐ 11-20

☐ 31-40

☐ If jointly owned, please specify your role here...............................

12. Do you own a smart a phone?

☐ Yes

☐ No

☐ Refuse to mention

13. Does any other member of your household own a smartphone?

☐ Yes

☐ No

☐ Refuse to mention

14. Does anyone in your close community (radius of 1 kilometer) own a smartphone?

☐ Yes

☐ No

☐ Refuse to mention

PART b) How do individual, technological, social, and environmental contexts affect the usability of digital applications?

Part b. 1) How do the users' specific characteristics mediate the adoption or use of the applications?

1. Have you heard about any of these applications (*the Moderator probes the participant's knowledge of Farmerlink, Sevi, and Kucheza apps separately? If yes, the moderator asks the participants to speak separately about the training they received in three applications. Depending on the participant's previous answers, the moderator further probes their knowledge regarding the significance of the three applications*).

2. Have you viewed any of the three applications (Farmerlink, Sevi, and Kucheza)? *(If yes, the moderator probes if the participant has seen the applications in action carrying out their functions. If yes, the moderator asks the participant to explain the application's navigation system).*

3. Have you interacted with the applications (Farmerlink, Sevi, and Kucheza) on your own without the help of the trainer? *(Moderator probes whether the participants can interact with either of the apps on their own. If Yes, the moderator probes further into how the participants experience interfacing with the applications. If No, the moderator asks the participants to probe why).*

4. Based on the participant's answer above, the moderator asks the participants their understanding of the application (*Moderator to probe if the participants; 1=Not understood at all, 2= somewhat understood, or 3= Understood*)

5. Did you provide all the required information specific to Farmerlink and Sevi applications? (*If no, the moderator probes the participant to explain why).*

6. Specifically, for Farmerlink and Sevi applications, based on the information required, is there any you would be unwilling to disclose? *(If the answer is yes, the moderator task participant to please explain further. Moderator further asks the participant to suggest relevant solutions to the above problem*).

7. Concerning the information required for Farmerlink and Sevi application, was all the required information important? *(Moderator probes if the participant feels that*

any critical information was left out yet it should have been requested. If the response is yes, the moderator asks the participant to specify).

8. Are you comfortable providing the required information to the app? *(If the answer is NO, the moderator to ask the participant to explain please).*

9. What do you think about digital platforms? *(Moderator probes to find out about attitudes towards digital applications)*

10. Have you heard of credit access using digital platforms? *(If yes, the moderator asks the participant to specify others)*

11. Have you ever accessed a credit facility on a digital platform*? (If yes, the moderator asks the participant to please specify the digital platforms from where he/she accessed a credit facility)*

12. Have you received any digital credit training (s)? *(If yes, moderator probes on the different related digital received)*

13. Can you trace your credit payments on the app without help from the Apiary Masters? *(If the answer is No, the moderator further probes if any challenges are encountered by the participant in this process. Moderator asks the participant to please suggest possible solutions).*

14. Have you used the Sevi app to access materials on credit *(If the answer is No, the moderator probes the participant on the hindering reasons. If the answer is yes, the moderator asks the participant to specify the borrowed materials. Moderator further probes if the participant understands and can demonstrate the process followed to borrow).*

15. Specifically, for the Sevi application, accessing credit through the app or going to a Microfinance institution, which one would you trust more? *(Moderator probes further for possible reasons, for example-* e.g., *whether you remember your training in this app?).*

16. Specifically, for the Sevi application, would you recommend it to other people as an alternative credit facility platform? *(If the answer is No, the moderator probes the participant on possible reasons)*

17. Moreover, do you need skills to use these apps? Which ones?

18. Do you lack some skills to use these applications?

19. Are you afraid of using mobile applications like Farmerlink, Sevi, or Kucheza? (*if yes, the moderator to probe further into what these fears are*)

Part b. 2) How do the technological aspects affect usability? What are the technological factors that promote or inhibit usability?

1. Do you use your phone to work with the applications? (If no, the moderator tasks the participant to explain what other platform he/she has used to access the app. If yes, the moderator what the participant's experience has been specifically on; *Downloading the app, Opening the app, Signing into the app, Navigating the app, Playing the game step by step, Closing the app, other, please ask the participant to specify. Moderator asks the participant to demonstrate how the applications work*).

2. Specific to the Kucheza application, have you encountered any difficulty (ies) in playing the game? (If Yes, the moderator asks the participant to share difficulties. *Moderator further probes on; Failure to download the app, Failure to open the app, Failure to register as a user on the app, Failure to sign into the app, Failure to navigate the app's menu, Slowness from one stage to another, Internet interruptions, Network interruptions, Other please specify*)

3. Are the applications running smoothly? (*Moderator to probe on if the three apps are running separately. Probe further – see how network issues, internet issues, and equipment failure*).

4. How is your interaction with the Apiary Masters?

5. What issues may they encounter when working with their device and the application?

6. *Which technologies / technological devices are necessary to use the applications (specify per application)*

Part b. 3) Impact of social factors on the use of digital applications

1. Have you been encouraged by anyone in your community to interact with any of the three apps? (If Yes, the moderator to probe further on who precisely)
2. What do people around you think about using applications like Farmerlink, Sevi, or Kucheza? (Moderator to the problem on each of the mentioned applications individually).
3. Have you been encouraged by anyone to access credit using a mobile app like the Sevi app?
4. What do people around you think about accessing credit using a mobile app?
5. Have you faced any internet coverage issues? (If yes, is the moderator to follow up on how much internet coverage issues have affected the participants' interaction with the applications?)
6. How have you faced any electricity blackout issues? (If yes, is the moderator to follow up on how such blackouts have affected the participants' interaction with the applications?)?
7. Have you received any technical assistance from the Apiary Masters whenever any difficulties arise?
8. Do many people around you use mobile phones, the internet, and other digital devices? *(Moderator probes on how widespread digital technologies are and how the beekeepers themselves relate to this)*

Conclusion

MODERATOR asks the participant to suggest recommendations on what could be improved in all three applications to help TUNADO and its developers improve them.

END

Appendix 2: Guide for Apiary Masters

We are going to talk to you about three applications, that is, Farmerlink, Sevi, and Kucheza. We are interested in your opinion on how these three apps have been used in rural settings in Uganda. We want to know if these apps have helped document the beekeeper's information, how they have guided farmers in making informed business decisions, and helping them to access required materials. We also want to know the challenges faced while interfacing with the three apps and your suggested solution to the mentioned challenges.

Part a) <u>Demographic Information</u>

FACILITATOR says in 5 minutes; I am going to ask you to tell me about yourself. *The FACILITATOR asks the participant about the following background information group.*

1) **Participant Identification Number**: _____
2) **Date**: _____
3) **Time started**: _ _ : _ _
4) **Time ended:** _ _ : _
5) **Duration:** _ _ **hour(s) and** _ _ **minute(s)**
6) **Gender**:
   - ☐ Male
   - ☐ Female
7) **Age**
   - ☐ 15-25 years
   - ☐ 36-45years
   - ☐ 46-55 years
   - ☐ Above 55 years
8) **Level of education**
   - ☐ No school

☐ Primary

☐ Secondary

☐ Diploma

☐ Degree

☐ Other, please specify here.....................

9) RTC name.

☐ Bunyangabo beekeepers Cooperative (BBC)-Isingiro

☐ Delta Bees limited - Mbarara

☐ Bee House limited-Mubende

☐ Above 40

Part b.1) Individual characteristics and app usability

1) Have you been trained in Using Farmerlink, Sevi, and Kucheza apps? *(Moderator probes Yes or No. If yes, the moderator inquires how many trainings the Apiary Master has attended).*

2) Do you remember you are training on these applications (apps)? (*Moderator asks the Apiary Master to state Yes or No. If yes, Moderator, what did you learn about the app? Moderator probes on; Downloading the app, Opening the app, signing into the app, Navigating the app, Onboarding beekeepers' information on the app, Synching the data, Closing the app, Other, please specify).*

3) Have you used Farmerlink app to onboard beekeepers' information? *(Moderator probes on whether the answer is Yes or No. If yes, Moderator asks approximately how many have you on board. Moderator asks the Apiary Master to please explain the onboarding process)*

4) How receptive were the beekeepers to providing the required information? *(Moderator asks the Apiary Masters to specify either; Not receptive at all, Somewhat receptive, and/or Very receptive. If receptive, the moderator asks if beekeepers willing to provide complete information Required-Yes or No. If is No, the moderator probes what information was given more reluctantly).*

5) Specific to Kucheza and Sevi Applications application, do you have this app on our phone? *(Moderator asks Yes or No. If No, the moderator asks Apiary Master to specify which platform he/she uses).*

6) Specific to Kucheza, please demonstrate how the game work

7) Specific to Kucheza, have you trained any beekeepers in playing the game? *(Moderator probes Yes or No. If yes, the moderator asks Apiary Master to specify the number of beekeepers trained. Moderator further probes Apiary Master's experience interfacing with the app).*

8) Based on your answer in 7 above, on a scale of 1-5, what do you think of the beekeepers' perception of the game *(Moderator asks the Apiary Master to answer either, Very poor, Poor, Fair, Good, or Very Good. Moderator asks Apiary Master to explain his/her).*

9) Is it easy to access the data in the applications' database*? (Moderator asks the Apiary Master to specify Yes or No. If No, the moderator asks Apiary Master to explain. Based on the answer, the moderator asks Apiary Master to suggest possible solutions).*

Part b.2) Technological environment and app usability

1. Are all three applications running smoothly on the phone (*Moderator probes on the three apps are running separately. Moderator to focus on the Kucheza app. Moderator probes if the applications' menu is easy to follow and use).*

2. Is the answer to the above question? No, have you encountered any difficulties while interfacing with the app? *(Moderator asks the Apiary Master to specify Yes or No. If yes, the moderator asks about the challenges an Apiary Master has encountered; Failure to download the app, Failure to open the app, Failure to register as a user on the app, Failure to sign into the app, Failure to navigate the app's menu, Slowness in data inputting, Slow synching of the app's information, Slowness in data retrieving process, Difficulty in reading output, Internet connectivity, Other, please specify).*

3. Do the three applications require regular software upgrades? *(Moderator asks Apiary Master to specify either Yes or No. If yes, the moderator asks Apiary*

> *Master to specify which one. Moderator follows up by asking how frequently significant upgrades have been required since the app's launch; the moderator probes if upgrades are; Weekly, Monthly, Quarterly, Bi-Annually, Yearly Other, please explain).*

4. If the answer to question 3 above is yes, how does this influence the use of the app? Is that a problem?

5. Do you encounter any frequent changes whenever you use the applications?

6. Do the applications respond quickly in case changes have been made? *(Moderator asks Apiary Masters to answer with Yes or No. If no, the moderator probes for possible solutions).*

7. Do the three applications interface with each other *(Moderator asks Apiary Master to specify. If yes, the moderator asks Apiary Master to clarify this interaction)*.

8. During your training of beekeepers on any of the three applications, were there any cases of people dropping out of the game? *(Moderator probes Yes or No. If yes, the moderator asks Apiary Master to specify the number of beekeepers who dropped out and the application with the highest dropout rate. Moderator further probes the possible reasons for dropping out. Moderator asks for possible solutions).*

Part b.3) Social and environmental factors and app usability

1. Where do you get help if the phone where the applications are installed breaks down? *(Moderator to probe if there are close-by phone repairs or if he/she has to wait on TUNADO or the developers. If the answer is Yes, the Moderator probes further into where this help comes from).*

2. Do you face internet and network issues while using the three applications in the field? *(Moderator probes further on whether the Apiary Master needs an internet connection for the applications to function).*

END

END