Mobile Technology for Participatory Forest Management

Co-designing and testing prototypes in Kenya

July 2021

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Executive summary

Forests play a crucial role in stabilising our climate by regulating ecosystems, protecting biodiversity, absorbing carbon, and reducing soil erosion. However, forests and forest-related livelihoods remain under threat from deforestation and forest degradation: 290 million hectares of forest were lost between 1990 and 2015, and 1.3 billion people are now trapped on degraded agricultural land[1]. Consequently, halting forest loss and degradation, and promoting forest restoration, are central components of global climate mitigation and sustainable development strategies.

It is within this context that many low-and-middle income countries (LMICs) are focusing attention on community-led, or "participatory" approaches to forest management. These arrangements, through which local communities participate in rule setting, monitoring, and restoring forests, are expected to establish sustainable forest management practices and allow adjacent communities to reap sustainable economic and environmental benefits from the forest.

1 World Economic Forum (2020). New Nature Economy Report II: The Future Of Nature And Business.

In this report, we explore how mobile devices and applications can be leveraged to strengthen participatory forest management (PFM) efforts in Kenya. Driven by the voice of local communities living and working in and around Kenyan forests, we use human-centred research approaches to understand the key challenges in PFM implementation and to co-design and test three low fidelity prototypes. Although Kenya presents its own highly-contextualised challenges and opportunities, our research identified five cross-cutting findings that we believe could also shape the opportunity for digital innovation in PFM in other LMICs:

1. Community Forest Association (CFA) members are united by a passion for conservation and the need for sustainable income generation;
2. The use of digital technology is nascent but growing;
3. Current data collection activities are typically manual and slow, and provide little value to CFAs;
4. Financial incentives could accelerate tree planting and other ecosystem services; and
5. Improved access to information could lead to better conservation and livelihood outcomes.

The report also presents key insights from testing three low-fidelity digital prototypes with CFA members: a data collection and monitoring service; a payment platform; and an information sharing platform (including peer-to-peer advice). We found that CFA members were enthusiastic supporters of digital innovation, particularly when they saw opportunities for mobile technology to increase the environmental impact of their work or increase the recognition they receive for their services. Participants also emphasised the important role all three prototypes could play in relieving the unsustainable pressure placed on forests by local communities, either by making it easier for members to deliver their PFM Plans or by motivating more people, particularly women and youth, to join their ranks. There was also broad consensus that the prototypes would create value not only for the CFA, but also for individual environmentalists, conservationists, researchers, and business owners.

We recommend a three-staged approach for designing and implementing new PFM tools: developing a minimum viable product, driving uptake and usage, and moving to scale. At every stage, close collaboration between a multitude of organisations, including CFAs, community-based organisations, government stakeholders, mobile network operators (MNOs) and other technology organisations, will be critical.

Building on the central role that mobile technology already plays in the lives of CFA members and the operations of PFM, there is a real opportunity for a digital solution to be developed with the support of MNOs in Kenya. Our research suggests that engaging in the design of PFM tools could help MNOs establish positive relationships with local government and development partners, help expand the country's mobile money ecosystem, create new revenue opportunities and support sustainability pledges or commitments. Furthermore, participation in PFM projects could build the business case for expanding network coverage into remote areas (in response to increased demand for connectivity), particularly if operators designed tailored data packages and other solutions for rural consumers who are currently underserved.

As a next step, the GSMA ClimateTech programme aims to work with MNOs, PFM partners and other service providers to implement the actions and recommendations outlined in this report. We will seek to catalyse vital partnerships between the GSMA, the mobile industry, tech innovators, governments and the development sector with the aim of reducing fragmentation, facilitating scale and promoting collective action.

Introduction

Forests cover nearly a third of the planet's surface, and when managed well they provide a range of environmental, climate and socio-economic benefits that are critical to human existence and well-being. Forest ecosystems contain 80 per cent of the earth's terrestrial biodiversity, purify our air, produce and conserve soil, stabilise water flows, reduce the risk of natural disasters (such as droughts, floods and landslides) and regulate local temperatures, rainfall and wind patterns. Forests also act as highly proficient carbon sinks. One trillion tons of carbon are locked away in forests and forest soils (more than all the carbon currently found in the atmosphere),[2] and every year they absorb a third of the carbon emissions that humans release through the burning of fossil fuels.[3]

Close to 1.6 billion people – the majority of whom live in low- and middle-income countries (LMICs) – rely on forests for their livelihoods and subsistence, as well as for medicine, fuel and shelter. Forest resources also represent a significant share of women's contributions to household income and are often the only source of cash available to the most disadvantaged segments of society.[4] Furthermore, for many of the 750 million people who live within their borders, including 60 million indigenous people, forests provide a sense of identity, purpose, fulfilment and social connectedness.[5]

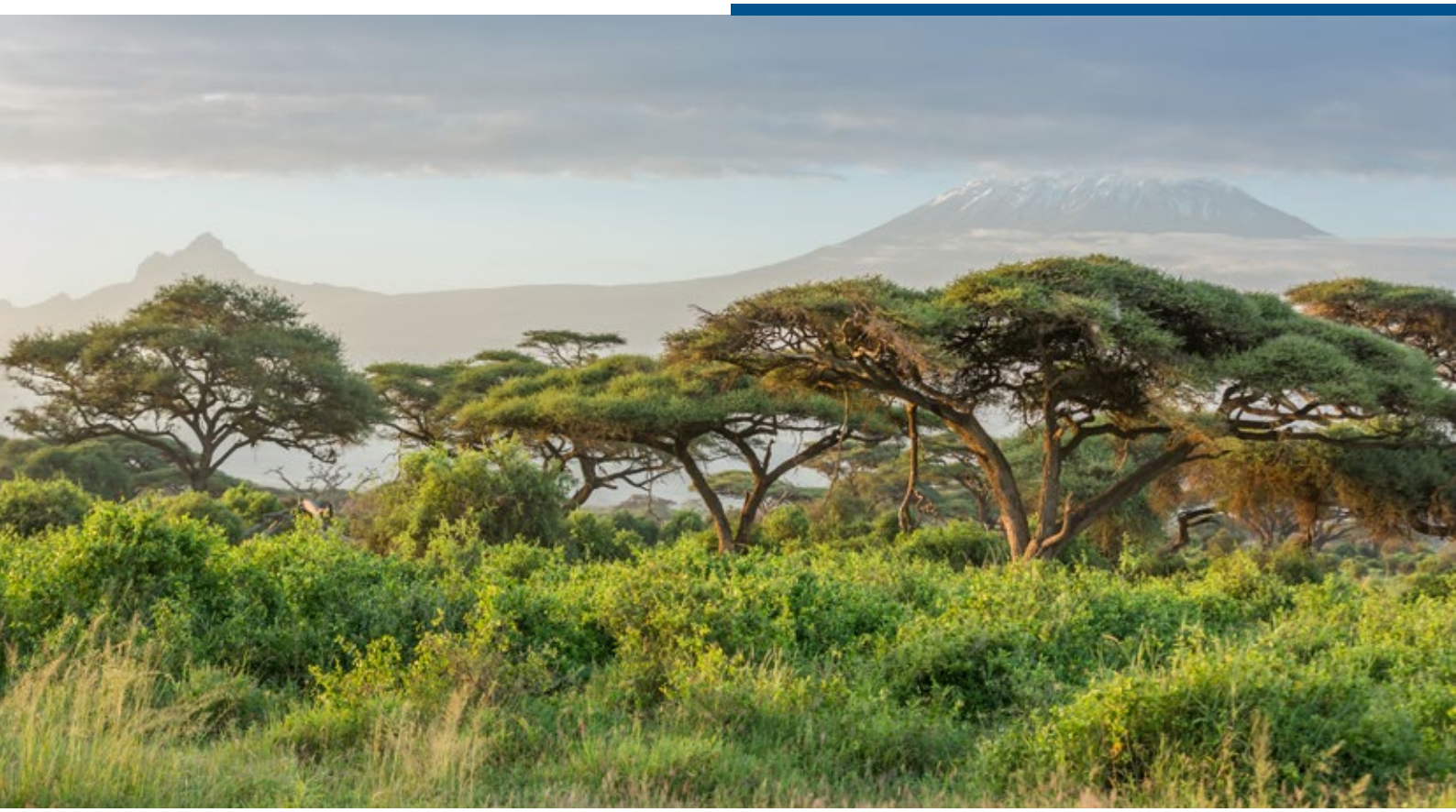
Today, however, the world's forests are facing growing and unsustainable pressure from climate change, increasing human consumption patterns, widening wealth disparities and population growth. Around 10 million hectares of forest (an area roughly the size of Iceland) are lost every year and another two billion hectares are affected by land degradation.[6] When forests are destroyed or degraded, much of the carbon they store is released into the atmosphere. Tropical forest loss alone accounts for nearly 10 per cent of the world's annual carbon dioxide emissions.[7]

Halting and reversing deforestation, therefore, would deliver a cost-effective and nature-based solution to curbing climate change. In fact, the World Resources Institute (WRI) estimates that protecting and restoring existing forests could provide almost a quarter of the climate mitigation needed over the next decade to meet the goals set in the Paris Agreement.[8] For this reason, global initiatives are building the capacity of governments and local organisations to recognise the value of the goods and services provided by healthy forests and offering incentives to improve forest conservation efforts.

It is within this context that many LMICs are focusing attention on community-led, or "participatory" approaches to forest management. These arrangements are based on the premise that by partnering directly with forest-adjacent communities, governments can conserve and regenerate forests more effectively while also alleviating poverty through the creation of sustainable forest-based livelihood opportunities. While participatory forest management (PFM) approaches are a relatively new trend in Africa, they have been implemented with success in many countries across Asia and Latin America for the last 40 years.[9] Across all these regions, evidence is mounting that PFM is an effective management approach that can deliver climate, environmental and socio-economic benefits.

New projects are also leveraging digital technologies, such as satellites, sensors and mobile apps, to help monitor forest activities and to support conservation efforts led by local communities, non-profit organisations, the private sector and government ministries.[10] In general, however, technological solutions that are designed to support PFM are immature and fragmented, and few have achieved scale. In many cases, digital solutions have been built without sufficient input from community members and other local stakeholders. This has created a disconnect between tech developers and PFM implementers and led to the design of solutions that do not reflect real needs, requirements and preferences.

2 UN-REDD Programme (n.d.), "Forest Facts".
3 IUCN. (February 2021). Issues Brief: Forests and Climate Change.
4 FAO and UNEP. (2020). The State of the World's Forests: Forests, Biodiversity and People.
5 IIED. (n.d.) Investing in Locally Controlled Forestry: Natural Protection for People and Planet.
6 FAO. (n.d.). "International Day of Forests".
7 Fritts, R. (18 October 2018). "Tropical deforestation now emits more CO2 than the EU". Mongabay.
8 Gibbs, D., Harris, N. and Seymour, F. (4 October 2018). "By the Numbers: The Value of Tropical Forests in the Climate Change Equation". World Resources Institute Insights.
9 FAO. (2016). Forty Years of Community-based Forestry: A Review of its Extent and Effectiveness. FAO Forestry Paper 176.
10 GSMA. (2020). Digital Dividends in Natural Resource Management.



Research objectives

The GSMA's 2020 report, "Digital Dividends in Natural Resource Management",[11] indicated that the expansion of 3G/4G mobile coverage, increases in smartphone penetration and high mobile money adoption offered new opportunities for LMICs to improve the efficiency, impact and transparency of forest management activities. The report concluded that additional, more context-specific research was required to help organisations develop sustainable business and partnership models that could support digital innovation and empower underserved populations to play a more active role in forest management. In particular, the research identified a need for more human-centred design research that explored how specific digital tools or services could be shaped by the preferences, biases, capabilities and needs of community members and stakeholders.

This report highlights key findings from the GSMA ClimateTech programme's research in Kenya, which built on our previous research by deepening our understanding of the specific challenges, incentives and benefits that institutional stakeholders and community members encounter when participating in, supporting or funding PFM activities. It also sought to explore how mobile devices and apps could be used to make PFM efforts more efficient, impactful and transparent, and identify important cross-cutting insights that are likely to shape opportunities in other LMICs where PFM approaches have become a priority.

11 GSMA. (2020). Digital Dividends in Natural Resource Management.

Forest management in Kenya: contextual considerations

The ecological and technological context in Kenya, combined with a well-established PFM system, created an ideal context in which to investigate how digital technology could make PFM approaches more effective.

Kenya is endowed with a wide range of forest types, including montane forests, lowland rainforests, savannah woodlands, dry forests, coastal forests and mangroves. These ecosystems are biologically rich, harbour high concentrations of endemic species, support ecological integrity and provide a diverse range of ecosystem services. The Kenyan Government has also recognised that sustainable forest management has a positive impact on several of the UN Sustainable Development Goals (SDGs) through the provision of food, medicines and fresh water; contributions to employment; the capture and storage of carbon; and the support of various ecosystem functions (such as reducing soil erosion and contributing to biodiversity).[12] Unfortunately, these benefits are increasingly undermined by climate change, unsustainable demands from local communities (e.g. for charcoal or agricultural activities) and a lack of collaboration in forest management.

In recognition of the critical link between forests, climate change and economic growth, Kenya's Constitution and the national development programme, Kenya Vision 2030, have set a target to increase the amount of land covered by forests to 10 per cent by 2022, up from an estimated 7.2 per cent today. As part of this national strategy, the government has established objectives to engage with NGOs and the private sector to support reforestation and conservation efforts, and to identify and promote innovative technologies for forest restoration.[13]

PFM was formally embraced by the government with the signing of the 2005 Forest Act, which established the process through which community members can form and register Community Forest Associations (CFAs) and assume responsibility for protecting, conserving and managing their local public forest in partnership with the Kenya Forest Service (KFS). PFM approaches are seen as critical to achieving national forest coverage targets, which will not only require the protection of current forest stock, but also the planting of more than a billion new trees. An introduction to the CFA model is found in **Section 1**.

Kenya is also home to one of Africa's most thriving mobile and digital innovation ecosystems. Approximately 53 per cent of the population subscribes to mobile services, which is among the highest rates in East Africa and above the average for the continent (49 per cent).[14] Low-cost devices and smartphone financing schemes have also helped accelerate the adoption of smartphones in the country, with the number of smartphone connections increasing by 24 per cent between 2019 and 2020. The GSMA predicts that Kenya will have 47 million smartphone connections by 2025 (up from 31 million today) – more than any other African market except Nigeria and South Africa.[15] The use of mobile internet is also increasing exponentially: 58 per cent of subscribers used mobile internet in 2020, but this is expected to climb to nearly 85 per cent by 2025. Additionally, Kenya is a global leader in the adoption of mobile money services, which enables the sending and receiving of money through mobile-based accounts and access to credit, insurance and other services. In 2019, 73 per cent of Kenyan adults owned a mobile money account, well above the regional average.[16] Kenya has also recently trialled 5G and is among the continent's leaders in cellular Internet of Things (IoT) connections.[17]

12 The National Strategy for Achieving and Maintaining Over 10% Tree Cover by 2022 specifically recognises positive impacts on SDG 1, 2, 3, 6, 13 and 15.
13 Republic of Kenya Ministry of Environment and Forestry. (May 2019). National Strategy for Achieving and Maintaining Over 10% Tree Cover by 2022.
14 GSMA Intelligence.
15 GSMA. (2020). The Mobile Economy: Sub-Saharan Africa 2020.
16 Navis, K. (14 May 2019). "And the World Leader in Mobile Money Adoption is...(Not Where You Think". Center for Global Development.
17 GSMA. (2020). The Mobile Economy: Sub-Saharan Africa 2020.

Research methodology

The research used a staged, multi-method approach to capture the perspectives and recommendations of over 400 CFA members from across the country, as well as a multitude of PFM stakeholders and experts. Due to the COVID-19 pandemic, all research activities were conducted remotely by researchers at the Nairobi-based Busara Center for Behavioural Economics. The research approach focused on stakeholder participation and collaborative design, ensuring that local actors were involved at each stage of the project.

Phase 1: Landscape framing

Desk research and stakeholder interviews were conducted to understand how PFM is currently working in Kenya, the partnerships and policies that have been created to support it, current and potential challenges that affect PFM implementation, and how previous or existing digital solutions are performing. A list of organisations engaged in this phase is found in Appendix 2.

Phase 2: Qualitative interviews with CFAs

In-depth interviews and photo journals conducted with 21 CFA members allowed us to document their role in their CFA, their motivation for participating in PFM, how membership supports their livelihoods and/or affects how they access and use forests, barriers or risks they face to effective PFM, current use of technology in the CFA and their initial ideas on how digital solutions could benefit them. Findings from this phase of the research are outlined in Section 2. The individuals engaged in this phase of the research were members of one of the following three CFAs:

Central
Ngare Ndare CFA

Chosen for its large membership, success, online presence, payment for services and familiarity with technology.

- Formed in 2004
- 5,540ha indigenous forest
- 7,400 members (55 men, 45 women)
- Ecotourism, non-timber product collection, grazing, IGAs, nurseries

Coastal
Mombasa Kilindini CFA

Chosen for its relatively small size and focus on mangroves. No payments for services, but some experience with technology.

- Formed in 2012
- 3,700ha indigenous and mangrove
- 260 members (75 men, 25 women)
- Ecotourism and income generating activities: apiaries, fisheries, nurseries

Rift Valley
Menengai CFA

Chosen for large forest size, gender balance, inclusion of a eucalyptus plantation and PELIS scheme.

- Formed in 2005
- 7,000ha indigenous and plantation
- 594 members (40 men, 60 women)
- Ecotourism, firewood collection, grazing, apiaries, nurseries

Phase 3: Co-design workshop

A virtual design workshop was conducted with PFM stakeholders (the same as those in Phase 1) to develop three low-fidelity prototypes for digital technology solutions. The prototypes focused on solving specific problems a PFM faced, as identified by CFA members. Wireframes for each prototype are found in Appendix 3.

Phase 4: Prototype testing

The digital prototypes were tested remotely with 21 CFA members (the same as those in Phase 2) through phone interviews. As with the initial qualitative interviews, prototype testing explored the perspectives of CFA members on the value and usefulness of the digital tools and collected feedback on how they might need to function. Insights from this phase of the research can be found in Section 4.

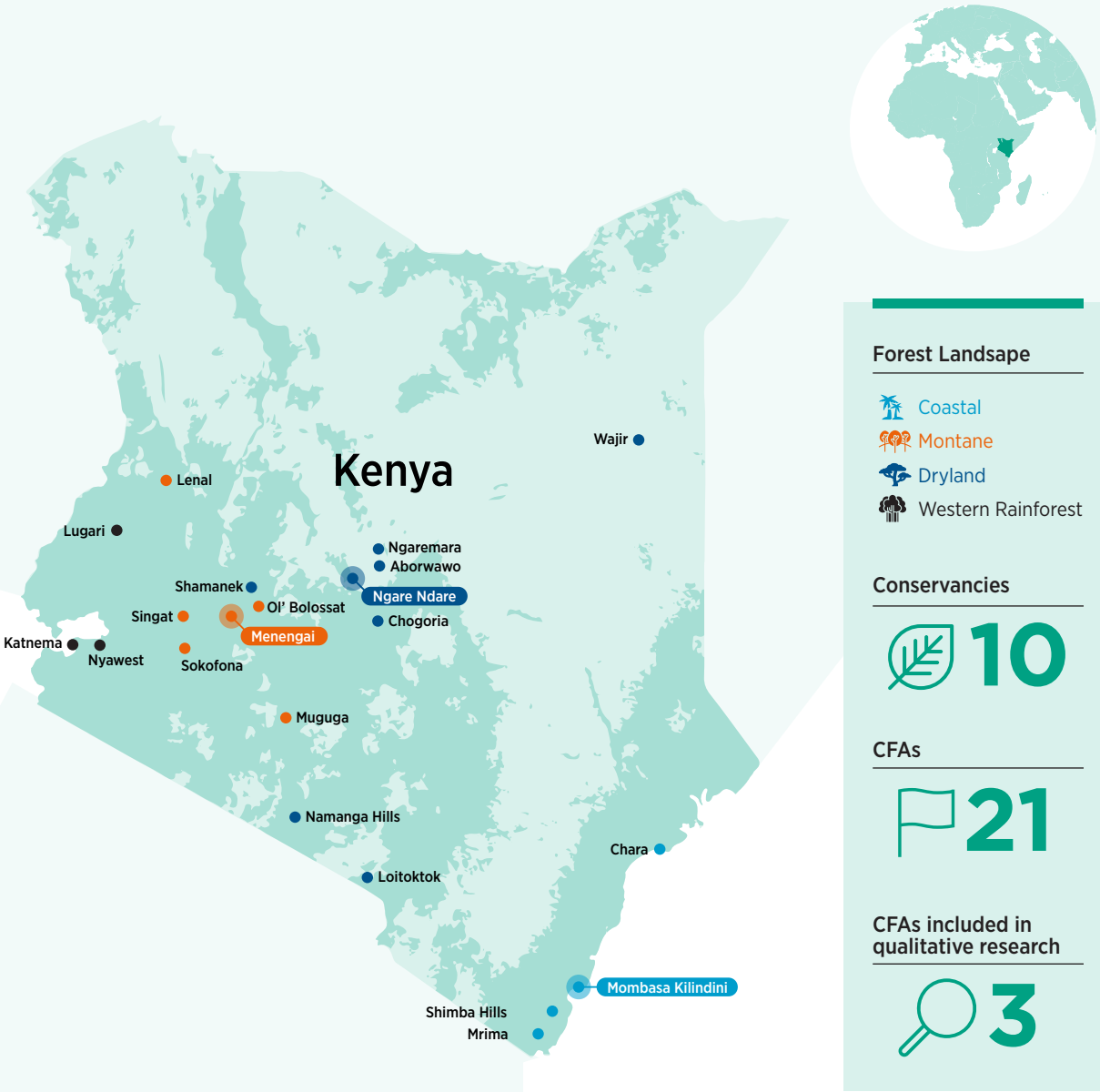
Phase 5: Quantitative validation

Finally, to help validate the qualitative findings and collect additional feedback on the digital prototypes, quantitative phone surveys were conducted with just over 400 individuals from 21 CFAs operating across the country. As with the qualitative research, the survey questions explored the members' perspectives on CFA structure, function and activities, such as tree planting and monitoring of the forest, as well as their experience with and needs for technological tools in PFM. Thirty CFA members with smartphones also participated in an app-based survey in which the participants reviewed the digital prototypes and were asked to provide feedback on whether and how they would interact with such services.

Figure 1

Sampled Community Forest Associations

Additional details on the research methodology can be found in Appendix 1.



SECTION 1
Overview: Community Forest Associations in Kenya

The PFM system in Kenya is designed to halt forest destruction and degradation by enabling local communities to co-manage and benefit sustainably from the country's public forests. Any member of a forest-adjacent community may, together with other residents from the same area, register a CFA and work with the Kenya Forest Service (KFS) to establish a five-year Participatory Forest Management Plan (PFMP). The PFMP is a formal agreement between the CFA and the KFS that describes the interactions or interrelationship between the community and the forest, documents the activities and methods through which the community will help conserve, monitor, protect and regenerate the forest, and establishes how the CFA will gain access to and use forest resources.

Once a PFMP has been approved, CFAs are given certain privileges, or "user rights", within the forest, which include the collection of forest resources (such as fuel wood or medicine), initiating new income-generating activities, establishing the forest as an ecotourism destination and conducting conservation research. The extent to which a CFA has access and user rights to a forest is highly dependent on how well community members design and negotiate their PFMP. For this reason, external support from NGOs, private sector stakeholders, forest management consultants or lawyers is sometimes provided to CFAs.

> "There are big differences in how well benefits are bargained from the CFAs. Sometimes they even hire a lawyer to negotiate for them and some of them have advanced strategic plans."
>
> **PFM stakeholder**

Internally, CFAs are run by elected committee members who act as the link between the CFA and the many organisations that support them, such as the KFS, the National Alliance of Community Forest Associations (NACOFA), research institutions and a wide range of public and private sector stakeholders. During their terms in office, committee members work closely with the KFS to oversee the implementation of the PFMP and establish bylaws for their members to regulate forest access and use. Committee members also work with the KFS and scouts (hired or voluntary) to ensure that forests are monitored regularly and, from time to time, carry out specific tasks such as mapping forest areas, fire control or checking on reports of forest destruction.

Beyond the committee, a CFA can be composed of hundreds, or even thousands, of general members who benefit from access to sustainable livelihood opportunities and are responsible for conducting a wide range of activities that help protect, manage and rehabilitate the forest. These activities can include forest monitoring, tree planting, reporting illegal activity and even fighting fires. Nearly every CFA, in one way or another, is also responsible for collecting data from the forest to help the KFS track progress on the implementation of the PFMP.

To fund the activities set out in their PFMP, CFAs must usually access funding from a variety of sources (see Figure 2). For many CFAs, most funds come from the CFA members themselves,[18] who must pay annual membership fees that typically range from KES 200 to 250 (approximately $1.80–$2.30) per person. CFA members might also pay additional fees on a monthly, annual or seasonal basis to gain access to certain forest resources. Research participants from the Ngare Ndare CFA, for instance, must pay a small fee for the right to graze their livestock in forested areas, while other CFAs reported charging members for fishing, firewood collection and certain agricultural activities.

18 Koech, C.K. et al. (2009). Community Forest Associations in Kenya: Challenges and Opportunities. Kenya Forestry Research Institute.

Additional funding is often received from external partners, such as the KFS, NGOs, private sector sponsors and other government bodies. However, external funds, particularly those from NGOs or private sector sponsors, are usually channelled to specific activities, such as capacity building, the development of PFMPs or tree planting. CFAs can also generate income by engaging in activities such as ecotourism (CFAs are permitted to keep a portion of the gate fees paid by tourists who visit public forests) or by finding sponsors for tree planting events. Although tree planting activities are usually carried out by members on a voluntary basis, sponsored events allow the CFA and its members to be compensated financially for their time and effort.

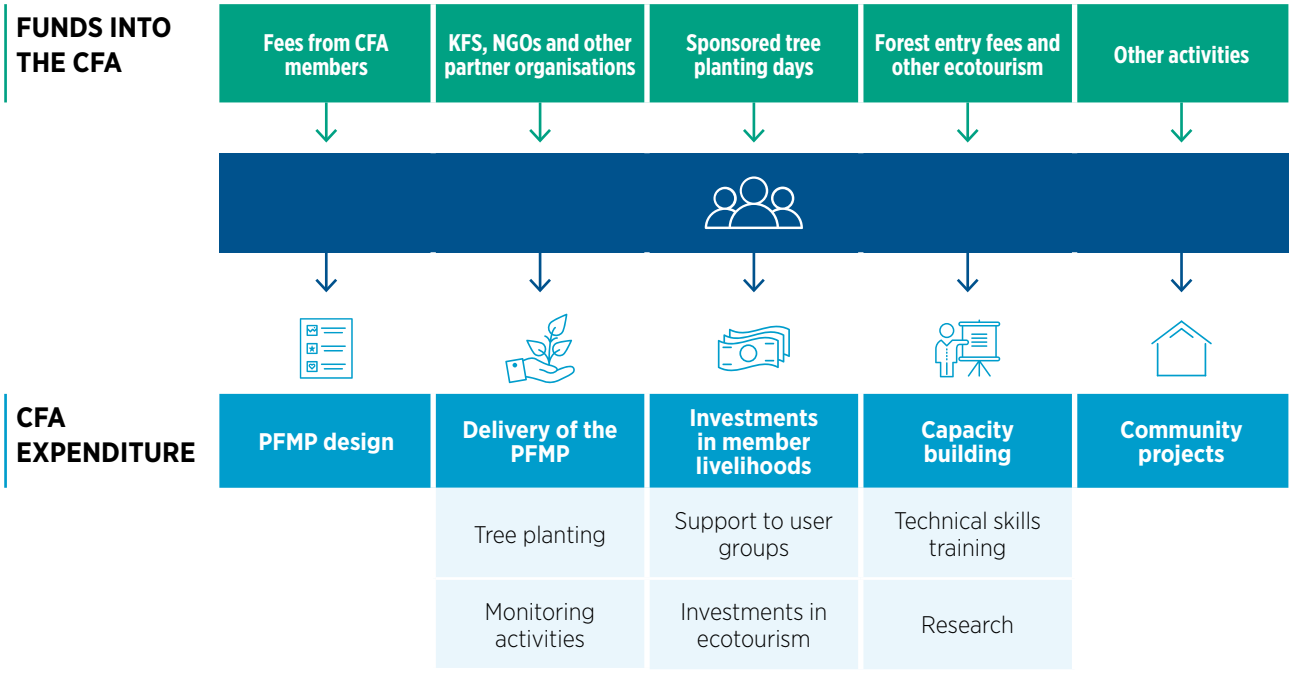
> "We have attended a number of trainings sponsored by various institutions like WWF, [and were] sponsored towards the finalisation and validation of our PFM Plan."
>
> **CFA member, Mombasa**

CFAs might also ringfence a portion of their funds to conduct conservation research. For example, one user group from Mombasa invests up to two-thirds of the income they earn by selling tree seedlings in new research projects to help improve their conservation work and enhance the survival rates of newly planted mangroves. In addition to paying researchers, these funds are often used to purchase equipment (e.g. laptops, smartphones and printers) that will help disseminate research findings to members and to provide educational scholarships so that members can study mangrove conservation and share what they have learned with the rest of the community.

Some CFAs might also seek to demonstrate their positive impact on the surrounding community by supporting local development projects, such as building schools, providing education bursaries or improving access to water. The Menengai CFA, for example, has provided scholarships to three local students to attend university. While this type of spending is not linked directly to conservation, it can be helpful in building goodwill in the community and motivating others to consider applying for CFA membership.

Figure 2

CFA funding and expenditure



SECTION 2
Key findings and opportunities for digital innovation

In the first phase of our project, desk research and expert interviews were conducted to identify the common and most pressing challenges CFAs encounter when delivering their PFMPs. The public and private sector stakeholders involved in this stage of the research have direct experience supporting or implementing PFM activities, and included forest management authorities, technology innovators, research institutions, and many other organisations that provide on-going financial, capacity building or research support to CFAs. Stakeholder insights and perspectives were then validated through qualitative and quantitative research with CFA members themselves.

The research participants reflected the diversity of backgrounds, experiences and perspectives found within CFAs. Although "CFA members" is often used as an all-encompassing term, we found that these groups are comprised of individuals with different pressures, skills, opportunities and goals, and often varying ideas about the best ways to pursue forest conservation, income generation and socio-economic development. We have also found that individual CFAs encounter their own highly contextualised challenges and opportunities when delivering their PFMPs. For instance, while all of CFAs describe unsustainable pressure from their local community as a key challenge to forest conservation, other immediate threats, such as wildfire, human-wildlife conflict, friction with indigenous communities, government infrastructure projects or even plastic waste, were more location specific.

This section highlights five cross-cutting findings that we believe are shaping the opportunity for digital innovation in PFM. These can be summarised as follows:

	Finding	Key takeaway
	**01** CFA members are united by a passion for conservation and the need for sustainable income generation.	CFA members are likely to find immediate value in digital tools that support their conservation and regeneration efforts, enables them to develop new conservation skills or builds their expertise in matters related to forest management. Tools that can help members grow or improve their income-generating activities would also have clear benefits.
	**02** The use of digital technology is nascent, but growing.	The near-universal use of mobile services and growing access to smartphones indicates that most CFAs will possess the basic digital skills required to use mobile-enabled PFM tools effectively. However, solutions should be careful not to exacerbate the digital divide between smartphone and basic handset users.
	**03** Current data collection activities are typically manual and slow, and provide little value to CFAs.	There is a clear need for digital tools that are simple to use and enable a wide range of relevant information to be collected and submitted in real time. Crucially, digital solutions should establish a circular process through which submitted data is promptly fed back to CFAs to aid decision making.
	**04** Financial incentives could accelerate tree planting and other ecosystem services.	Financial incentives tied to tree planting could provide CFAs with the funding and motivation they need to accelerate tree planting and other PFM-related activities. Digital tools must help make benefit sharing more transparent and avoid eroding commitments to conservation and a "volunteer spirit" among members.
	**05** Improved access to information could lead to better conservation and livelihood outcomes.	CFA members would benefit from platforms that offer site-specific, timely and relevant information and advice; allow users to exchange lessons and insights within and outside their CFA; and provide access to the marketplaces and resources they need to be successful.

Finding 1

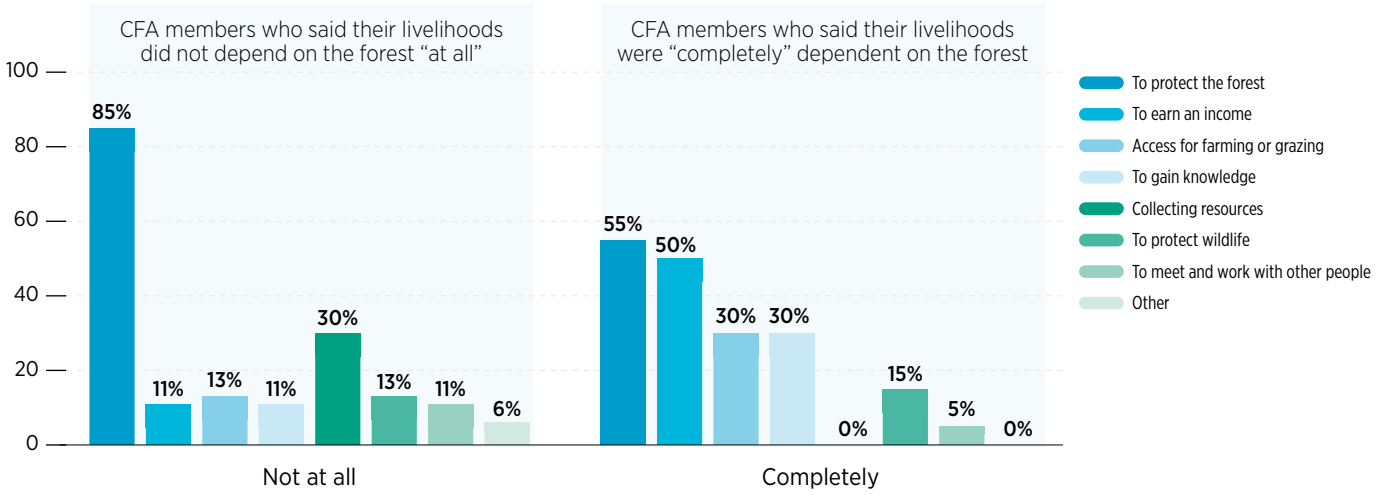
CFA members are united by a passion for conservation and dependence on forest resources for their livelihoods

When asked to reflect on their main reason for joining a CFA, most respondents said that it was an intrinsic desire to protect the forest (Figure 3). In interviews, CFA members highlighted their love for nature and wildlife, the link between the forest and their personal well-being and the enjoyment they derive from working alongside like-minded environmentalists. The social component of CFA membership, as well as the opportunity to take greater ownership of forest management processes, to bring an end to illegal activities and to be on the radar of decision makers and local authorities, also appeared to be highly beneficial to research participants. There was a clear appreciation among members for the ecosystem services delivered by healthy forests, such as supporting biodiversity and maintaining healthy waterways, and an understanding that contributing to conservation efforts and "following the rules" will increase the benefits the community draws from their local forest in both the short-term and long-term.

> "My love for nature made me get interested in joining the CFA."
>
> **CFA member, Menengai**

Figure 3

Main reason for joining a CFA



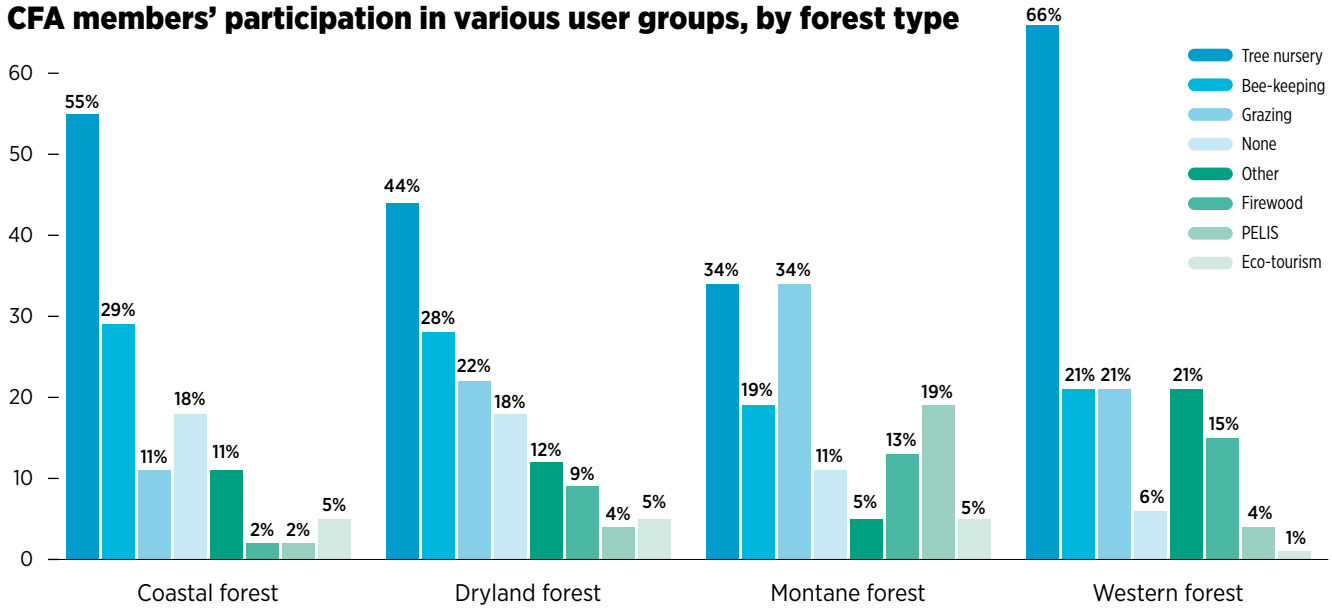
The other key drivers of CFA membership reflect the critical link between forests and community members' livelihoods. Almost 90 per cent of the CFA members participating in our survey said that their livelihoods depend on forest resources in some way, with 27 per cent reporting that they were highly or completely dependent. The research found that an individual's ability to generate sustainable household income, to enjoy user rights within the forest (e.g. permission to farm or graze) or to hold bargaining power over forest resources are highly dependent on being an active member of a CFA.

Those who hold official roles in the CFA, such as forest scouts, ecotourism guides or gate managers, are paid on a regular basis through CFA funds. However, 85 per cent of general members earn income from the forest through activities such as grazing, beekeeping, firewood collection, aquaculture, ecotourism or tree nurseries. Several CFAs also cultivate in the forest under the "shamba system" (commonly referred to as Plantation Establishment and Livelihood Improvement Schemes, or PELIS), which allow community members to plant crops alongside newly planted seedlings.

To access these income-generating opportunities, members join one or more community-based organisations known as "user groups" (Figure 4). Members of a beekeeping user group, for example, will be allocated a portion of the forest to establish apiaries, and might join together to purchase equipment and protective clothing, manage the hives, harvest honey and market their products. Decisions are often made collectively about how much of the group's revenue will be split among members, how much will be reinvested in new tools, inputs or equipment and whether to pay for new research or training. Most of the CFA members who responded to the survey belong to at least one user group, with tree nursery user groups the most popular (46 per cent of respondents), followed by grazing and beekeeping user groups (25 per cent and 24 per cent of respondents, respectively).

Figure 4

CFA members' participation in various user groups, by forest type



Despite the benefits of membership, many residents in forest-adjacent communities do not join a CFA, and motivating youth to engage in forest conservation work is seen as a particular challenge. CFA members believe this is due to a lack of understanding of the financial and ecological benefits provided by both the CFA and the forest, as well as an impression that PFM activities are too time consuming. Many CFA members are also concerned about the conflicts that arise when non-members try to access the forest (especially indigenous communities that feel their user rights are inherent) and fear that the growing generational divide will have long-term consequences for conservation.

> "The youth don't see any benefits from this kind of exercise. They want things they can see money in directly."
>
> **CFA member, Mombasa**

Taken together, the findings above suggest that:

- Existing CFA members are likely to find immediate value in digital tools that enhance the impact of their forest conservation and regeneration work.
- The many self-described conservationists and environmentalists in CFAs are likely to adopt tools that support their efforts to halt deforestation, plant more trees, improve seedling survival rates, develop new skills or build expertise in matters related to forest management.
- Tools that can help members grow, improve or coordinate their income-generating activities are also likely to be readily adopted.

Finding 2

The use of digital technology is nascent, but growing

In general, the use of digital technologies in CFAs is inconsistent and relatively immature. Widespread digitisation of PFM processes and activities remains constrained by low smartphone penetration, a lack of funds to invest in devices or other equipment and low digital literacy levels.

At the national level, there are several noteworthy projects testing or implementing digital innovations to support better forest management. This includes the use of satellite imagery to help authorities monitor and respond to deforestation,[19] digital platforms that allow private landowners to monetise tree planting,[20] and the use of drones to help CFAs map forest areas. However, it was rare for CFA members in our study to be aware of these types of initiatives or to articulate how frontier technologies, such as satellites, drones, artificial intelligence (AI) or connected devices (IoT), might be used to enhance their work. While some CFAs have experience using GPS devices or satellite applications, this was uncommon and typically required training and on-going support from partner organisations. Familiarity with using GPS or the mobile internet was also low, particularly among survey participants over the age of 50. Just 12 per cent of research participants had used their phone or another device to look up GPS coordinates while just two per cent had used GPS to record forest conservation activities.

On the ground, efforts to informally digitise CFA processes and communication channels have largely been driven by mobile devices. Mobile penetration across all CFAs is high, and 98 per cent of survey respondents were familiar with mobile money services, such as M-PESA. Most were also familiar with the idea of using voice calls or text messaging to share PFM-related information within the CFA.

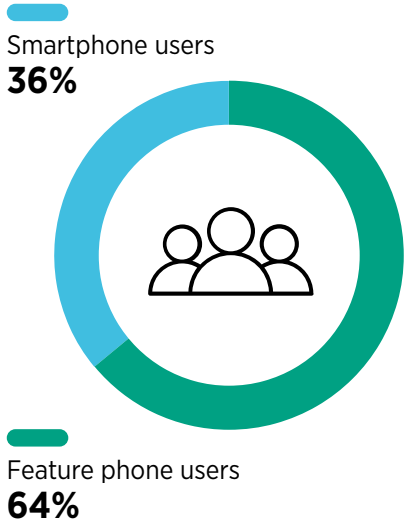
Over a third (36 per cent) of respondents owned a smartphone, with higher rates among younger members, committee members and men (see Figure 5 for breakdown). Although this is far from ubiquitous, it means that an increasing number of CFA members are able to use their smartphones to collect and share information on the CFA's behalf. A single device can often be used by groups of tree planters or forest monitors to record data, take photographs and document GPS coordinates. Of the research participants who own a smartphone, 70 per cent have used it to record forest activities, compared to 49 per cent of basic phone users.

> "We have few smartphones and cannot cover the whole forest. In some areas we have people with smartphones, and they have been educated, but a large area still remains uncovered when it comes to data collection using GPS."
>
> **CFA member, Mombasa**

19 See: https://ecometrica.com/forests-2020/
20 See: https://greenstand.org/home

Figure 5

Phone type of CFA members, by gender and age



	21-30	31-40	41-50	50+
Male	13	23	33	24
Female	11	15	13	17
Male	13	34	31	57
Female	17	25	43	48

Messaging apps, such as WhatsApp, are also increasingly used to communicate with the KFS, local partners and fellow group members. CFA members report using WhatsApp to send notifications of upcoming tree planting events, to ask other members for advice or support or to share photos of group activities. The use of email, social media apps (particularly Facebook and Twitter) and mobile internet was also fairly common among those with smartphones, who use these digital channels to share information, to market the forest to ecotourists, to find new customers for forest products or goods or to access learning materials.

The near-universal use of basic mobile services, a growing awareness of the benefits of digital technology and the improved ease with which CFA members are finding, downloading and using smartphone apps effectively suggest that:

- An increasing number of CFAs members possess the digital skills required to use mobile-enabled PFM tools effectively or will have easy access to someone who does.
- Designing digital tools or services that also work on basic phones will help to avoid exacerbating the digital divide, as could platforms that enable groups of CFA members with at least one smartphone user to submit or access information collectively.

Case study

Mombasa

Margaret[21] is a 25-year-old environmentalist from a small town outside of Mombasa. She has been part of a CFA for three years and is actively involved in the forest, where she earns money from mangrove planting, aquaculture and beekeeping. However, earning money was not her primary motivation for joining the CFA. *"First, I am an environmentalist. I wanted to join an umbrella of environmentalists so that I can get the same opportunities and activities as them. [Through the CFA] we also get education, and through interaction with others we get more knowledge and ideas."*

Planting new mangrove trees feels particularly urgent for Margaret's CFA, as their conservation efforts are being thwarted by the local community whose non-CFA members routinely cut down mangroves for charcoal and other uses, as well as industrial developers. *"Conserving should involve the community. You can imagine the indigenous people who have been there…their mothers and fathers have been there – and you from another country should come and stop them from doing what they do? The first question is where are you coming from? Do you know they have been there? Do you know our parents have been there? There is always that conflict. We [also] have the southern bypass [being built] in Mombasa and they have really cut the mangrove trees. We are not against the development as it will help us, but cutting the trees is not good for the environment."*

To monitor tree planting activities, her CFA typically uses manual processes, such as measuring the height of trees using ropes and sticks and recording data in a book. Recently, however, Margaret and some of her fellow CFA members involved in mapping activities have started to use their smartphones to capture GPS coordinates. *"You have to use it because you need the location of where the mangroves that you have planted are. We switch on our mobile data, then switch on the location [to get map coordinates]. Since we do not have software for the mapping, we are coordinated with the Kenya Marine Organization who help us get the maps."*

Turning these maps into useful information for the rest of CFA members is far from easy. *"I have a smartphone, as I have worked hard and got one, but for the others it is a problem, as they do not have the funds to get a smartphone. It therefore proves difficult to get into websites. There is no money for printing the information."*

As a researcher, Margaret loves the idea of using new digital tools that would help her CFA collect data and share actionable insights. *"When we are doing our mapping, we have to place the coordinates then send information to someone else who will come up with the map. It is a long process."* She thinks that being able to do this in one place would be better, and would also love to have a tool that would allow members to record other useful information about the area, such as the contours of the landscape, the temperature and the tidal range. *"We could analyse the data and have useful information that would help the community, other groups and researchers around."*

"We need to share the information if we are to develop. We need to share ideas."

21 Interviewee names have been changed in all case studies.

Finding 3

Current data collection activities are typically manual and slow, and provide little value to CFAs

CFA members are routinely tasked with recording and submitting data on the number, location and species of newly planted seedlings, and are usually required to monitor tree growth and survival rates over time. On a more ad hoc basis, members will also report signs of forest degradation, illegal activities or hazardous events (such as human-wildlife conflict or wildfires) that they encounter as they patrol or pass through the forest. All the CFA members we interviewed participate in routine data collection activities, and nearly half of those surveyed said they have reported at least one illegal activity, typically by calling a committee member or local KFS officer.

The collection of reliable high-quality data is essential to PFM, as it allows both the KFS and the CFA to track the progress of their PFMP, monitor changes in tree coverage, improve the survival rates of newly planted trees and respond quickly to forest threats. CFAs are also finding that robust data collection can help attract external financing, as it is becoming more and more common for donors and sponsors of tree planting events to ask CFAs to report on progress and document their impact (in terms of the number of trees planted or the size of reforested areas).

> "KFS provides us with a map of the area. My work is to make the plots. Physically with a pencil on how they appear on the map."
>
> **CFA member, Menengai**

A lack of digital tools and low smartphone penetration has meant the vast majority of CFAs collect data and map tree planting sites using pen and paper. These manual processes are limiting both the quality and quantity of data submitted to the KFS and other partners, as well as the speed at which information is collected, analysed and acted upon. CFA members estimate that two-thirds of the forest data they collect is stored in physical files or books at a CFA office where the records are susceptible to loss or damage and are often outdated.

Furthermore, due to internal reporting processes and a lack of training on data analysis, it is rare for general members to see how the data they collect is being used or to derive useful insights for themselves. Most CFA members reported that, as far as they were aware, no one from their CFA is formally trained in analysing data once it is collected, and very few understood what happened to the data once it was entered into a logbook or submitted electronically to the KFS. While members do not seem to be demotivated by having limited access to the insights gleaned from the data they laboured to collect, a lack of transparency in how authorities respond to reports of illegal activity is often a source of frustration (see Case study 2).

Despite a general lack of access to digital technology, CFA members understand that mobile-enabled tools could help enhance data collection and benefit the CFA, for instance, by allowing both PFM authorities and CFA members to be more aware and responsive to what is happening in the forest, perhaps even in near-real time. Although some stakeholders feel that the absence of technical skills and training act as a barrier to the adoption of new digital tools and processes, some CFAs are proactively addressing this skills gap. A CFA member from Menengai, for example, reported that they had attended training on satellite monitoring while a member of the Mombasa Kilindini CFA learned about GIS mapping through training delivered by an external group.

There is a clear need for digital data collection tools that:

- Are simple to use (i.e. they mirror the existing analogue data collection process) and can be used by those with low digital literacy.
- Enable a wide range of relevant information to be collected and submitted in real time. This might include "positive" information, such as newly planted trees or conditions that have led to high seedling survival rates, as well as "negative" reports of illegal activities or other forest threats.
- Are designed to provide CFA members and other stakeholders with a greater degree of "situational awareness" by establishing a circular process through which data is collected from the field, monitored and analysed in near-real time, and promptly fed back to members to aid decision making.

Case study

Menengai

David[22] has been a member of the Menengai CFA since 2008, and lives in a small town about two kilometres from Menengai Forest. As the CFA's ecotourism officer, going into the forest is part of his daily routine. *"I am the ecotourism officer so I begin my day looking at whether there is a reservation for people who want to visit the forest. I basically organise the reservation and organise visits. I receive visitors. I arrange the activities for the visitors who are to be taken down the forest. I ensure we have guides who will take the visitors around the forest."* A key part of the job is ensuring that ecotourism promotes conservation and has a positive impact on local communities. David owns a smartphone and regularly uses services such as M-PESA and the internet for personal and business reasons. This includes email (Yahoo and Gmail), LinkedIn and various social media platforms. He manages all of the marketing for the CFA through their website, Facebook page and a WhatsApp group, to help ensure that potential visitors' questions are answered and they have an enjoyable experience.

David's wages are paid for by the CFA at the end of each month using income earned from entry fees collected from tourists. In 2020, when the COVID-19 pandemic caused tourism to grind to a halt, David came up with the idea of running a tree nursery in the forest to supplement his income. *"The location of the Menengai is that one side faces the posh area, so some [residents] come to do landscaping in their plots or areas. They look for flowers. That prompted me to introduce flowers on my site. I also make flower pots."* As a CFA member, David is allowed to collect seedlings from the forest and establish them in his nursery, and because this is his personal enterprise, he can keep all the revenue.

To support CFA activities, such as tree planting, David uses his smartphone to collect data from the forest, including photos and GPS coordinates. *"Pictures are taken when communities are given plots [and] when the young seedlings were planted. Then gradually, as the seedlings begin to grow in phases, pictures are also taken up to the end product."* GPS enables people who are not there to locate the area independently. *"So a person who is in Nairobi or in the internet wherever, given the GPS location can be able to narrow down using the satellite or any image. They will arrive at the location. So it enables in terms of accurate location and the area coverage."*

However, most of the forest data is still entered manually into books at the CFA office, and it is not clear how this data is shared with CFA members. David hopes this will be improved, and believes that digital technologies like GPS and smartphones can improve data collection. *"They appear to be accurate in terms of numbers and as well storing such information is not as hard as talking to people with books and pens. We would want to be capable to build on how to use the equipment on how to do data collection. First, we would want to be taught how to use them through our phones. You would prefer someone to go to our website [that is] easy for even the old to understand. That [would] impact CFAs or the forest in a positive way."*

22 Interviewee names have been changed in all case studies.

Finding 4

Financial incentives could accelerate tree planting and other ecosystem services

Implementing a PFMP requires substantial financial resources, and fees collected from members are rarely sufficient to cover the costs of even the most critical PFM activities, such as planting new trees, communicating information to members and other activities aimed at preventing illegal activities or the overuse of forest resources. Tree planting activities are particularly costly and dependent on external support, especially in situations where a CFA is required to purchase seedlings or reimburse planters for their time and expenses.

> "We spend a lot of time on these [reforestation] activities but we are not paid. That is the biggest challenge. No one refunds you."
>
> **CFA member, Ngare Ndare**

Funds that come into a CFA can either be put towards group activities tied to the PFMP (e.g. purchasing seedlings or new tree planting equipment) or distributed among individual members for their personal use. It is important to note that while just under two-thirds of members believe that income from PFM activities is fairly distributed, most also believe that financial management processes lack transparency. This can sometimes create mistrust between general and committee members and make it more difficult to attract funding from external partners. Members suggested that being paid through mobile money services such as M-PESA could help address these concerns.

Although tree planting is usually conducted on a voluntary basis by CFA members, donors sometimes offer compensation via the CFA for lost daily income, the cost of transportation to planting sites, or data and airtime used while coordinating planting activities. While most CFA members seem motivated to support forest regeneration efforts out of a love for nature, most agreed that they should receive some sort of compensation in the form of money, food or tree planting equipment as a small reward and form of recognition. Of the general CFA members we surveyed, 85 per cent agreed they would plant more trees if they received payment for their efforts. Many also believed that financial rewards would motivate community members currently outside the CFA to participate, including youth.

This mindset mirrors previous research on natural resource management (NRM), which found that in order to create a "constituency for conservation", stakeholders must often explore how to achieve environmental objectives in tandem with addressing other pressing community needs, including income generation. However, PFM stakeholders in Kenya had mixed opinions on the topic of monetary incentives and emphasised the importance of maintaining a "volunteer spirit" within CFAs and sustaining the intrinsic motivation of members to protect the forest.

Future digital tools or processes will need to ensure that incentives for tree planting and other ecosystem services continue to foster a commitment to conservation, rather than motivating members to prioritise the specific actions or ecosystem services that offer financial rewards.

Case study

Mombasa

Paul[23] is a businessperson who earns a living buying and selling goods at his local market. While every day varies, he generally spends the majority of his day – from 8am to 6pm – in the mangrove forest. *"I go to the forest to conserve, plant and then educate members of the community. We keep bees, we have fish ponds, we do eco-walks where tourists visit."*

Paul joined the CFA because he wanted to help support forest conservation and liked that the CFA would give him the opportunity to network with other like-minded community members and partners. He is also a member of multiple user groups and involved in selling fish, honey and seedlings. To support these initiatives, the CFA provides access to land and links the user groups to potential clients.

Paul says that the CFA currently accesses information on forest-related matters, for instance, advice about seeds, from partners like the Kenya Forest Research Institute (KEFRI). However, the CFA is quite far for many partners so they do not get a chance to engage with them frequently. *"KEFRI usually come to Mombasa during the annual show [and] during such times we get information on materials and other information that we need on conservation. Because we do not engage them frequently we have a problem. Because we are [far] we have to wait for them to come to Mombasa - that's when we can engage them."*

Every time he goes to the forest, Paul and others make sure they record any new trees that are planted, as well as how many have died and need to be replaced. "*We have laptops, smartphones and also GPS because when we plant we have to take coordinates because we plant in different areas. Last year we had some organisation who came and we planted with them trees, so they wanted us to be sending photos to them and also coordinates for them to know the exact location. I use android phone to take GPS. Before we start planting, we take a picture of the place when its bare, when people have started planting you also take a picture, during monitoring you also take a picture."*

This information is shared with the CFA, where it is stored in laptops or on paper, before being shared with the KFS. Most of the time, information is shared verbally or handed to KFS officers in person. This can be time-consuming, and CFA members often travel to the KFS office only to find that officers are out of the station. This inefficient process is most frustrating when it comes to reporting urgent or illegal activities happening in the forest. *"You can go to the forest and find people doing the illegal activities but you don't get that quick response to have them arrested - eventually you will have to set them free."*

Paul has recently heard about organisations that pay for carbon credits and is interested in learning more about this opportunity. *"I have heard that there is an organisation that deals with buying of carbon credit. I would like to have that information because for us we do deal with carbon, so if we can be selling carbon to them that would benefit us...Mangrove is a good carbon sink as it takes a large portion of that carbon and stores it in the plants...There is a way they do [measurements] using their technology, and they get to know the amount of carbon they can get. Then I would also like to know how other area are doing so I would like to have that exchange and see how they are also doing [this] in their environment."*

"If we can get the money, we can do a lot of things. If we can be empowered and be recognised that would be great for now, we are never recognised."

23 Interviewee names have been changed in all case studies.

Finding 5

Improved access to information could lead to better conservation and livelihood outcomes

Nearly 40 per cent of CFA members state that they do not receive enough information to manage the forest effectively, for instance, how to conduct monitoring activities, tackle external logging threats or establish sustainable income-generating activities. This lack of actionable information and advice was ranked by CFA members as one of their top three challenges.

In particular, general CFA members feel that they are unable to regularly access information that is site specific, timely and relevant to their day-to-day PFM activities. Members tend to receive information from the KFS when they physically gather at annual meetings, or when local KFS representatives or other partners organise smaller, ad-hoc meetings with those who are able to assemble at the CFA office. PFM stakeholders, such as KEFRI and the Center for International Forestry Research (CIFOR), currently distribute information at annual open days, via flyers or over the radio, but these approaches are sporadic and often do not reach large numbers of people. Both organisations highlighted that complementing these activities with digital tools could provide a more direct and effective link between information providers and CFA members.

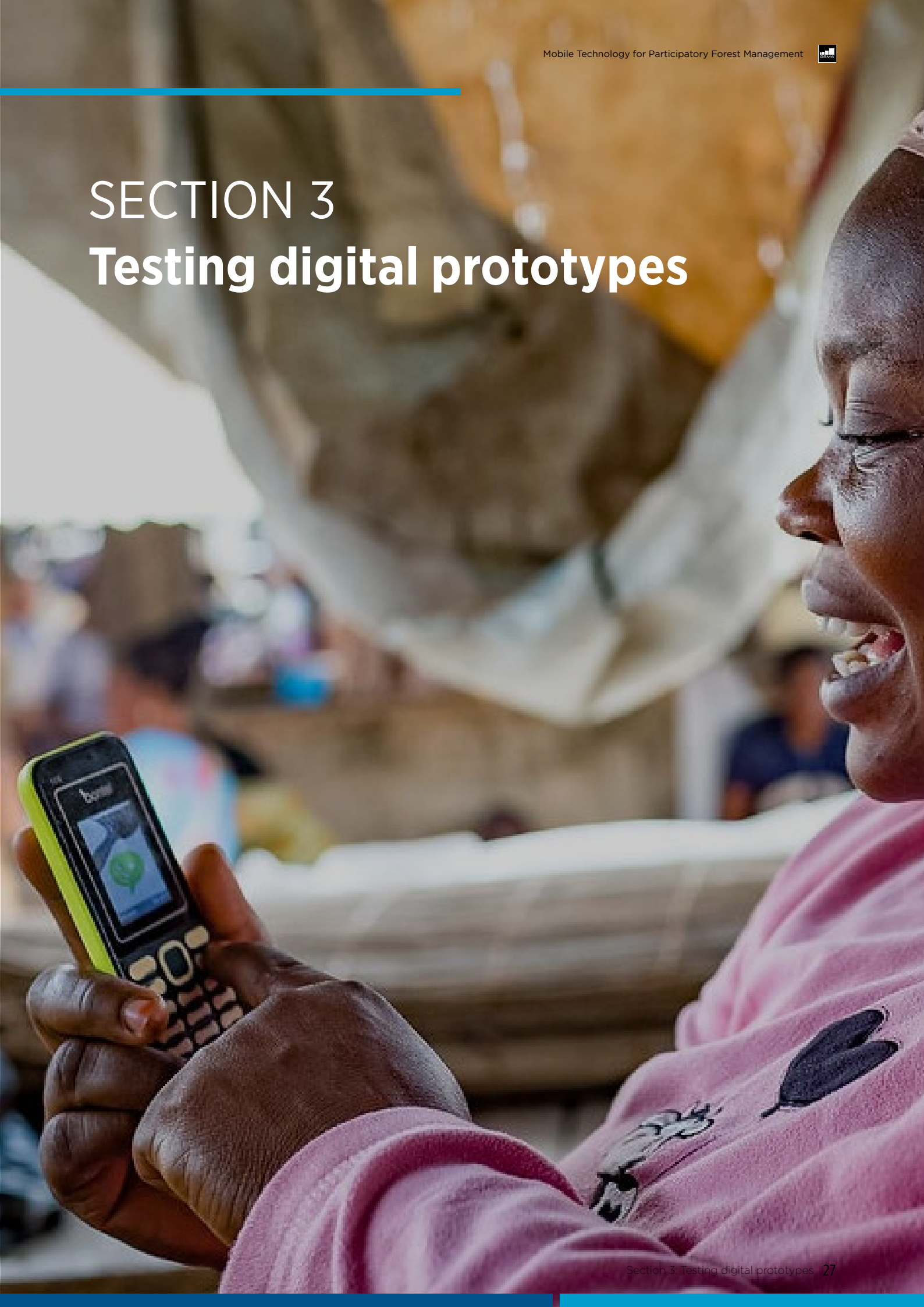
Although in-person meetings have advantages, many members have time and resource constraints that prohibit them from attending meetings. This means they miss out on key information completely or hear it second-hand. However, due to the COVID-19 pandemic, virtual meetings are becoming more common across CFAs and are allowing members to meet more frequently and at a low cost. Although these meetings are not accessible to those without a smartphone or other internet-enabled device, CFAs have seen first-hand how digital tools can help improve communication and access to information.

> "It is always a challenge getting all the members together because it requires support from KFS and other partners. We have close to 200 members – to bring them together will require some resources."
>
> **CFA member, Mombasa**

CFA members in our study expressed a clear preference for receiving targeted and more frequent information through online channels or digital messaging platforms, such as SMS or WhatsApp. In addition to improving how CFA members communicate with their partners and with one another, research participants also voiced an interest in exploring how to share lessons and advice with other CFAs in the same region or across the country. A third of participants had heard of WeFarm24 or DigiFarm,25 which offer small-scale farmers a suite of information and financial services, allow users to exchange knowledge and provide access to the marketplaces and resources that farmers need to be successful. It is likely that CFA members could benefit from platforms that replicate the approach and success of such services.

24 See: https://about.wefarm.com/
25 See: https://www.safaricom.co.ke/faqs/faq/810

SECTION 3
Testing digital prototypes

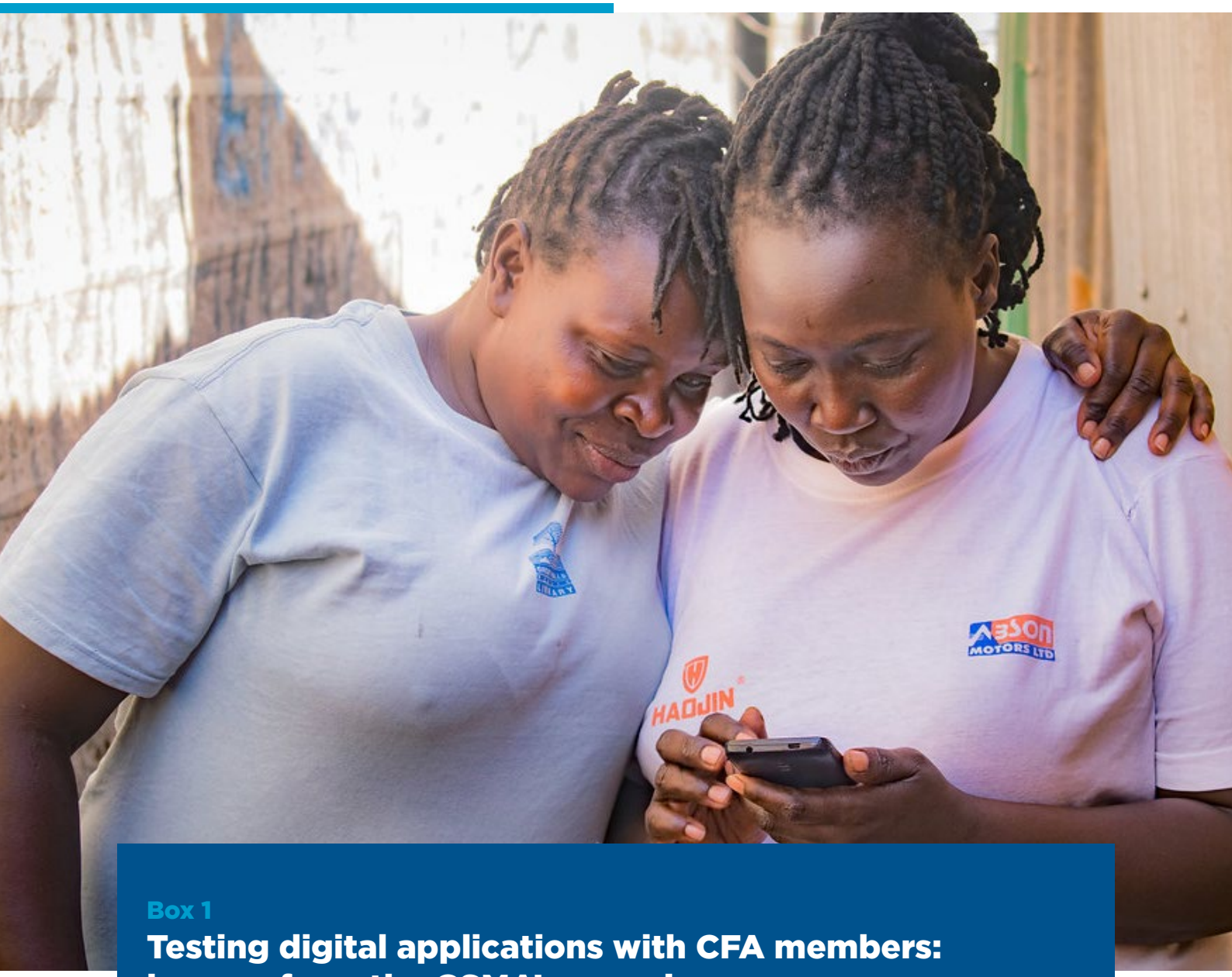


To explore how future digital solutions could address the challenges and opportunities outlined in the previous section, the GSMA ClimateTech programme team worked collaboratively with PFM stakeholders to co-design three low-fidelity digital prototypes to test with CFA members. Based on the insights generated from our qualitative research and their own understanding of the PFM landscape, stakeholders decided to prioritise mobile solutions that could support: 1) data collection and monitoring; 2) incentives for PFM activities; and 3) information sharing. The specific features and benefits tested with each prototype are summarised in Figure 6. A summary of the key takeaways from the prototype tests – highlighting the benefits, risks, design needs and design limitations of each prototype – can be found in Figure 7 in Appendix 4.

Wireframes developed for each prototype (see Appendix 3) were presented to CFA members to help them visualise how these solutions might look and function on either a smartphone or basic phone. Through in-depth interviews and digital survey tools, CFA members shared their perspectives on the value and usefulness of each mobile prototype, from the specific features or benefits that would promote adoption in their CFA, the potential risks or challenges users were likely to face and how each tool might need to function.

This section provides an overview of the key insights collected in the prototype testing. In general, CFA members were enthusiastic supporters of digital innovation, particularly when they saw opportunities for mobile technology to increase the environmental impact of their work or increase the recognition they receive for their services. Participants also emphasised the important role all three prototypes could play in relieving the unsustainable pressure placed on forests by local communities, either by making it easier for members to deliver their PFMP or by motivating more people, particularly women and youth, to join their ranks. There was also broad consensus that the prototypes would create value not only for the CFA, but also for individual environmentalists, conservationists, researchers and business owners. This indicates that digital solutions have the potential to support the dual mission of PFM: to facilitate better forest management and to support sustainable livelihoods.

However, CFA members cautioned that uptake of all three prototypes could be negatively impacted by poor connectivity within and outside the forest, the cost of mobile data and a lack of digital skills. They also emphasised the potential unintended consequences of digital approaches, such as the exclusion of those without smartphones or the risks associated with reporting illegal activity. Engaging with civil society organisations has proven to be an effective way to protect vulnerable communities from negative outcomes, to build trust and cooperation between project stakeholders and to ensure that digital services and platforms are built with community needs and capabilities in mind.



Box 1

Testing digital applications with CFA members: lessons from the GSMA's experience

To support our quantitative research, the 151 survey participants with smartphones were asked to download a mobile app called KITE that would allow them to review and provide feedback on the digital prototypes. However, a time- and resource-intensive process of sending SMS instructions and arranging follow-up calls was required to drive downloads. In the end, only 60 of the participants (40 per cent) were either willing or able to do so, despite the promise of a small financial reward. Furthermore, only 30 of the 60 participants who downloaded the app managed to complete the wireframe survey, and these participants often required even more follow-up calls or help from friends and family to navigate the app and submit their answers. There were three key takeaways from this experience that clearly demonstrated why capacity building support will be critical to the uptake and use of digital PFM solutions. First, we learned that using unfamiliar apps can still be challenging for CFA members and might not be intuitive, even among smartphone users. Second, even when a survey respondent was digitally savvy, poor connectivity or other time pressures often made it difficult or inconvenient to complete the survey. Third, participants who had initial difficulties navigating KITE, but remained motivated to complete the survey, were able to learn to use it by seeking help from correspondents or friends.

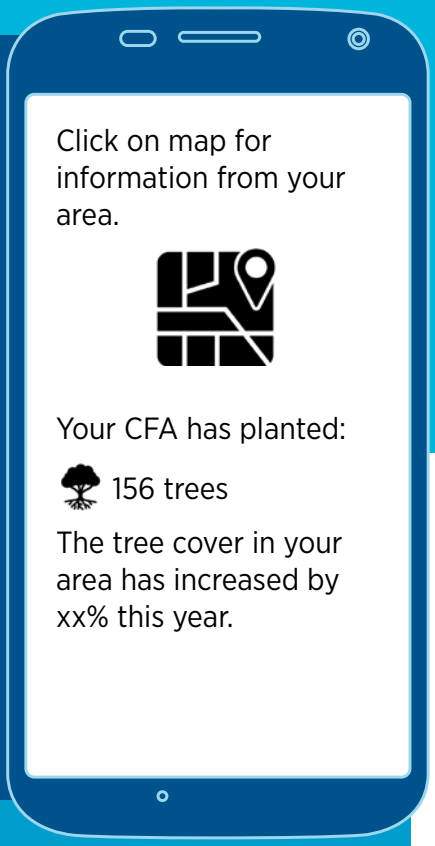
Insights on Prototype 1:
Data collection

Prototype functions:

- Enables CFA members to digitally collect and submit data from a wide range of conservation and regeneration activities, including forest threats.
- User-submitted data, photos and GPS coordinates automatically populate maps showing CFA activities and incidents, and allow users to find suitable locations to collect firewood or to graze animals.
- Users receive alerts if there are forest threats nearby.

Potential benefits:

- Practical insights from the submitted data are fed back to CFA members to support monitoring activities and inform decision making.
- Real-time reporting of incidents or threats would enable a more transparent and rapid response from relevant authorities.



Prototype 1 is viewed as a critical and foundational tool. Once a CFA is able to submit trustworthy data on a regular basis, it might be possible to offer the CFA and/or its members rewards for their forest conservation and/or regeneration activities (**Prototype 2**) and/or to provide them with relevant and timely information or advice (**Prototype 3**).

Summary

CFA members believed that mobile-enabled data collection tools offered a more efficient way to collect and share data compared to current manual processes. There was an expectation that these digital tools could democratise access to timely and relevant information, and ensure that authorities responded quickly and transparently to forest threats.

The data collection prototype tested CFA members' familiarity with registering for new digital services and their willingness to submit personal details, such as their name, location, CFA, phone number and photo. Most members were comfortable with the process and understood why an app might ask for this information, especially if they are submitting data on newly planted trees or other activities. Eighty per cent of people who reviewed the wireframes were comfortable taking a photo of themselves to use the app whether they were reporting positive information, such as tree growth, or negative information, such as illegal logging. However, many highlighted that they felt insecure about attaching their name and photos to reports of illegal activity out of fear of retribution (more on this below).

CFA members also believed that digitising data collection would improve the accuracy, trustworthiness and security of the information they collect and preferred this system to the manual procedures currently in place. Most members seemed to agree that using a smartphone app to submit data in real time, with GPS coordinates and time-stamped photos, would allow the KFS and other partners to validate tree planting activities and track changes in forest coverage more accurately. However, it was accepted that an app alone would not eliminate the human error that can lead to double counting or misreporting, and that additional sources of truth (such as in-person checks by the KFS or satellite monitoring) might still be required. Furthermore, while an SMS-based reporting function would allow all CFA members to submit basic data on tree planting activities, it was recognised that only smartphone users could collect photos and GPS coordinates. A potential solution suggested by CFA members was to deploy a "communal smartphone" model in which at least one device was used to capture this evidence on behalf of other members.

There is an expectation that improving the quality and quantity of data collected would have two distinct benefits for CFAs. First, members believed it could democratise access to information and give every member the ability to monitor what was happening in the forest at all times and from any location. It was exciting for participants to think about how they could track progress against their CFA's PFMP or access maps that alerted them of forest threats, such as illegal activities, wildfires, floods or wildlife. In Mombasa, CFA members also hoped that making PFM data more transparent would help raise awareness of the negative impact that local infrastructure projects are having on mangrove forests, and potentially put pressure on the responsible institutions to halt deforestation.

> "We would expect urgent response from the intended organisation that has been notified and of course they should have the same app to respond to. So, if I communicate with KFS I expect a response so that I know that they have got the information. It should be with a section where I get instant feedback e.g. 'Yes. Thank you' or 'noted'."
>
> **CFA member, Menengai**

Second, members envisioned that the prototype would allow them to share information about forest threats with relevant authorities in near-real time and that this, in turn, would enable a quick and transparent response. It was recommended that the "reporting service" should include design features that compel authorities to acknowledge they have received the alert and provide evidence that they had acted on it. This particular benefit was so appealing to members that two-thirds of survey participants responded positively to the reporting service, despite being aware of the potential risk that their personal information could be leaked. PFM stakeholders suggested that individuals should not be able or asked to report illegal activities – both for their own safety and to ensure that the feature was not used dishonestly. As a middle ground, one stakeholder suggested that the reporting function could only be made available to a group of selected "informers" who can be guaranteed confidentiality, are known to have integrity and could prevent others from reporting for malicious reasons.

In general, the data collection prototype was viewed as a compelling opportunity to make current processes better and easier for CFAs, the KFS and other partners. The potential benefits appealed most to members' conservation mindsets and, for this reason, most agreed that it would not help motivate other community members to join the CFA. Additionally, non-financial incentives, such as feedback mechanisms and the introduction of "friendly competition" (allowing users to see how many trees other members or CFAs have planted) may incentivise additional tree planting.

> "Forest matters are not normal matters. Taking pictures where trees are being cut down is risking your life because you don't know who is watching. If we are confirmed of our safety, and that this information will not be leaked outside then that will be fine."
>
> **CFA member, Menengai**

> "I feel that [reporting] will result in conflict among people due to the legal proceedings taken towards the perpetrators. In as much as I am trying to conserve the forest, I don't want to get involved in rivalry.'"
>
> **CFA member, Ngare Ndare**

Finally, CFA members believed that capacity building would be critical to driving uptake and ensuring the solution was used effectively. One CFA member in Menengai surmised that if people were asked to download the app without any support or guidance, it would take them two years of practice before they were able to submit accurate information. This perspective underscores the important role that community-based organisations and other local partnerships will need to play in supporting training and capacity building.

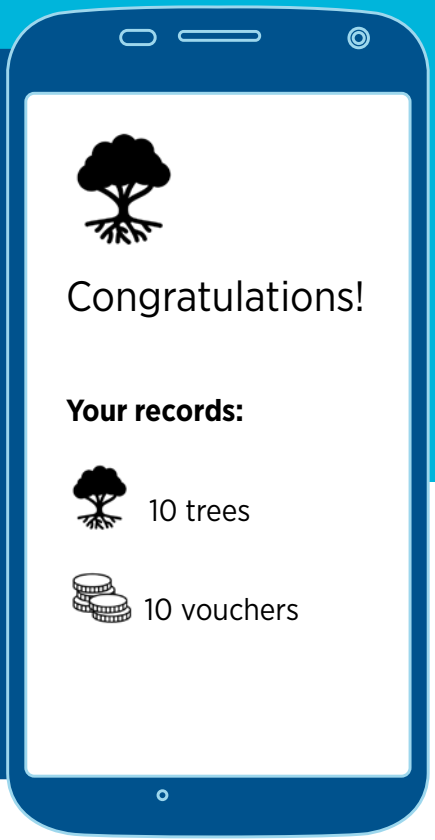
Insights on Prototype 2:
Payments for ecosystem services

Prototype functions:

- CFA members record the planting of new trees and receive a voucher to reward them for this activity. Rewards could go directly to the CFA or an individual member.
- Vouchers can be redeemed for personal benefits, such as mobile money payments, airtime or new seedlings, or group benefits, such as community development projects.
- The distribution and use of vouchers could be made visible to all CFA members.

Potential benefits:

- Fills the funding gap for tree planting activities and increases financial transparency.
- Linking payments to CFA activities increases the value of engaging in conservation and has the potential to attract new members.



Summary

While the data collection prototype was seen as the best way to make existing CFA processes more efficient, the payments prototype is viewed as an opportunity to accelerate tree planting and attract new members to CFAs. Benefit-sharing arrangements and smartphone-sharing models could help ensure that every member has an opportunity to personally benefit from these tools and ensure that PFM activities are better funded.

Having used the data collection prototype to explore whether CFA members appreciated the non-financial incentives offered by digital data collection tools – better access to information, more control over tackling illegal activities and greater transparency from local authorities – the second prototype introduced CFA members to the possibility of receiving financial rewards for actions that delivered environmental value, such as tree planting. This kind of arrangement is often referred to as "payment for ecosystem services" (PES).

In our prototype, a CFA or CFA member would receive one voucher for every new tree planted, which could then be converted into airtime or monetary rewards, or used to purchase goods, such as seedlings. The introduction of a voucher system raised no concerns from CFA members, and there was consensus that offering these incentives would not erode their dedication to conservation. Rather, the benefits were viewed as a form of well-deserved recognition, a source of motivation to plant additional trees and an effective way to help

community members outside the CFA appreciate the value of conservation. Nearly two-thirds of members believe that a payment scheme for tree planting would lead to additional community members joining the CFA. The funding provided by the vouchers – which members assumed could come from the KFS, local NGOs and private companies, or even through the sale of carbon credits – would also provide much-needed resources for the delivery of PFMPs.

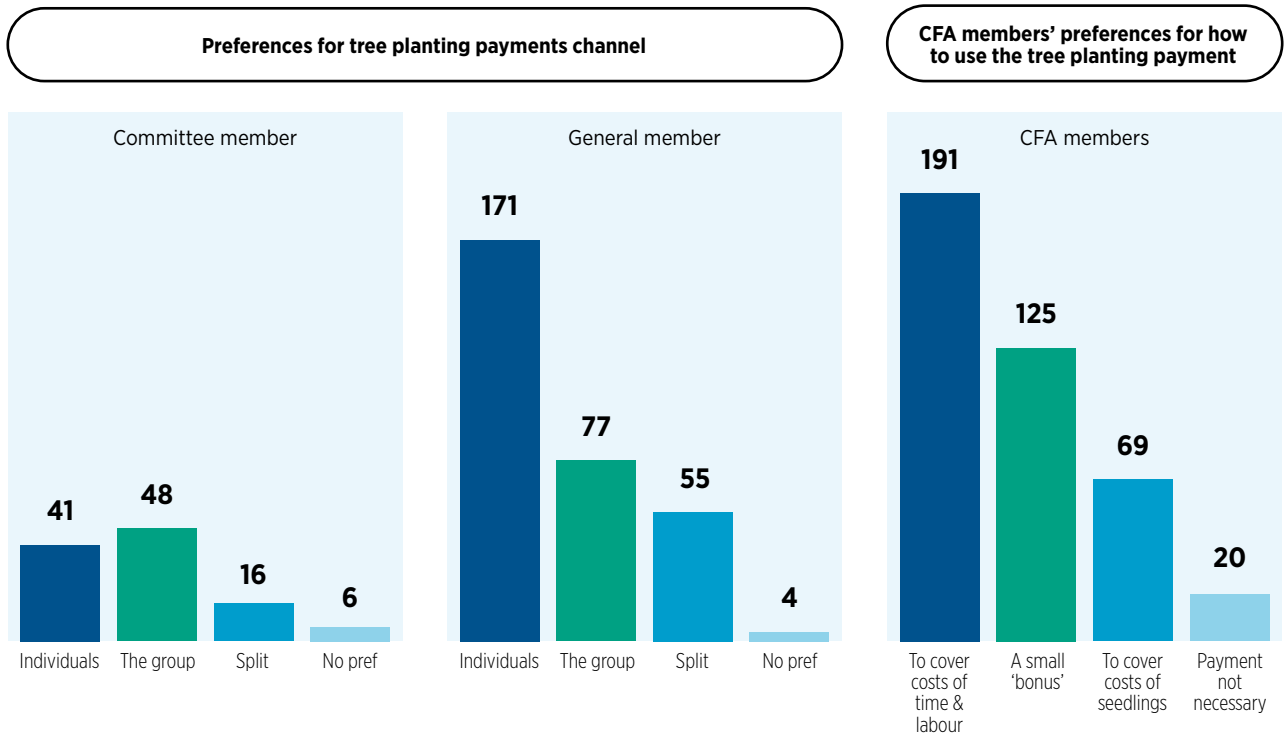
> "The vouchers will motivate the young people and those with no work, as they will see a benefit in protecting the environment."
>
> **CFA member, Menengai**

Opinions on whether the voucher should go directly to individuals or to a communal CFA fund varied. Initially, direct payments to individuals seemed to be the "fairest" option, as it ensured that "no one benefits from someone else's sweat". In this scenario, most members said they would either exchange their vouchers for mobile data or airtime, or for money to purchase personal items or more seedlings. However, when members were presented with the option of vouchers going directly to the CFA, they tended to shift their preference, noting that this arrangement would ensure that activities tied to the PFMP were better funded and could also be used to support community development projects. Some members suggested a middle ground, with a proportion of the rewards going to the CFA to ensure that conservation work was supported, and the remaining funds used to ensure that members had "something to take home".

Discussions about benefit sharing revealed a noticeable difference between committee members and general members. While committee members showed a preference for incentives that benefited the group, such as training or the sponsorship of community development projects, general members were more likely to be motivated by personal rewards, such as vouchers or direct payments. Stakeholders noted that CFA constitutions typically set rules and procedures for how funds are used and distributed across the CFA, and any new processes should consider how to work within these arrangements rather than imposing new ones or creating opportunities for internal conflict.

Figure 8:

Payment preferences



When asked to place a monetary value on the voucher (i.e. the expected incentive for planting one tree), responses ranged significantly from KES 50 to 10,000 ($0.50–$90). At the lower end of this range, respondents simply viewed the payment as a small token of appreciation similar to receiving lunch or a snack at a sponsored tree planting event. While some respondents advised that the payment only needed to cover the cost of each seedling – a mangrove seedling, for instance, costs KES 100, others were clear that it would only be motivating if they earned more than what was required to cover their own costs. At the higher price range, members typically wanted to be paid a full day's wage to reflect the level of work required for tasks like digging soil and transporting seedlings. Importantly, both members and stakeholders highlighted that vouchers should not only be linked to tree planting, but also to monitoring the continued growth and survival of trees. Most smartphone users, after seeing the prototypes, said they would be willing to monitor trees monthly if they were rewarded through the platform.

> "As the tree grows, maybe to a certain height, then the voucher should change … this will assist in making sure that the tree is well maintained. It will grow protected and the efforts that have been made will not go in vain."
>
> **CFA member, Menengai**

Taking photos and using GPS coordinates to verify tree planting was considered a satisfactory basis for payments. To ensure that members without smartphones are not excluded from this opportunity, future solutions might need to create "pots" for sharing out benefits or be designed to allow shared smartphones to capture validation data for several members. Indeed, nearly all committee members (94 per cent) said there is at least one smartphone in their CFA they could use for capturing tree planting, and over half of general members said they would borrow a smartphone to use such an app.

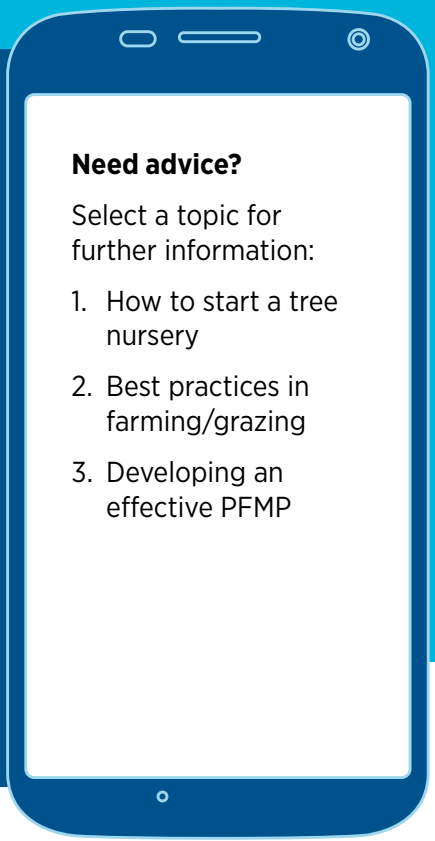
Insights on Prototype 3:
Information sharing

Prototype functions:

- CFA members gain access to information and advice from trusted experts or other CFAs in Kenya.
- Users can select preferences for topics, frequency of updates and language.
- Topics could be PFM-related (tree planting, water management) or livelihood-related (beekeeping, grazing, ecotourism).
- CFA members can ask specific questions on the platform and receive a direct response.

Potential benefits:

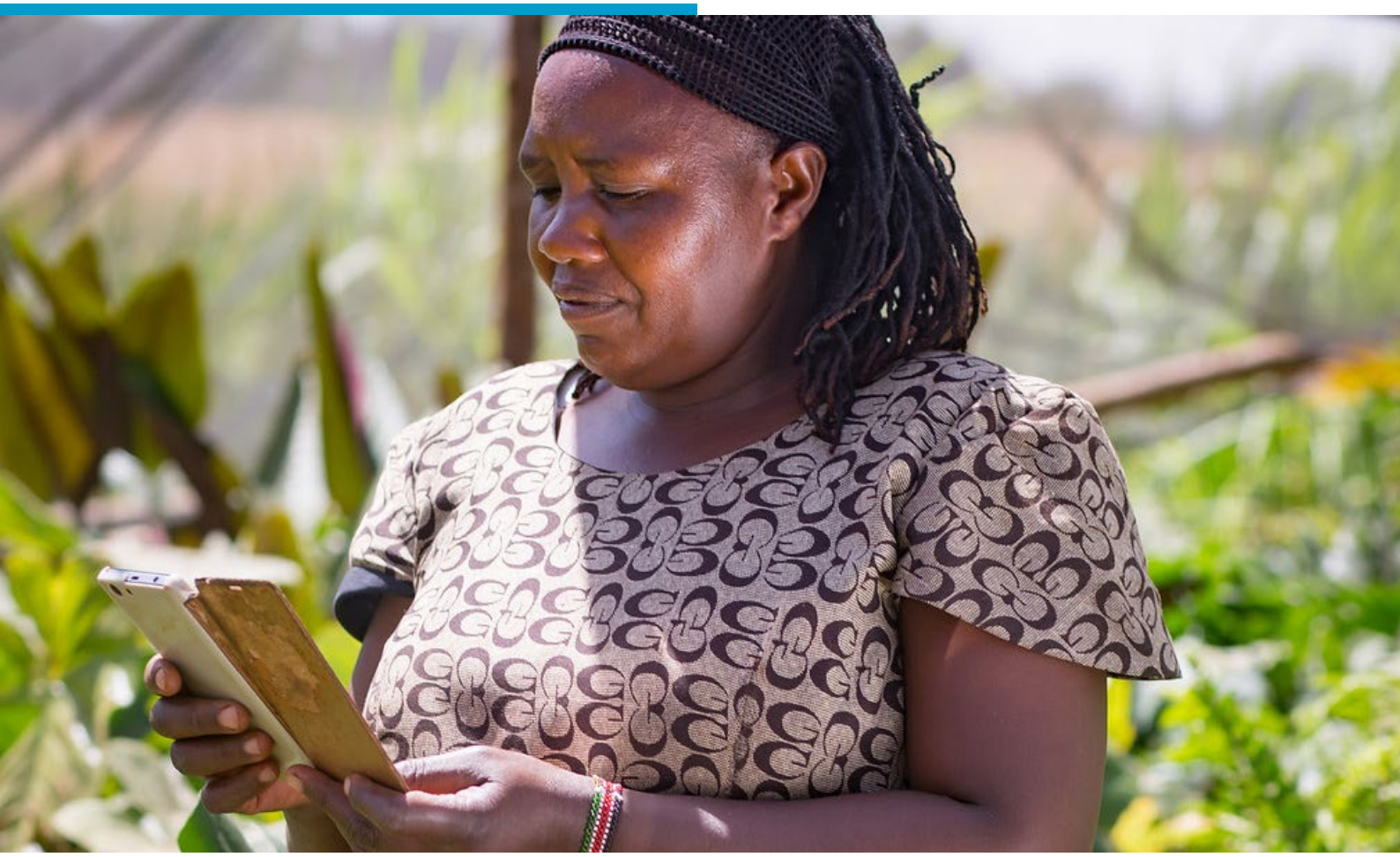
- CFAs gain access to information that enhances the effectiveness of their work.
- New communication channels opened with other CFAs and stakeholders.



Summary

There is strong interest in an information-sharing platform for CFA members to network and learn from each other, as well as connect with external stakeholders. Such a tool would be highly dependent on a strong user base and effective partnerships.

The information-sharing prototype revealed a strong desire among CFA members to connect with subject matter experts and other CFAs that could help them address their day-to-day challenges, identify best practices in conservation and improve their income-generating activities. Ninety-two per cent of members surveyed said they would sign up to share information and advice with other users. In qualitative interviews, members said they would like the platform to provide access to a broad range of content, including advice on how to access markets, improved farming and grazing methods, advice on pest control, guidance on which types of seedlings were best suited to specific areas, information about permits and best practice conservation tips for their area. Overall, advice on how to manage tree nurseries and updates on tree planting emerged as the greatest information needs.



> "We will learn from others and if we are lagging behind, we can start working harder. It is also important to know how others are working so that we can grow together as Kenyans."
>
> **CFA member, Ngare Ndare**

There is a growing desire among CFAs to network and learn from what other groups are doing, both by sharing stories of what has gone well and what approaches or processes have failed. For example, members reported that they were interested in connecting with other CFAs to compare the market prices they receive for forest products, to learn how much they are grazing and what methods they are using and to learn how they are dealing with wild animals in the forest. Members responded positively about a service that would create a place to learn how others have overcome similar challenges. Some members also believed this platform could create positive "friendly competition" between CFAs, leading to greater environmental and society-wide benefits.

Most members said they would like to receive information and advice through messages on the app or by SMS, with a slight preference for content that was in Swahili. Some smartphone users reported that receiving a PDF or photo would also be desirable as it would allow them to review lengthier information and advice at their own pace and when it was convenient for them. A relatively small number of participants, perhaps reflecting those with low literacy or digital skills, said they would prefer to request tailored information using a hotline, believing it to be a more efficient and expedient way to connect with experts.

The provision of such a service is highly dependent on sustaining partnerships with key stakeholders and content creators, such as the KFS, KEFRI, CIFOR and other local partners. Regular and consistent interactions with users will be critical to uptake and on-going use. CFA members also mentioned that lack of airtime for communicating with each other and with others can be a barrier. Many users said they will be forced to consider, "is the app worth the limited space on my phone?"

Voting on specific features from the three prototypes

Research participants were asked to vote on prototype features according to various criteria. The results are shown in Figure 9. The payment for tree planting feature was believed to be the most beneficial to individuals, closely followed by the SMS reporting service linked to the data collection tool, while a smartphone app for recording tree planting was believed to be the most beneficial to the CFA. In contrast, a smartphone map with information about the forest was believed to be the most beneficial to the KFS and the forest. Overwhelmingly, the SMS reporting service was believed to be the easiest to use and had included the features that were needed most urgently. These voting results highlight the potential value of integrating various features to provide maximum benefit to the range of stakeholders involved in the PFM process.

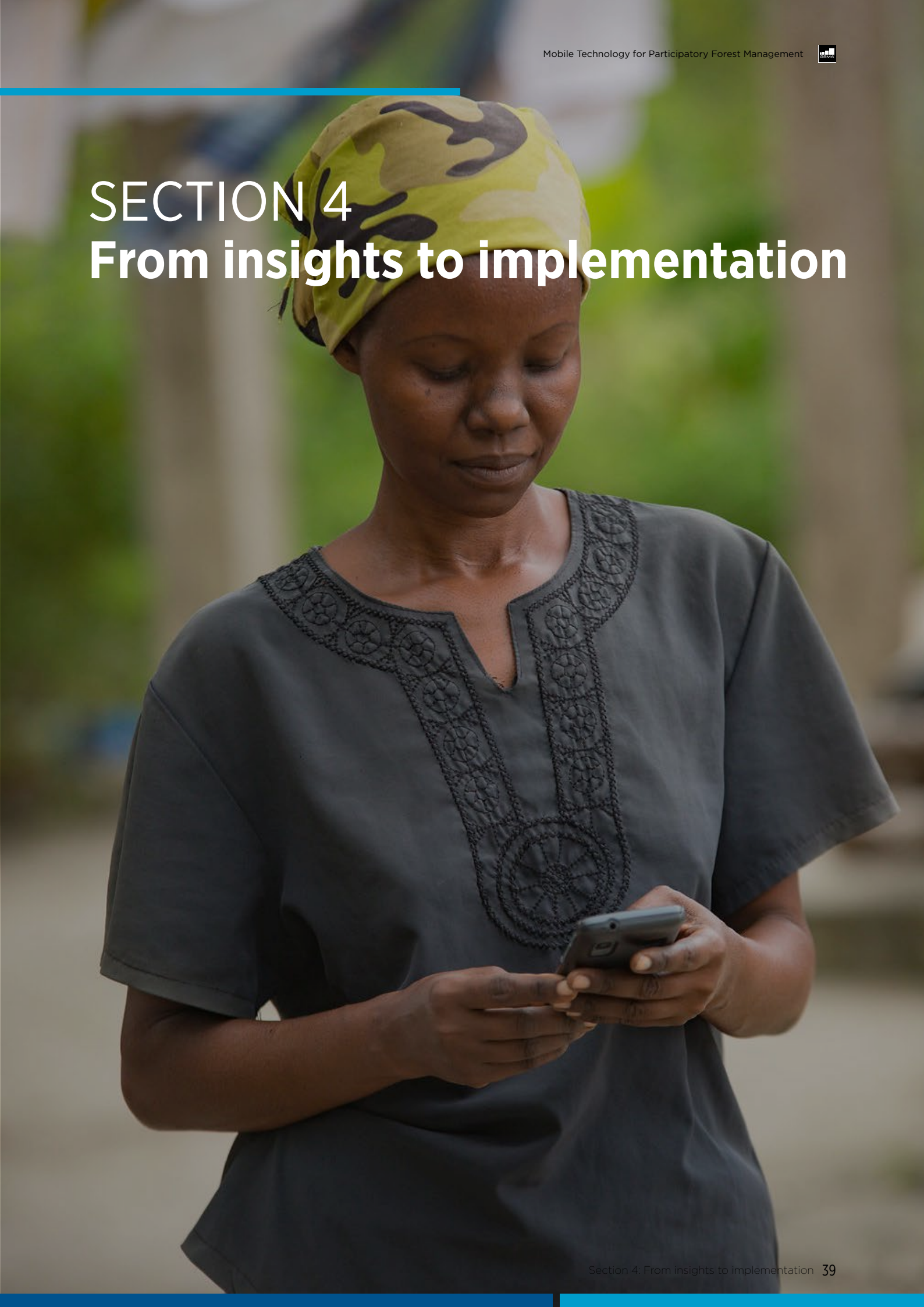
Figure 9

CFA member voting on prototype features, according to various criteria

Y-axis (columns): Different prototype features / X-axis (rows): Different criteria

	SMS reporting service	Smartphone reporting service	Smartphone map information about the forest	Smartphone app for recording tree planting	Payments for tree planting	SMS information service to get advice about PFM	SMS information service to get news from other CFAs
Most beneficial to an individual	99	68	41	50	100	40	17
Most beneficial to the CFA	87	42	70	96	44	50	26
Most beneficial to the KFS	79	40	148	51	14	62	13
Most beneficial to the forest	58	17	110	103	40	76	13
Needed most urgently	110	47	57	58	83	48	6
Easiest to use by most people	237	40	15	23	47	48	6

Number of votes



SECTION 4
From insights to implementation

Source: infocongo.org

Our analysis suggests there is clear demand and a growing need for digital tools that can tackle the persistent challenges CFAs encounter as they work towards delivering their PFMPs. There is consensus among PFM stakeholders and CFA members that there is an immediate need to focus on solutions that support fast and accurate data collection, facilitate payments for ecosystem services and/or enable the sharing of timely and relevant information.

This section provides recommendations on how to turn these insights into action. We anticipate that designing and implementing new PFM tools will require a staged approach: from the development of a minimum viable product, to driving uptake and usage and finally moving to scale. At every stage, close collaboration between a multitude of organisations, including CFAs, community-based organisations, government stakeholders, mobile network operators (MNOs) and other technology organisations, will be critical.

The GSMA and its members have an important role to play in supporting digital innovation in PFM. Our research indicates that by partnering with CFAs and other PFM stakeholders, MNOs have the opportunity to:

1. Build the business case for expanding network coverage into remote areas (in response to increased demand for connectivity);
2. Design tailored data packages and other solutions for rural consumers who are currently underserved;
3. Grow their customer base and build brand loyalty by helping to raise awareness of the benefits of PFM, and by increasing digital literacy and inclusion;
4. Leverage their assets and services to help digital platforms achieve scale and sustainability;
5. Expand and increase mobile money usage;
6. Bring like-minded organisations together to reduce fragmentation, share best practice and broker new partnerships.

Developing a minimum viable product

Although the data collection, payment and information-sharing solutions were presented to CFA members as three distinct prototypes with unique attributes and benefits, stakeholders agreed that the "end point" should be a unified PFM solution that incorporates features from all three concepts. However, stakeholders universally agreed that developing CFAs' data collection and monitoring capabilities is a critical first step. Once digital data collection is creating value for CFA members and providing verifiable information to stakeholders, additional products or services, such as payment platforms and information-sharing apps, could be incorporated, based on additional and more extensive human-centred design research.

Step 1: Establishing digital data collection

Feedback from CFA members suggests that new PFM solutions are unlikely to achieve uptake and consistent use unless they deliver immediate, continuous and discernible value. Prototype testing indicated that data collection tools would be best suited to meet this expectation for CFA members due to their ability to help address everyday frustrations, make existing and agreed processes faster and easier and potentially facilitate transparent and more effective responses to reports from relevant authorities (depending on the willingness of stakeholders to engage with and respond to reports).

Although designing for basic feature phones will help promote digital inclusion (more on this in the Moving to scale section), developing apps for smartphone users is likely to be an easier and more scalable starting point. Compared to basic devices, smartphone apps have a more user-friendly interface, are inherently more secure (all data can be wiped remotely if the phone is lost or stolen) and are much easier to customise when new features or requirements need to be added. Smartphone devices can also make data collection faster, easier and less prone to error due to bigger screens, full keyboards and dropdown menus. Because CFA members already have experience using a single device to capture or submit data on behalf of a group, it is likely that many of the benefits of the smartphone app will be shared with those without a smartphone device of their own.

While people on the ground are in the best position to monitor forests and manage their resources, previous GSMA research on natural resource management found that significant benefits can be gained by pairing multiple data collection and real-time monitoring technologies.[26] Supporting mobile-based data collection with drones has proven to be an effective way to map and document land rights, and low-cost drones have become more readily available to resource-constrained organisations and local communities when used for projects that do not require the devices to log extensive flight times or carry heavy payloads. Alternatively, satellite data can help organisations monitor global patterns at a macro level and in a way that is highly repeatable, positioning it well to evaluate changes in tree cover or land use over time, to identify emerging hotspots for biodiversity or to generate environmental impact assessments.

26 GSMA. (2020). Digital Dividends in Natural Resource Management.

For many organisations, satellite data and tools provided for free by initiatives such as Global Forest Watch[27] have had a transformational effect on their ability to monitor and raise awareness of deforestation and land change. In Kenya, the KFS has been working with a wide range of partners to monitor deforestation and forest degradation using satellites as part of the Forest2020 initiative.[28] Through this project, launched in 2017 and sponsored by the UK Space Agency, forest data is processed and analysed as satellites pass over areas of interest. When change is detected, the KFS pushes alerts to forest rangers in the field so they can collect additional data on their mobile devices. This experience suggests there is already an institutional understanding of how mobile and frontier technologies can be paired to support forest management, and potentially a willingness to test them through new, community-led approaches.

Innovative approaches to data collection: Forest Watcher
Location: Global

Forest Watcher is a free mobile app that allows community forest monitors, park rangers, conservation organisations and protected area managers to detect areas of forest disturbance, make informed decisions about patrol routes and collect digital information from their observations. The app brings the dynamic online forest monitoring and alert systems of Global Forest Watch and makes them accessible to smartphone users who are offline and in the field. Forest Watcher makes it easy to pinpoint and monitor areas of interest, view deforestation and fire alerts, navigate to a point of interest using the phone's internal GPS and collect information about what they find using a simple-to-use form and photos. Through the app's web portal, users can customise reporting templates and facilitate collaboration by creating, reviewing and assigning reports to team members. In Cameroon, the app is being used to combat illegal activities by allowing the Ministry of Forestry and Wildlife, forest guards, indigenous communities and law enforcement to gain access to up-to-date information on forest change and enabling users to capture photos and data related to deforestation as they patrol the forest.

Step 2a: Incorporating payments for ecosystem services

Robust data collection solutions will enable stakeholders to implement payments for ecosystem services (PES) by giving them the capacity to measure and verify the environmental and social impact of CFA activities in a way that is transparent and trustworthy, and ensure that payments are targeted, accessible and fair. Additional research with CFA members will be required to determine which types of incentives and benefit-sharing arrangements are most appropriate for PFM, are most motivating to members and are most likely to accelerate tree planting.

PES schemes often face challenges ensuring that both financial and non-financial benefits reach all the individuals responsible for the project's success. To help address this challenge, mobile money platforms could provide a more convenient, cost-effective and transparent way for organisations to transfer incentives to CFA beneficiaries. The GSMA Mobile Money programme has advocated that enabling third parties to integrate with mobile money services is key to driving ecosystem growth, increasing value for end users and creating new revenue streams for mobile money providers (MMPs).[29] The high uptake of mobile money services in our sample of CFA members suggests that collaborating with MNOs to deliver payments would be valuable.

27 See: https://www.globalforestwatch.org/
28 See: https://ecometrica.com/forests-2020/
29 Pathy, V. (27 October 2020). "What value do open APIs bring to the mobile money landscape". GSMA Mobile for Development Blog.

While financial payments are typically considered the most motivating reward, many organisations in and outside of Kenya have agreed that financial incentives on their own do not foster commitments to conservation, but rather to the specific conservation action(s) for which they are paid.[30] Some communities might prefer PES schemes that help them develop new digital skills and capabilities, give them more ownership over PFM-related data and processes, allow them to reinforce their rights to land or resources or amplify their voice in decision-making processes. Successful PES schemes in other countries have provided information linked to community livelihoods, such as weather forecasts or guidance on sustainable fishing practices. In Papua New Guinea, where the cost of mobile phone use is relatively high, community monitors have been highly amenable to receiving mobile phone credit as a reward.[31]

Innovative approaches to PES: Rainforest Foundation US

Location: Peru

Rainforest Foundation US is partnering with local community organisations and tech partner Regen Network in Peru to use blockchain technology to track, verify and reward communities for protecting and regenerating forests. The project is being piloted in the Ticuna community in the north of the country where local community members agreed to collectively conserve 1,000 hectares of Amazon rainforest and simultaneously undertake an ambitious reforestation project on degraded land. The community committed to zero deforestation and to actively patrol their territory using an existing community monitoring programme, as well as drones and other tools to investigate deforestation alerts they receive from the Global Forest Watch system. The community is compensated for maintaining net zero deforestation through Regen Network's blockchain-based payment system, which deposits funds into a communal bank account. Families in the community agreed to use the collective funds to help plant, tend and monitor the forest over the coming years. Compliance with tree planting was measured and verified by satellite data, as well as by community forest monitors who provided quarterly updates on the trees planted and their growth. The community has been able to reduce deforestation rates from approximately 10 per cent annually to zero from 2018 to 2020 and is now shifting from responding to deforestation to proactively reforesting and maintaining existing forests in one of the most threatened areas of the Peruvian Amazon.

If financial incentives are chosen as the preferred incentive, the key question for stakeholders will be, who pays? The GSMA believes that consideration should be given to linking PFM activities to the voluntary carbon credit market. In 2021, the Taskforce on Scaling Voluntary Carbon Markets published its blueprint for creating a large-scale, transparent carbon credit trading market, stressing that this will be critical to limiting atmospheric warming to 1.5 degrees Celsius and achieving net-zero emissions by 2050.[32] The rapid scaling of natural carbon solutions, such as avoiding deforestation or increasing tree coverage, is considered a key opportunity for smaller scale project developers, especially those that can provide evidence of co-benefits, such as impacts on the SDGs or technology innovation. To support small-scale suppliers, the Taskforce recommends the creation of a supplier/financer matching platform where suppliers can upload proposed projects, and the exploration of satellite imaging, digital sensors and distributed ledger technologies (DLT) to further improve speed, accuracy and integrity.

The findings from this research suggest that PFM projects could be a strong candidate for this type of project. However, many buyers remain concerned about the potential negative social impacts that can arise from developing and implementing climate-mitigation projects; the ability of project developers to demonstrate, beyond any doubt, that the project and associated credits cover the correct amount of emissions; and whether projects maintain GHG reductions or removals on a permanent basis. This further underscores the critical role that data collection tools will play in unlocking new funding opportunities.

30 GSMA. (2020). Digital Dividends in Natural Resource Management.
31 Ibid.
32 See: https://www.iif.com/tsvcm

Step 2b: Incorporating information services

As the quality and quantity of data improves, it will be easier for stakeholders to create actionable insights and disseminate highly relevant, localised information from trusted sources, both within and outside a CFA's immediate network. These services are likely to appeal most to CFA members who view themselves as conservationists or environmentalists, as the research showed that these individuals are already investing time and resources into searching for PFM information. Younger CFA members might also be more aware of the need for new information, and more open to taking advice from new sources (NGOs, subject matter experts) and using digital channels. Previous research from the GSMA has shown that targeted information can also be particularly beneficial for vulnerable individuals or those with lower social capital, as they are more likely to receive outdated or incomplete information.[33]

Innovative approaches to information sharing: WeFarm

Location: Global (founded in Kenya)

WeFarm is a mobile platform that connects more than 2.4 million small-scale farmers to share knowledge more effectively, combine their buying and selling power, reshape global supply chains for their benefit and fulfil their economic potential. The platform provides a place where farmers can connect with each other for farming advice on everything from techniques and products to potential pitfalls and market prices. Farmers also gain access to a network of trusted independent businesses that partner with WeFarm to provide members with quality inputs at fair prices. WeFarm is free for farmers to use, and based on SMS rather than a website or app, which allows farmers without internet access to also use the platform. Once registered on the platform, members can text questions or queries, and WeFarm's AI matches the question with the best answer to serve their needs. Since launching in 2015, 5.6 million questions have been asked on the platform and there have been 11.3 million answers. The median response time to receive an answer is around six minutes.[34]

33 GSMA. (2018). Digital Identity for Smallholder Farmers: Insights from Sri Lanka.
34 Heathman, A. (29 April 2020). "WeFarm: the social network keeping farmers connected and providing support through coronavirus". Evening Standard.

Partnering to drive uptake and use

Partnership requirement 1: Trusted organisations that can support capacity building

CFA members value the close relationship they have with the KFS, as well as the contributions of partner organisations that invest time and resources in their CFA's success. Local KFS representatives are perhaps the most important touchpoint for CFAs, as they provide training to members (e.g. how to monitor forests or report illegal activities), own the data collected from the field and have ultimate oversight of PFMPs. For this reason, data collection and payment tools should be designed in collaboration with the KFS to facilitate and incentivise a quick and efficient response to submitted data, particularly when it involves a report of dangerous or illegal activity.

Raising awareness of digital solutions and delivering the necessary capacity building should be carried out by organisations that already have a close relationship with CFAs. Community-based organisations, NGOs (such as WWF) and the National Alliance of Community Forest Associations (NACOFA) could help build trust in new digital tools and develop the capacity of CFAs to use them effectively. They can also act as a bridge between CFAs and MNOs, technology organisations and other stakeholders to ensure that CFAs are supported and protected when working with outside organisations and authorities to co-develop new processes or solutions.

Partnership requirement 2: Local organisations with contextual insights

Partnerships should also be considered with organisations engaged in similar monitoring and conservation activities. Through their national Keep Kenya Breathing campaign, WWF has developed an open platform that enables all stakeholders – government, the public, companies and peer organizations – to monitor up-to-date information on tree coverage, with the aim of promoting positive actions to help restore Kenya's 10 per cent forest cover. The portal also compiles location-specific data (sourced on the ground) on the types and volumes of new trees planted and their survival rates. CIFOR, for example, have experience working with community-level Water Resource Associations PES schemes. Not only could such organisations provide practical advice on data collection or the implementation of PES, but they could also serve as points of contact for PFM digital tools to be rolled out to forest-adjacent communities engaged in conservation activities.

Information and advice distributed through, or in support of, digital tools need to be supplied by a reliable source with local knowledge of Kenya's forests and the practicalities of delivering PFMPs. Local organisations, such as KEFRI, which is currently establishing an online knowledge management portal, would be ideal partners to provide such information and connect other researchers with the tool to distribute content.

Partnership requirement 3: MNOs

By collaborating closely with CFAs and other PFM stakeholders, MNOs can build the business case for expanding network coverage into remote areas (in response to increased demand for connectivity) and designing tailored data packages and other solutions for rural consumers who are currently underserved. MNOs can also grow their customer base and build brand loyalty by helping to raise awareness of the benefits of PFM, and by increasing digital literacy and inclusion.

The GSMA has also found that digital platforms – defined as technology-enabled business models that facilitate the easy exchange of data, information and/or monetary value between a CFA and other groups (KFS, NGOs, local authorities, individual members, carbon credit buyers, etc.) – are highly dependent on MNO assets and services, such as mobile internet access, smartphone penetration, digital payments and digital expertise.[35] Additionally, MNOs have several resources that digital platform owners can leverage to achieve scale, including large customer bases, well-recognised and trusted brands, a range of physical and online distribution points, market expertise and relevant payment and communication channels. MNOs also have considerable experience developing digital solutions that transmit data from hard-to-reach areas with limited connectivity, for instance, by storing data until the user re-enters an area with mobile coverage and the information can be transmitted.

Mobile money payments can help to reduce the problems associated with cash transactions (such as delays in payments and a general lack of transparency), enhance users' experience with digital platforms and help lead to scale. In Sub-Saharan Africa where mobile money has been driving financial inclusion, providers are transitioning to a "payments as a platform" approach to connect consumers with third-party services. The M-PESA payment platform has over 40 million users and processes over one billion transactions every month.[36]

This project's multi-stakeholder workshops demonstrated that the PFM landscape in Kenya is comprised of numerous stakeholders with similar or complementary objectives and a motivation to share lessons from their initiatives, to co-design digital solutions that deliver collective benefits and to imagine new ways of working together to address funding, skills and technology gaps. The GSMA and MNOs in Kenya should consider how they can help bring like-minded organisations together to reduce fragmentation, share best practice and broker new partnerships.

35 GSMA. (2021). Scaling digital platforms through partnerships: The value of collaboration between mobile operators and digital platforms in emerging economies.
36 GSMA. (2021). Scaling digital platforms through partnerships: The value of collaboration between mobile operators and digital platforms in emerging economies.

Moving to scale

Innovations often go through a pilot or proof-of-concept stage to ensure they solve a specific problem before expanding into other parts of a country. This could involve reaching more users in the same context (e.g. increasing marketing to attract new CFA members or targeting non-members), adding more functions to increase value for current customers (e.g. moving from data collection to PES) or replicating the solution in new contexts (e.g. targeting private land owners). Before the platform has reached saturation in Kenya, the owners of the digital platforms should also consider expanding to neighbouring countries or other markets that have embraced PFM approaches.

Digital tools should be delivered with basic phone users in mind

Because it will take time for smartphone use and digital literacy to improve, particularly in rural areas where PFM approaches are typically implemented, stakeholders will eventually need to consider how to design solutions for feature phone owners. This might include integrating USSD reporting or data collection features with any smartphone tool for collating forest information and designing information services that can be accessed through SMS or USSD. This is particularly pertinent to designing payment platforms for conservation work. As the research highlighted, problems could arise in communities if only smartphone owners are paid for their tree planting due to validation issues.

Plan for testing other business models that focus on private land

Stakeholders noted that public forests do not account for all of Kenya's forest coverage. This suggests that in order for the country to achieve its aim of 10 per cent coverage, solutions will also need to be developed to provide private landowners with the tools and incentives they need to support forest conservation and regeneration. Notable examples of projects operating in this space include Wildlife Works, which has established a successful model that uses the emerging marketplace for REDD+ Carbon Offsets to protect threatened forests, wildlife and communities. REDD+ allows local landowners to monetise their forest and biodiversity assets whether they are communities, ownership groups or private individuals. Although they have not worked with CFAs in Kenya to date, their Kasigau REDD+ project protects over 500,000 acres of highly threatened Kenyan forest, securing the entire wildlife migration corridor between Tsavo East and Tsavo West National Parks, and delivers the benefits of direct carbon financing to more than 100,000 people in surrounding communities.[37]

Greenstand has developed the mobile-based Treetracker app, which allows individual growers to earn income by planting trees and taking periodic, geotagged photos of them as they grow.[38] These are uploaded to a verification platform where Greenstand screens each new tree photo, verifies that it represents a living tree and tags it with additional attributes, such as species. Each individual tree capture then appears on their web map. Tree growers own their environmental impacts, and they have the option to trade or sell their "Impact Tokens" on an open market platform. Investors and donors can purchase those tokens directly from tree growers.

Stakeholder interviews suggest that solutions targeting private landowners face many of the same challenges reported by CFAs, including low access to digital tools (such as smartphones), digital skills gaps, inefficient payment channels and data storage and analysis needs. MNOs and other PFM stakeholders should consider how the new approaches, solutions or platforms being developed for CFAs can both learn from these initiatives and be tailored to reduce fragmentation and create new efficiencies in this sector.

37 See: https://www.wildlifeworks.com/what-we-do
38 See: https://greenstand.org/

Looking ahead

Our research has confirmed that PFM stakeholders, including CFA members, are eager to implement and will benefit from digital solutions that improve data collection, payments and information sharing. Building on the central role that mobile technology already plays in the lives of CFA members and the operations of PFM, there is a real opportunity for a digital solution to be developed with the support of MNOs in Kenya. In the long term, the research suggests that engaging in the design of PFM tools could help MNOs establish positive relationships with local government and development partners, help expand the country's mobile money ecosystem, create new revenue opportunities and support sustainability pledges or commitments. The roll-out of digital solutions should be inclusive, staged and collaborative. It is crucial that platforms deliver value for non-smartphone users, that local stakeholders are actively involved to inform and support these services, and that capacity building and appropriate incentives are used to drive uptake of the tools among CFA members.

As a next step, the GSMA ClimateTech programme aims to work with MNOs, PFM partners and other service providers to implement the actions and recommendations outlined in this report. In Kenya, the programme is now working with Safaricom and 4RDigital (a B2B company that creates innovative digital products and services that create positive environmental, social and economic impact) to support the development of a new platform called CaVEx. This platform will use digital technology to bring efficiencies to voluntary carbon markets by digitising the verification and exchange of carbon credits and streamlining associated payment flows. In doing so, CaVEx will enable a wide range of micro/small climate projects, previously excluded from carbon markets due to size or economic constraints, to access climate finance. The CaVEx minimum viable product is initially being constructed to demonstrate four use cases, one of which will be CFA-led reforestation projects. The platform will require collecting four phases of inbound data to verify the project activity and quantify the carbon credits: 1) seedling data; 2) plantation data; 3) monitoring data; and 4) measurement data. Safaricom will support the project by testing how their mobile money platform (M-PESA) can facilitate payments to CFAs or individual tree-planters on the ground, and they will also leverage their existing network of partners and knowledge of CFA process (Safaricom partners with CFAs as part of an ongoing commitment to plant 5 million trees in five years) to help demonstrate how access to climate finance can accelerate tree planting. The GSMA is working closely with 4RDigital and Safaricom to capture lessons from this pilot.

Elsewhere, the programme will seek to identify, promote and inform the development of digital PFM tools and develop pathways to align forest and climate action with the sustainable development agenda. We will also seek to catalyse vital partnerships between the GSMA, the mobile industry, tech innovators, governments and the development sector with the aim of reducing fragmentation, facilitating scale and promoting collective action.

Appendix 1: Research methodology

Our research was conducted in five phases: landscape framing (desk research and stakeholder interviews); qualitative research with CFA members (in-depth interviews and photo journals); co-design workshop; prototype testing; and quantitative validation. Due to the COVID-19 pandemic, all research activities were conducted remotely by researchers at the Nairobi-based Busara Center for Behavioural Economics.

Desk research and stakeholder interviews were conducted to explore how PFM is currently implemented in Kenya, the policies and regulations that have been created to help support it and areas of Kenya where PFM is being practiced and how successful it has been. Semi-structured interviews were conducted with stakeholders from Kenya's forest management sector, a well-established CFA in Nairobi, an MNO and multiple other organisations with experience working in PFM in Kenya. A list of organisations engaged in this phase are found in **Appendix 2.**

Following this, qualitative research was conducted with a total of 21 individuals from three CFAs: Menengai CFA in the Rift Valley, Mombasa Kilindini CFA on the coast and Ngare Ndare CFA in central Kenya. These CFAs varied in geographical location, size and types of forest and their member numbers and demographics (as summarised in Table 1). For each CFA, research participants were sampled to include one to two committee members and five to six general members, a 50:50 gender balance and a 50:50 ratio of smartphone to feature phone users. The age of participants ranged between 25 to 61 years. Participants took part in multiple rounds of qualitative interviews to understand their perspectives on PFM, the challenges and barriers they face, their current use of technology and their needs for digital solutions in PFM. The interview rounds were as follows:

1. Participants were interviewed about their personal relationship with the forest, their role in the CFA and their current use of technology in PFM.
2. Participants submitted photo diaries to demonstrate their daily interactions, benefits and challenges with the forest and their CFA. These diaries were submitted every second day over a period of two weeks, following prompts that asked them about their everyday life, CFA activities and challenges.
3. Follow-up interviews with a subset of participants clarified details on the CFA structure, as well as payments and access to information within this structure.

A virtual design workshop was conducted with PFM stakeholders to develop three low-fidelity prototypes for digital technology solutions that focused on solving specific problems faced by PFM, as identified by CFA members. Wireframes for each prototype are found in **Appendix 3**. The digital prototypes were tested remotely with 13 CFA members (the same as those in Phase 2) through phone interviews. As with the qualitative interviews, prototype testing explored CFA members' perspectives on the value and usefulness of the digital tools and collected feedback on how they might need to function.

Finally, to help validate the qualitative findings and collect additional feedback on the digital prototypes, quantitative phone surveys were conducted with 420 individuals from 21 CFAs operating across the country (including the three CFAs from the qualitative research in phase 1 and 2). As with the qualitative interviews, the survey questions explored members' perspectives on CFA structure, function, and activities, such as tree planting and forest monitoring, as well as their experience with and needs for technological tools in PFM. The 21 CFAs, summarised in Table 1, represented a selection from 16 counties across 10 conservancies in Kenya. As well as geographic variation, the CFAs varied in terms of the age of the organisation (mean = 11 years, range = 1–19 years) and membership size (mean = 945 members, range = 20–7,400 members).

The CFA contact list was received from NACOFA and then the chair of each CFA was asked to send their membership lists, from which participants were sampled. Reports from the chairs indicated that, on average, CFAs had 48 per cent female representation (range = 20-70 per cent female) and 36 per cent smartphone usage (range = 2–100 per cent) among their members. There was similar representation in the sample, with 45 per cent female participants and 36 per cent smartphone users.

Approximately 20 participants were randomly sampled from each of the 21 CFAs, including up to five committee members from each. Using SurveyCTO software to record answers, quantitative surveys were conducted over the phone, with slight variations in the questions asked of committee and general members. As with the qualitative interviews, these questions explored the members' perspectives on CFA structure, function, and activities, such as tree planting and forest monitoring, as well as their experience with and needs for technological tools in PFM.

Of the 420 participants, all 151 smartphone users were sent an SMS asking them to download KITE, Busara's bespoke digital panel app. Of the 146 participants who received the SMS, 60 downloaded the app and 30 completed the survey administered through the app. The survey showed participants wireframes of the digital tool prototypes and asked for their feedback on whether and how they would interact with such services.

Despite 36 per cent smartphone ownership in the sample, only 20 per cent of the participants with a smartphone fully completed the app-based survey on KITE. Reasons for these low levels of engagement included participants struggling with network issues to download and load the app or not having airtime to log in. Several members also reported that they were not familiar enough with using apps to fill in the survey on their own, or needed help logging in and then forgot their password. These insights are relevant for designing and rolling out PFM-related digital tools and highlight the need for full functionality in poor network areas, as well as capacity building to use such tools.

Table 1:

Summary of the CFAs included in this research

Statistics on member and gender numbers are as reported by CFA chairs.

	Conservancy	County	CFA	Year formed	Members	Gender (% female)	Forest size (ha)
1	**Nairobi**	Nairobi	Namanga Hills	2002	240	55	11,784
2		Nairobi	Loitoktok	2020	100	33	200
3	**North Eastern**	Wajir	Wajir	2012	28	20	4,046
4	**Nyanza**	Homa Bay	Nyawest	2014	350	35	7,855
5		Homa Bay	Katnema	2012	20	45	N/A
6	**Western**	Kakamega	Lugari	2007	700	40	2,163
7	**Coast**	Kilifi	Chara	2019	330	40	20,234
8		Mombasa	Mombasa Kilindini CFA	2012	265	25	3,700
9		Kwale	Shimba Hills	2012	3000	55	35,000
10		Kwale	Mrima	2015	425	60	320
11	**Central Highlands**	Laikipia	Shamanek	2005	1240	60	1,840.5
12		Kiambu	Muguga	2008	400	62.5	600
13		Nyandarua	Olbollossat	2005	1500	60	3,326.9
14	**Eastern**	Meru	Chogoria	2010	450	62.5	16,000
15			Ngare Ndare	2004	7400	45	5,540
16	**EWASO North**	Isiolo	Ngaremara	2015	50	60	N/A
17		Isiolo	Aborwawo	2008	20	65	0.4
18	**North Rift**	West Pokot	Lenal	2006	687	33	800
19	**Mau**	Nakuru	Menengai	2005	594	70	7,000
20		Narok	Sokofona	2008	1740	42.5	500
21		Kericho	Singat	2005	300	33	125
	10 Conservancies	**16 Counties**	**21 CFAs**	**Mean age: 11 years**	**Mean: 945 members**	**Mean: 48% female**	**Mean: 6,370 ha**

Appendix 2: List of stakeholders

The GSMA would like to acknowledge the contributions of the stakeholders who were interviewed and those who provided feedback during the course of this research:

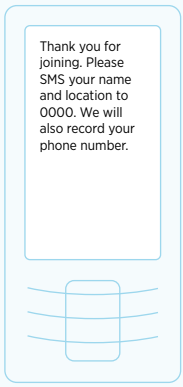
- African Forest Forum (AFF)
- Ecometrica
- Fair Tree
- Forest Action Network (FAN)
- Friends of Karura
- Global Forest Watch (GFW)
- Greenstand
- ICRAF/CIFOR/CGIAR
- Integrated Forestry Conservation Management Consultants (IFCMS)
- Kenya Forestry Research Institute (KEFRI)
- Kenya Forest Service (KFS)
- Kenya Forests Working Group (KFWG)
- National Alliance of Community Forest Associations (NACOFA)
- NETFUND
- Safaricom
- Wild Lab
- Wildlife Works
- World Resources Institute (WRI)
- WWF Kenya
- WWF Panda Labs
- 3-Sided Cube

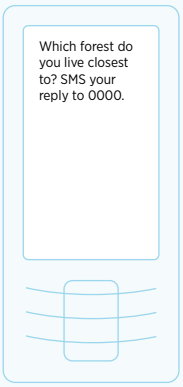
Appendix 3:
Prototype wireframes

Data collection and monitoring

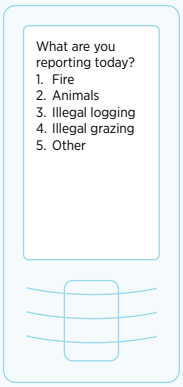
Feature phone

Signing up and choosing location:

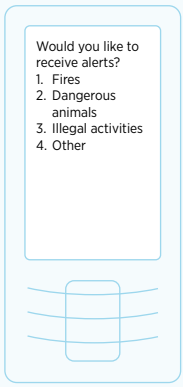




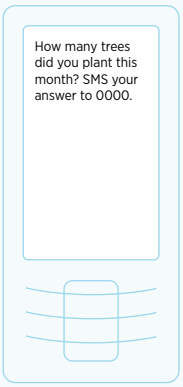
Reporting illegal activities and other incidents:



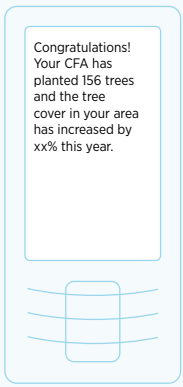
Setting up alerts:



Tree-planting and validation:

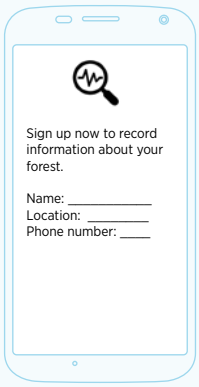


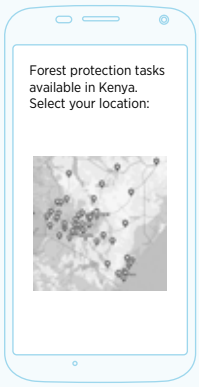
Updates on progress:



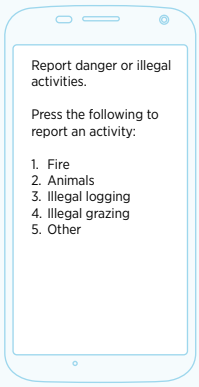
Smartphone

Signing up and choosing location:

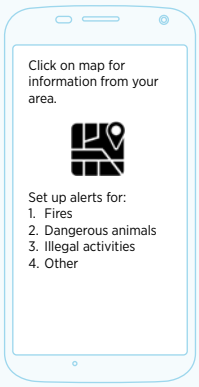




Reporting illegal activities and other incidents:



Setting up alerts:



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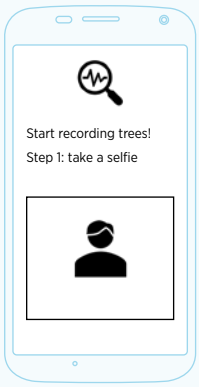

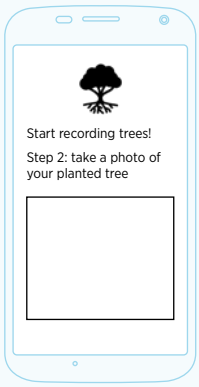

Updates on progress:

Payments

Feature phone

Adding a voucher system for tree planting:

Congratulations this month you planted 10 trees. You now have 10 vouchers.

Keeping track of income and vouchers:

You have 10 vouchers. Would you like to keep track of other income? Did you earn any money from CFA activities this month?
1. Yes
2. No

Communal vouchers and voting:

This month, your CFA earned 200 vouchers. How do you think it should be spent?
1. Community development
2. Fixing roads and fences
3. Buying equipment
4. Mpesa payments to members
5. Other

Smartphone

Adding a voucher system for tree planting:

Congratulations!

Your records:

10 trees

10 vouchers

Keeping track of income and vouchers:

You have

10 vouchers

Would you like to keep track of other income? Click here to record the money you made this month from CFA activities.

Communal vouchers and voting:

This month, your CFA earned:

200 vouchers

How do you think this should be spent?

1. Community development
2. Fixing roads and fences
3. Buying equipment
4. Mpesa payments to members
5. Other

Information sharing

Feature phone

Signing up:

"Join the CFA network today, SMS JOIN to 0000 for conservation information and updates from other CFAs around Kenya."

Welcome to the CFA network. We send out educational information about conservation efforts around Kenya, keep you updated on forest management activities around the country, and help you track income you have generated from the forest.

Selecting preferences for receiving information:

Select your preferred language:

1. English
2. Swahili

How often would you like to receive news?

1. Weekly
2. Monthly

What topics would you like to receive information about?
1. Tree planting
2. Water management
3. Bee-keeping
4. Grazing
5. News from other CFAs in Kenya
6. All of the above
7. None of the above

Updates on progress:

Thank you for registering. You will now receive information every xx weeks about the topics you have selected.

Need advice? Select a topic for further information:

1. How to start a tree nursery
2. Best practices in farming/grazing
3. Developing an effective PFMP

Receiving news and updates:

Monthly newsletter about CFA activities around Kenya:

1. XXX CFA planted 1234 trees this month.
2. YYYY CFA have found that this method of bee keeping increases their honey yields.

Peer-to-peer communication system:

Do you have any questions about forest conservation?

SMS your question to 0000 and we will help you find an answer.

Q. How can I improve my honey production?

A. I planted flowers near the hives

A. Our chairman brought ICIPE for a training.

Information sharing

Smartphone

Signing up:

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Appendix 4: Key takeaways from prototype testing

Figure 7

Key takeaways from prototype testing

	Prototype 1 Data collection	Prototype 2 Payments for ecosystem services	Prototype 3 Information sharing
Why CFA members would want to use it	• It is a more efficient way to do their current work. • Information can be shared very quickly with relevant authorities, with the expectation of a quick and transparent action. • CFA members would be more aware of what is happening in the forest (e.g. illegal activity, fire, rainfall, animals) at all times, from any location. • It will help ensure that CFAs are recognised and receiving support from the KFS. • Provides a more accurate and more permanent record of CFA activities. • It would support research/ education and reduce deforestation by measuring forest benefits and changes in coverage.	• An incentive would be motivating for individuals, the CFA and the community. • This would encourage more people, especially youth, to join the CFA and incentivise more activities and action. • Monetary rewards would allow CFA members to buy more seeds, invest in their businesses, purchase airtime, buy household items or support community development projects. • It will help CFAs and individuals gauge progress with tree planting and motivate them to do more. • It will allow people to be recognised for their hard work.	• It will help CFA members learn how to address day-to-day problems by communicating with experts and/or other CFA members. • The ability to network with other CFAs will help members learn from their successes and failures, gauge their progress, identify how they can improve and learn new techniques. • Competitive elements will motivate members to do more and to share what they have been doing.
Why CFA members would NOT want to use it	• Worries about confidentiality and the consequences of personal information being shared with those carrying out illegal activities. • Including a photo will make people feel insecure. • This is not likely to motivate new community members to join the CFA.	• For some, the payments will only be interesting "if it's a lot of money". • Do not want to reveal too much detail about how much money they are making. Money associated with tree planted is viewed as acceptable to share, but details on other income is private.	• No concerns were raised.

	Prototype 1 Data collection	Prototype 2 Payments for ecosystem services	Prototype 3 Information sharing
Design needs and wants	• It needs to be easy to use. • The app should automatically tag photos with location data and provide a menu of options for reporting needs. • Should allow members to report both positive and negative information. • Information should go directly to a relevant authority. • See the results of information sharing in order to keep using the app (evidence that reports have been followed up on). • See insights from data collection (e.g. historical data, contribution to national coverage, maps of tree species, data on survival rates) and whether they are improving tree survival rates. • CFA members should get alerts about fire or weather hazards, animals or forest destruction. • For non-smartphone users, it would be best for the CFA, KFS or NGOs to validate information first-hand. • Would be motivating to see what other people/CFAs are doing, as they will want to "keep up". • CFA members should be able to take photos on behalf of those who don't own a camera. • The app could provide information on the area, longitudes and latitudes, contours, temperature, tidal range, etc.	• Should include images of trees planted, date and time of planting and the details of people involved (e.g. the chairperson, tree planters and the forester). • Can use other CFA members with smartphones for verification. • Value of voucher ranges from KES 10 to 1,000. Some thought any amount would be motivating while others wanted to cover the cost of planting. • The value should increase with the height of the tree to help ensure it is maintained. • Responses were mixed on whether the incentive should go to an individual, the CFA or be split. Many initially said it should go to the individual, but changed their mind when they realised the funds could support community projects. • Payments need to be quick and transparent. There was some concern about how long it would take for a CFA to distribute money. • M-PESA was considered the most transparent and convenient method. • Should be paid for by the KFS, NGOs, foreigners (carbon credits) or companies in Kenya. • It would be best if CFA members could vote on how to use the funds. • Showing the number of vouchers received would motivate others.	• Preference for weekly updates with very targeted information. • Include information on tree planting, agriculture, income-generating activities, water management, how to develop a PFMP, agroforestry, issues with tree growth, reports of illegal activities. • News from other CFAs and advice from experts or "big organisations", such as the KFS. • Receive updates on the forest, how it is doing and how the CFA can support it. • An interactive hotline that would allow members to ask questions quickly and easily, especially on basic phones. • SMS or an app would allow members to store and read the information they receive on their own time. • Have the ability to ask questions as they are carrying out an activity, like tree planting. • Range of answers about how often they would ask questions. • Have the ability to share ideas about conservation with other CFAs. • There should be a search function that allows CFAs to explore what other CFAs are doing.

	Prototype 1 Data collection	Prototype 2 Payments for ecosystem services	Prototype 3 Information sharing
Design limitations	• An awareness campaign would be needed to drive uptake. • People who live and work in the forest do not usually have smartphones and might not have credit or connectivity. • Members might use the app and neglect their other duties. • Many people are not able to send photos. • Some people might deliberately make false reports to harm others. • Sending information on a basic phone can be time consuming . • Training will need to be provided, otherwise the information will not be accurate.	• Trees are not always planted frequently, especially during the rainy season. • Would not want people to see how much money they are making, but it would be ok to see how many vouchers they have earned. • Some smartphone users are not familiar with how to find and download apps. • Those without smartphones are concerned they will be left behind unless there is an SMS-based function, or if project implementers gave them a smartphone.	• Literacy rates can be an issue (some people could not read SMS). • Battery life, network connection and credit would impact usage, especially if advice was needed in real time. • Lack of smartphones might make the service less interactive and appealing.

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For more information, please visit the
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