

Design and development of a digital farmer field school. Experiences with a digital learning environment for cocoa production and certification in Sierra Leone



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ABSTRACT

This article reports on the design and development of the Digital Farmer Field School (DFFS). The DFFS offers a tablet-based digital learning environment for farmers and extension agents for knowledge sharing and knowledge co-creation. It provides an alternative to conventional agricultural extension training and monitoring. The prototype DFFS applies Farmer Field School (FFS) learning principles and is designed and developed following user experience (UX) design principles and user interface (UI) design principles from a responsible innovation perspective, using existing FFS material and tailored films which support and enrich the content. The prototype DFFS has been tested in Sierra Leone to assess its success in providing a substitute for face-to-face voluntary sustainability standard certification training for cocoa farmers. Results show that the DFFS as an off-line, telephonically connected and regular on-line updated learning platform offers an appropriate environment in which collective and individual learning is stimulated and facilitated. The DFFS prototype was socio-culturally and technologically appropriate and fitted the operational and strategic communication skills of cocoa farmers and other value chain stakeholders. Films capturing the testing are available as additional learning media.

1. Introduction

The Ebola outbreak in West Africa in 2014 and 2015 and the resulting restrictions on gathering in groups of more than five people was the direct motivation to design an innovative learning environment to support cocoa certification training that had commenced in Sierra Leone. The challenge was to offer cocoa certification training without face-to-face meetings. In this context it was realised that information and communication technology-based solutions and acting upon contemporary critical reflections of the effectiveness of rural communication services (see for example [Leeuwis and Aarts, 2011](#); [Ingram et al., 2016](#); [Paschall and Seville, 2012](#)) could be a way forward. Digital learning environments are increasingly recognised as potential contributors to agricultural knowledge and extension systems ([Asenso-Okyere and Mekonnen, 2012](#)).

This context led to the development of a Digital Farmer Field School (DFFS), based on a user experience (UX) design in which the human-computer interaction is central. The design envisioned the use of tablets by small groups of farmers in an off-line mode with

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the aim of learning and knowledge exchange about cocoa production and certification. It was envisioned that farmers could use the tablet in an off-line mode and connect by phone or text messaging with extension agents in a back office in real time or recorded modes. The direct function of this back office would be to give support and advice to cocoa farmers and to answer specific questions. The back office would also be responsible for downloading and processing recorded information and thereby monitor the relevance of the content provided, support content creation by farmer users and connect with the wider knowledge system. The back office would also play a crucial role in facilitating periodic updating of the tablet and otherwise support the use of the DFFS by the farmer groups.

The user interface (UI) design of the tablet comprises of animations of a group of seven farmers, with Fatu, a female cocoa farmer, playing the main role. Fatu guides the learner(s) through the DFFS. A female character was chosen to ensure gender sensitivity and enhance inclusion of both female and male farmers in certification and the learning environment. The other characters were designed to be representative of the Muslim/Christian distribution within the Sierra Leonean population.

Few studies have been done on the use of tablets in agricultural extension in rural areas in the Global South. The few studies that have been done (Eitzinger, 2015; Muilerman et al., 2013; Romani et al., 2015) demonstrate that information and communication technology (ICT) can not only gather information more effectively but is dynamic and responsive and can lead to the creation of a shared, audio-visual knowledge, used for different purposes including learning, consulting on farming practices, promoting farm inputs and extending farmer's social networks. ICT can be understood as a force (Castells, 2010) with an “ambivalent face, empowering and hindering at the same time” (Lanzara, 2009, p. 38).

The article first addresses the theoretical points of departure and the underlying guiding principles for the design and development of the digital interface. Based on these principles the article discusses how the specific user experience (UX) and user interface (UI) design for the prototype DFFS on cocoa production and certification was developed. A section presenting empirical results and the analysis of testing the prototype in Sierra Leone follows this.

Although the DFFS was approached as a professional activity, requested by Jula Consultancy and FairMatch Support as the organisations responsible for the certification training, to alleviate the pressing situation experienced in Sierra Leone, this article aims to document the experiences obtained for a wider relevance of similar digital interfaces for farmers with low literacy levels and extension systems with digital ambitions for enhancing knowledge exchange and learning. The conclusions are thus situated in this broader context, with guidelines for further development in Sierra Leone and wider proposed in the closing section.

2. UX design of a digital interface for cocoa production in Sierra Leone

This section addresses the underlying theoretical principles of the UX design. The DFFS design was based on knowledge of rural communication services and cocoa certification (training) in Sierra Leone, gathered from farmers and stakeholders (trainers, extension agents and certification organisations) in the cocoa value chain. Secondly, being a first initiative of its kind to open up to digital learning for people with low literacy levels in Sierra Leone, the UX design required the learning principles of knowledge sharing and knowledge co-creation to be articulated. The main principles applied in the development of the prototype DFFS are in line with the learning principles of Farmer Field Schools (FFS). Thirdly, an explicit perspective on content strategy and accessibility is explained. Accessibility issues in the Sierra Leonean context were studied as the basis for the design of the UX and the content. Finally, the design and development follows the principles of responsible innovation (RI) (Stilgoe, 2013).

2.1. Rural communication services and cocoa certification in Sierra Leone

Cocoa is, along with rubber, coffee and palm oil, one of the major export commodities from Sierra Leone (State House, the R. of S.L., 2014). In 2014 around 13,000 smallholder cocoa farmers, working in farmer groups and cooperatives, aimed to achieve UTZ, Fairtrade and Rainforest Alliance certification. The logic behind certification is that demand and the higher ‘premium’ price paid for certified cocoa has a direct positive impact on farmers’ income and livelihoods (Blackman and Rivera, 2010). Jula Consultancy, based in Kenema, Eastern Sierra Leone, in partnership with the non-profit organisation FairMatch Support—a developer of sustainable supply chains—had organised the certification process with training and audits with the farmer groups. Jula Consultancy employed ‘trainers’ and ‘field monitors’ to conduct seminars, training and demonstrations in the field. However, due to Ebola the certification training given by Jula Consultancy in Kailahun, Kono and Kenema districts in 2015 was interrupted and the certification process could not be restarted on time for the 2016 harvest to become certified.

The challenges faced in the organisation and delivery of these agricultural extension services and certification activities originate from diverse causes. The geographic working area for Jula Consultancy staff covers large distances between the office and rural communities; agricultural extension services by the government do not support these initiatives; cocoa farmers have limited resources to procure services from private sector providers; and communication media are limited and often not considering the local languages. When rural communication services are available, a top down orientation of transmitting messages often limits their relevance further. This is then aggravated by not taking into consideration socio-cultural aspects such as literacy aspects of text and visual communication, the gender of users and other contextual specifics.

2.2. Learning principles for a DFFS

The design of the prototype DFFS was inspired by FFS learning principles in the context of cocoa certification, given that FFS is the main agricultural extension model used in Sierra Leone and generally appreciated for its merits as extension approach tool (Davis, 2008). In the FFS approach, groups are recognised as the key element (Anandajayasekeram et al., 2007; Braun and Duveskog, 2008;

Van de Fliert, 1993). Groups can differ in age, gender and other socio-cultural aspects, but find common ground in their rural livelihoods. Groups are formed on the basis of a crop or a commodity or on the physical proximity in a rural farming community, and the field is considered to define the curriculum, providing the training material and the training context. The original FFS approach was developed with a strong emphasis on Agro-EcoSystem Analysis and Integrated Pest Management (IPM) aspects. Facilitation is seen as an essential element to make FFS operational and to connect with relevant outsiders. After Sierra Leone's civil war, the government (Ministry of Agriculture, Forestry and Food Security) and non-governmental organisations launched a FFS initiative in 2002 with the aim of improving food security.

Cocoa certification in general and the certification guide as used with the farmer groups organised by Jula Consultancy provide a main entrance point: farmers have to organise in groups, they are trained by extension staff to meet certification standards regarding good agricultural practices, and are prepared for inspections and auditing in groups. These farmer groups receive support and service provision; they receive training on integrated crop and pest management, credit and fertilisers, by organisations such as cocoa traders, NGOs and the government. The manuals used for training on cocoa certification contain one-direction instructions, illustrations on 'good' and 'bad' practices, which contradicts with the pedagogical approach of FFS, which is based on learning through experience and reflection as formulated by Taylor et al. (2012) stating that FFS can foster transformative learning as participants start questioning their own assumptions and discard or accept new farming practices based on experience.

Another aspect where FFS and certification training differ is that the FFS approach only recently has an increasing focus on issues of quality and market linkages in the entire value chain. Differences are not considered as confounding aspects, but rather relate to different roots.

The FFS learning principles in a context of certification were adapted into the following design principles for the DFFS UX:

- The DFFS design envisions farmers organised in a group (i.e. cooperative or association) as direct users.
- The DFFS positions farmers as stakeholders in a larger value chain.
- The DFFS positions extension agents or other direct service suppliers in a back office for knowledge exchange and communication by means of the digital interface, telephone and other communication means where possible.
- The DFFS design focuses on Integrated Pest Management (IPM) in agricultural production and certification.
- The DFFS design focuses on the observation, documentation and analysis by farmers of the seasonal performance of their cocoa farms.
- Conventional certification content is recognisable in the digital learning interface.
- The DFFS design links and supports farmers, extension agents and other stakeholders to enable communication, knowledge exchange and to facilitate internal certification and third party audits.

2.3. Content strategy and accessibility of the digital interface for foreseen users

Whereas the learning principles defined for the UX design reflect a general perspective on cocoa production and certification, a content strategy perspective to condition or influence an UX design implies an explicit focus on the usability and accessibility. In case of the DFFS, envisioned users are farmers and extension agents or certification trainers. Halvorso (2011) defines content strategy as planning for the creation, delivery and governance of useful, usable content. Taking usefulness and usability as defining characteristics for content strategy, the digital technology model (Van Dijk, 2005; Van Deursen and Van Dijk, 2009) was adopted to study accessibility for the situation of smallholder cocoa production in Sierra Leone. Van Dijk distinguishes four categories of access: motivational access, material access, skill access and usage access. This model has been developed mostly in a western, urban context of individual users, which differs greatly from the DFFS, which envisions diverse users with groups of farmers, service providers and other stakeholders in a knowledge system related to cocoa production and certification. This critical perspective can also be framed as a concern for 'technology as amplifier' as described by Toyama (2011, p. 1), which highlights that "technology tends to amplify existing inequalities".

Van Dijk's interface usability model was therefore adapted to the situation in Sierra Leone as a means to articulate accessibility as a crucial component of the content strategy. Below we elaborate on the categories of Van Dijk and their adaptation to the situation in Sierra Leone in more detail.

Motivational access described as the motivation to use digital technology resulted from the request for the DFFS, originating from the situation during the Ebola epidemic, which created pressing external motivation for all stakeholders involved as the certification process came to a halt. As the Ebola context becomes part of recent history this external motivation will change and thereby influence the content strategy design to consider a different focus on alignment and enhancement with the internal and external motivation of all stakeholders involved to sustain their livelihoods, especially farmers and service providers as main direct users of the DFFS.

As the direct need for a solution to the certification process will change the motivational aspects, direct users may also open up to a more integrative UX design for contents beyond cocoa like for example adult literacy training or health related information for farmers.

Material access relates to the possession of hardware, software and aspects of connectivity. Material access relates to the possession of hardware, software and aspects of connectivity. This aspect as well as the usage aspect were not decisive in the UX design, had limited attention in development of the DFFS prototype and were not prioritized during testing. A deeper focus on contemporary material access, which was known to be very low, was not addressed for the design and development of the prototype, considering the specifics of the Ebola context and the urgent search for alternative information systems that would overcome the ban on travelling and live encounters.

Jula consultancy and FairMatch Support, the organisations requesting an alternative approach to the banned live trainings, considered the current difficult material access as a situation that would change fast as the digitalisation advances worldwide (Aker and Fafchamps, 2014). Sierra Leone appears to be no exception and material access is fast changing and not only from a perspective of the external technological context but also from “users agency and desire for change” as described by Sam (2015, p. 18) in a study on mobile phone use in post-conflict Sierra Leone.

It is however acknowledged that with increased material access, attention to digital divides is imperative. For further development of DFFS, attention to the enabling environment is critical, as for example Thindwa (2001) highlights: “An enabling environment is a set of interrelated conditions – such as legal, organisational, fiscal, informational, political, and cultural – that impact on the capacity of development stakeholders such as civil society organisations to engage in development processes in a sustained and effective manner”.

Skill access - the possession of digital skills – was a major focus in the design and development of the prototype and an important factor taken into consideration in testing the prototype. Operational skills were differentiated into operational skills and strategic information skills. Operational skills focus on skills or competences of users on operating the DFFS prototype, in this case a tablet. Especially for farmer users, it was defined that the prototype:

- acts as a digital facilitator,
- enables access and navigate the interface,
- provides a logical (intuitive) sense of orientation to its users,
- builds on navigation actions, which are basic and consistent,
- limits aspects that create noise, complexity and distraction, and,
- facilitates task completion of basic activities.

Strategic information skills refer to user skills or competences to search, find and act on information of the digital interface. Strategic information skills were addressed separately for farmers and trainers as main stakeholders.

The DFFS interface sought to enable farmers to:

- search required information in the appropriate places of the tablet,
- document pest and diseases, and,
- communicate their questions and concerns with service delivery staff and trainers.

The DFFS interface also sought to enable trainers and field monitors to:

- communicate, to receive and respond to incoming calls and messages from farmers,
- operate as back office,
- support farmers use of the DFFS, and,
- manage and produce content for the DFFS.

Van Dijk’s model influenced the decision to design the DFFS with a ‘closed’ architecture: the content of the DFFS focuses on cocoa production and certification for smallholder farmers and related service providers in Eastern Sierra Leone.

2.4. A responsible innovation perspective towards the DFFS design

In line with complexity thinking in rural contexts in Sub Sahara Africa, the learning design builds on the principle that smallholder cocoa production in Sierra Leone is local, complex, dynamic, diverse, uncontrollable, risk-prone and unpredictable (Chambers, 2010). The UX design complements such an outsider view with a strong view on agency and resilience to be able to shape ambitious spaces for learning and change.

These considerations were articulated to prevent repeating challenges in the existing conventional communication services as described in 2.1. To make such ambitions operational, the DFFS development was framed as a process of responsible research and innovation (RRI). It was envisaged that RRI could provide a framework for enhancing the relevance and appropriateness of the DFFS for its main users in a sustainable manner.

RRI is in line with a definition on responsible innovation as: “A transparent, interactive process by which societal actors and innovators become mutually responsive to each other with a view to the (ethical) acceptability, sustainability and societal desirability of the innovation process and its marketable products (in order to allow a proper embedding of scientific and technological advances in our society).” (Stilgoe, 2013, p. 1570). The authors further elaborate on questions that represent aspects of societal concern and interest and thereby describe RI as the “deliberate embedding” of questions of process. To make this operational, four dimensions provide a framework to characterise a “more responsible vision of innovation”: anticipation, reflexivity, inclusion and responsiveness (Stilgoe, 2013, p. 1570).

An RRI perspective of the process also enables a focus on design accountability as the specifics of the low literacy levels and very limited digital competences of major end users are often leading to excluding such user groups. Design accountability from a RRI perspective in the DFFS aligns with Medhi et al. (2011) and Steyn and Van Greunen (2014), who emphasise the irrelevance of textual interfaces for low literacy and novice users.

To view the DFFS development as responsible research and innovation in action, the dimensions as elaborated by [Stilgoe \(2013\)](#) were operationalized as design principles for the interface and as criteria for the innovation process in general, as follows:

- The interface provides access to training and certification in times of Ebola and beyond.
- Developers take up their accountability to design an accessible UI, which matches the skills of the main users; farmers and trainers.
- The content strategy of the interface contributes to scenarios of desirable futures and increases resilience and farm productivity.
- The UI is designed in direct contact with potential users and where possible further developed in co-creation with end users and other stakeholders.
- The DFFS is only further developed if considered relevant and accessible by its main users.
- The interface recognises diversity of users and focuses on inclusive learning with alertness for new interdependencies and agenda-setting mechanisms.

Whereas the above mentioned design principles directly refer to the development of the DFFS, RRI also inspired a design research methodology with a focus on reflection. To that end the DFFS design and the prototype development were carefully documented. Analysing the DFFS development process through a RRI lens also aimed to contribute to the empirical understanding of rural communication and ICT based extension alternatives in rural communities.

2.5. UX design principles for the DFFS

The previous sections described how the UX design of the prototype was inspired by FFS learning principles focussing on seasonal on-farm event observation, group learning and action and digital communication with the back office. Cocoa certification training defines a content strategy covering the four areas of certification, agricultural practices, social practices and environmental practices. The adapted digital technology model provides a framework to support existing digital skills and invite for new skills of the main DFFS users, which are illiterate and novice users in the farmer groups.

The DFFS design principles can be summarised as creating a relevant knowledge and communication system that materialises in a digital interface for farmers and service providers in a context of cocoa production and certification in Sierra Leone, which:

- adapts FFS learning principles to the DFFS,
- engages farmers and service providers in a system that is relevant for cocoa production and certification in the context of Eastern Sierra Leone,
- provides and enhances motivational access for its users, and,
- aligns with the operational and strategic information skills of its users (focussing on farmers and extension agents).

3. UI design of the DFFS

3.1. UI accessibility and navigation

To align the DFFS with the operational skills of its foreseen users and their low literacy levels, a visual and narrative approach to the UI was outlined. Considering the relevance and interest for literacy training, the interface supports literacy training by providing written transcripts of text in the audio-visual content. The narrative and visual approach resulted in films and animations with dialogues and voiceover text in the local language Krio. Also the design principle to focus on IPM by observation and documenting pests and diseases, called for the use of visual elements and tools, such as pictures of pests and diseases, to be stored in a digital library, requiring a storage facility that could be shared with the Jula Consultancy trainers for further analysis.

Given that the (visual) content is foreseen for use in groups, it was decided to design the interface for touch screen tablets because of their larger screens, as compared to smart phones. It was also considered that smart phones are currently not commonly possessed and tablets have a lower purchase price as compared to an equivalent number of individual possessed smart phones. Also the mature age of cocoa farmers and a general lack of reading glasses influenced the decision that tablets were more appropriate.

Based on above considerations the prototype was developed with an opening screen that shows the sections of the DFFS represented in 11 buttons each made up of an iconized line-drawing and a name in text below (see [Fig. 1.](#)). Contrary to the understanding that a linear design provides an optimal navigation structure for low literacy users, the UI foresees a linear start followed by a branched structure, which is introduced and supported by the animated character Fatu who stands in the centre of the opening screen. The prototype as tested was fully available in Krio, the most common of local language.

A welcome button 'Kushe' (meaning Hello in Krio) was placed on the left side of the upper screen row icons. Clicking on the 'Kushe' button leads to short animations about the DFFS, a short animation about taking pictures and a film and an animation about the operation of the prototype tablet. To the right of 'Kushe' are four buttons that focus on the cocoa production and certification at farmer system level: 'Agriulchu praktis' ('Agricultural Practices'), 'Soshal praktis' ('Social Practices'), 'Satifikashun' ('Certification'), and 'Envayroment praktis' ('Environmental Practices'). The lower row has buttons relating to the wider system of production and certification: 'Di ofis' ('The Office'), 'Di makit' ('The Market') and the button 'Di labyri' ('Library'). The buttons, 'Myusik' ('Music'), 'Pikchu en film' ('Photos and film'), 'Voys rikoda' ('Voice Recorder') and 'Snap' ('Camera') are function buttons. In the following sections the content strategy of the icons relating to production and certification are elaborated.

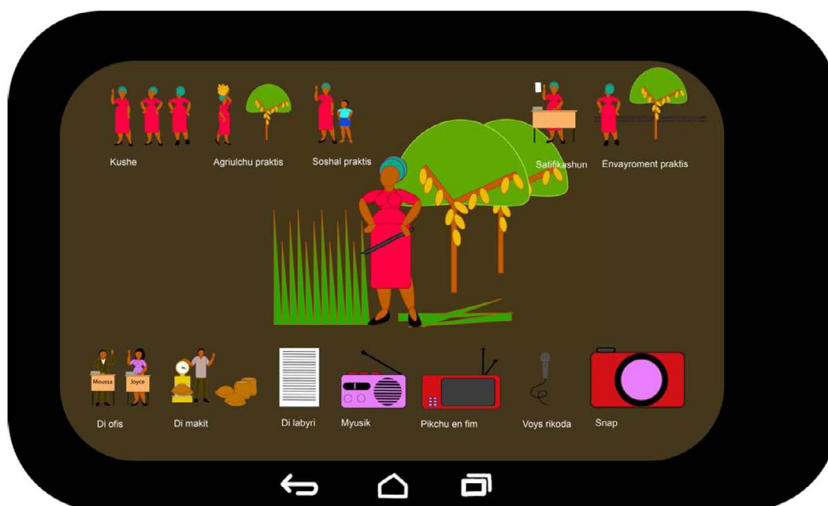


Fig. 1. The opening screen of the DFFS prototype.

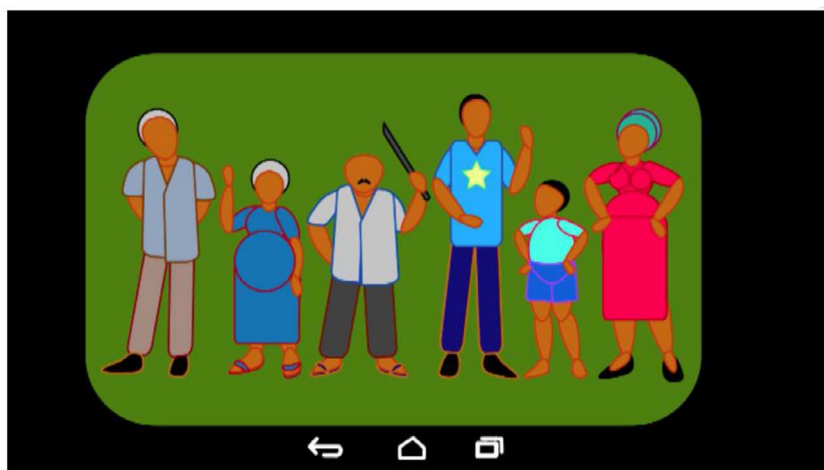


Fig. 2. The DFFS farmer group (the lady on the right is Fatu.).

3.2. An animated DFFS farmer group

To make the FFS learning principles visible, a narrative structure was created around a FFS group. This comprised characters representing the diversity of a farmer group in terms of gender, age, family composition and farm size (see Fig. 2).

The six characters are animated and personalised by first person singular narratives. The leading character is Fatu, a female cocoa farmer; she is not young, not old. Except for her son Beau, no specifics regarding her family and livelihood are provided to enhance identification with her by a wide array of users. The name Fatu was selected after an internet search of common names in Sierra Leone and considering cultural, religious diversity and the melody of the name. Fatu was created as a female farmer to sidestep gender debates and issues and align with Sustainable Development Goals. Fatu is placed centrally on the opening screen.

Regarding style issues of tone and voice, initially the DFFS was named a ‘computer school’. Upon testing this name turned out to connect with conventional interpretations of agricultural extension, focusing on content delivery using well-known discourses such as ‘good practices’ and ‘teaching’. Using the name DFFS supported a reframing to the digital interface as a space of knowledge creation and learning, as the farmer Fatu talking about ‘practices’ and ‘the way we do things’. An anecdote to exemplify the relevance of careful checking of the discourse comes from the translation of a voiceover from English to Krio. Whereas the ‘experts’ in the film *Looking at the Photos from the Cocoa Farmers*¹ say that farmers were “reporting about a disease”, this conversation changed in the Krio translation to “Farmer dem wae complain”. By changing the action verb ‘reporting’ to ‘complaining’, the conversation in Krio suggests a different relation between farmers and experts. The verb reporting would be the correct verb in the horizontal communication

¹ The film *Looking at the Photos from the Cocoa Farmers* – <https://vimeo.com/150686265>.

between farmers and service providers about pests and diseases, as foreseen in the UX design.

The combined use of film and animation was chosen considering production realities and challenges, and advantages and peculiarities of an appropriate style. Short films, produced in documentary style from recording on location provide a localised context and the direct participation of local stakeholders. However, filming also requires particular conditions, technological competences and planning in terms of the cocoa season. Animations, on the contrary, can bridge complexities such as distance, acting competences and production limitations on location. Animation also requires a production organisation involving specific professionals and skills, with a conscientious approach that addresses the local context, farmer's needs and system requirements.

3.3. Cocoa production and certification

The buttons on Agricultural Practices, Social Practices, Certification and Environmental Practices represent the common sections of certification training. A major feature of 'Agricultural Practices' was to introduce an option for the visual documentation of pest and diseases by farmers and communicate this with staff in the back office. The film '*Looking at the Photos from the Cocoa Farmers*' was included to show the follow up response after uploading pictures. In 'Certification Practices' section, the film '*Salamatu Visits the Cocoa Processing Plant*'² provided insights on quality throughout the cocoa value chain.

The button on 'The Office' leads to the back office, which is staffed with the animated characters Joyce and Moussa. Clicking on 'The office' leads to a menu with phone numbers for calling, texting or otherwise contacting either the male or female character implicating that the service provider employs male and female support staff members to communicate as these characters would do when answering a phone call: "Good morning, I am Joyce/Moussa, can I help you?". The button on 'The Market' is foreseen to lead to information on market prices and buyers, but was not further elaborated in the prototype. The button on 'The library' was foreseen to store a variety of documents in text or audio relating to certification.

3.4. Content creation

Inspired by the RRI framework to include co-creation led to searching for alternatives for direct contact between designers and the end users as they were located far apart and the contact was originally impeded by the very Ebola context, which the DFFS was searching to mitigate. Throughout the entire design and production process ongoing communication and consultation between the involved knowledge institutes, Jula Consultancy in Kenema and Fair Match Support took place.

As an alternative to the existing situation of limited communication with direct end users, a DFFS was the subject of a series of design workshops organised with international students of the MSc course Rural Development, Communication and Innovation at Van Hall Larenstein University of Applied Sciences and the Centre for Development Innovation of Wageningen University (CDI), the Netherlands. These students work in their African and Asian home countries as rural development professionals in a context of communication for rural innovation and were more than willing to contribute to an Ebola response. Besides their professional relation to the work of Jula Consultancy and their practical knowledge of rural livelihoods, they also hold specific cocoa production and certification knowledge and experience. The 2014/2015 cohort explored in the course Media Design for Social Change, amongst others, the communication between farmers and service providers in a DFFS context when farmers would make pictures with a tablet. This exploration resulted in the short film *Looking at the Photos from the Cocoa Farmers* to visualise the responsiveness of service providers to farmers who would upload and share the pictures in the DFFS. The 2015/2016 students constituted a first test panel of the prototype and contributed suggestions about accessibility³ and general interface design.

Another alternative was found in cooperation with Dutch citizens originating from Sierra Leone. Feedback contributed to the UI design and content development in organised feedback sessions and also more spontaneous as Dutch citizens originating from Sierra Leone cooperated in translating the original English texts of the animations and films to Krio language. Other contributions included acting as the main character in a film documenting the processing of cocoa beans to powder.

4. Testing the DFFS prototype in Sierra Leone

In January 2016, Jula Consultancy organised five workshops with the aim to explore the UX and UI design with farmers and Jula Consultancy staff members as the main user groups. The workshops with Jula staff took place in Kenema and three villages' workshops were organised with farmer groups in Kailahun and Kenema district in Sierra Leone.

The prototype DFFS was uploaded on three tablets (Prestigion MultiPad 8.0i) with an opening screen with links and buttons leading to second and third level content. In addition to the tablet, full colour prints of the opening screen and of the wireframe were available for all participants. The tablet had a SIM card with credit to allow interactivity between cocoa farmers and the back office. It was explained to all participants that independent of the findings, the testing did not represent a promise of implementation of the DFFS.

The testing intended to enhance insights on the relevance and feasibility of the DFFS for cocoa production and certification training, for Jula Consultancy staff and farmer groups they work with before the Ebola outbreak. It was also envisioned that assessing the DFFS prototype would provide guidelines for further development, which could be put in practice in case the testing outcomes

² The film *Salamatu Visits the Cocoa Processing Plant* – <https://www.youtube.com/watch?v=oMNTi18h5wo>.

³ They also contributed with the film *An Adapted Manual Tablet for Cocoa Farmers in Sierra Leone* – <https://www.youtube.com/watch?v=nfRTSC9UyPc>.

Table 1
User groups participating in the prototype testing.

Location	User group	Male	Female	Total
Kenema	Jula Staff	16	6	22
Kenema	Jula staff	12	7	19
Bunumbu II	Farmers	21	3	24
Kambema	Farmers	12	11	23
Nekabo	Farmers	19	20	39
Total		80	47	127

were promising, and funding would become available for further design and development.

About 20 staff members of Jula Consultancy participated in each of the workshops, with a gender division of 60% male and 40% female staff. They also joined the activities in the villages as translators and facilitators. During each visit to a farmer group, male and female trainers stayed in the office in Kenema to take up a role of ‘Joyce’ or ‘Moussa’ in the back office, with the phones whose numbers were at display in ‘The Office’.

Eighty-six farmers participated in the workshops. Other community members were present as the workshops took place in public places such as communal centres and cocoa warehouses. The gender balance coincides with the situation commonly found in certification training. Table 1 presents an overview of participating user groups in the prototype testing.

After a visual informed consent procedure, described by Lie and Witteveen (2015), the testing activities were documented on film. Participants’ consent was signed, most often with an inked fingerprint, confirming farmer’s low literacy levels. Filming of the activities aimed to document the experience and to provide material for a short film to share the events with all participants in a later stage. Jula Consultancy staff members also documented their observations and experiences in short reports.

In the following sections results from testing of the prototype are presented per participating user group with a focus on aspects of accessibility and navigation.

4.1. UX and UI design and prototype testing with Jula Consultancy staff

Jula Consultancy staff was very aware of the potential changes to their work if the DFFS approach would be adopted, as expressed by a male trainer:

This approach represents a radical departure from earlier agricultural extension programmes in which farmers were expected to adopt generalised recommendations that had been formulated by specialists from outside the community to concise and precise information on the tablet.

Jula Consultancy staff that played back office roles, reported on the complementary experience of the testing in the villages, as expressed by one of the female trainers:

I received phone calls from different farmers. It creates a constant link between the farmer in the field and the Jula office. Through audio messages recorded by the farmers, it makes Jula’s office address the concerns of the farmers.

To make he reconfigured position of Jula Consultancy staff in the back office operational for farmers during prototype testing required practice before the workshops with the farmers. Role-plays for the telephone calls from farmers were practised by Jula Consultancy staff members in the Moussa or Joyce roles. Observing and practising the back office situation from the perspective of a farmer calling the back office by selecting the phone button on the tablet, enabled Jula Consultancy staff to imagine their role. Jula Consultancy staff recognised the enthusiasm and the positive prospect of a DFFS based on the experiences with the prototype. A male field monitor expressed his experience as follows:

DFFS creates a good relationship between the farmers, field monitors, trainers and the office. Farmers were able to explain their problems, which affect them. This was done through recording voice messages. Farmers have a basic insight and motivation to discuss certification and insight into the quality aspects through the cocoa value chain. Farmers were motivated to document pest and diseases and share their concerns with service delivery staff and trainers and expect a response in return. It also helps field monitors and trainers to have access to information and documents that provide background knowledge in certification. Service staff is motivated to respond to farmers’ inputs such as photos.

The interactions between farmers and staff members of Jula Consultancy during the workshops were observed as friendly and polite. The interaction during the phone calls was equally positive. These observations suggest that phone calls are a promising means of communication. The audio-recordings of farmers in absence of connectivity suggest that both live phone calls as audio messages have potential for communication between farmers and service providers.

It was realised after the testing that the issue of farmers groups versus an individual approach had not been addressed. Throughout the testing it seemed ‘normal’ or ‘natural’ to focus on a group approach. This was attributed to previous FFS experiences and socio-cultural dynamics. To exemplify the collective nature, it was observed in the villages, during the phone calls that the whole group stayed assembled during the phone call, supporting the conversation with gestures, catching the attention of the caller or making suggestions. The potential of a digital interface as a collective device for training and communication appeared to be confirmed.

Jula Consultancy staff expressed their motivation to play a role in a DFFS, as they all had experiences of the limitations to visit farmers and stay in touch with ‘their’ farmer groups. They imagined that the DFFS would appeal especially to young farmers. They also expressed doubts in relation to their job security as they realised that the creation, delivery and governance of the DFFS requires competences they do not possess and which are difficult to acquire in Kenema.

Smart phone possession was common for Jula Consultancy staff members, and although no explicit discussion of costs and connectivity was made with the staff members, experiences during the study showed that Internet access was generally unreliable and slow, even more so outside the city of Kenema.

A female trainer elaborated on her field observations as follows:

I have learnt how difficult it is for some farmers to make phone calls unless they have to climb a very big hill in search of network. I also learnt how difficult it is to even charge their phones unless they send it here for charging, which involves money.

4.2. UX and UI design and prototype testing with farmers

After distributing the tablets in the farmers group without specific instructions, uncertainty and shy responses were observed. On several occasions farmers suggested that ‘it’ resembles a big phone and should be handled accordingly and that younger farmers were expected to put this suggestion into practice. The tablet used had small power and volume buttons, which were sometimes difficult to operate, even for experienced mobile phone users. Despite the complexities, a female trainer of Jula Consultancy observed that:

The farmers were able to boot the tablet on their own. The farmers were able to adapt to the system very fast, for example taking photos, making phone calls to Musa and Joyce at the office.

It was frequently observed that farmers took great interest in the tablet and were aware of such technologies, illustrated by the comment of a female farmer in Bunumbu II:

It is nice to touch a computer.

Navigation took place using the Home and the Return button. Tapping on the buttons or clicking to open an application seemed to be a kind of ‘muscle learning’ skill requiring some practice and confidence of its effect. Nothing happens when tapping too softly, whereas a tap too long or too hard opened up the settings of the buttons. Tapping turned out to be an unpopular term and it was proposed to use the verb ‘touching’. Such suggestions were taken as aspects of increased freedom and appropriation of the digital environment. ‘Touching’ was the most common navigation method, rather than scrolling and zooming. Swiping was required to start the opening screen and was perceived as difficult and often left to an experienced participant. In return this participant often motivated peers to practice.

After tapping on the film or animation button an option was presented to select Photos or Video Player. Such options created confusion and uncertainty. Not completely unexpected though surprisingly convincing, the full-colour print of the opening screen supported gaining familiarity with navigation. Farmers used it as reliable reference. During the testing all farmer groups were able to take pictures, all groups made photos of their group, two groups were taking photos in the field and one group of the black pod disease, uploading these to discuss with Jula Consultancy staff in the back office. In absence of functional connectivity, 12 audio messages were recorded by farmers, mostly related to pests and diseases. All farmer groups reacted very enthusiastically to the digital back office. Moussa and Joyce quickly became familiar and farmers were quite decisive in their choice to phone either Joyce or Moussa. The name Moussa was proposed to change to Musa, so that he became Sierra Leonean, whereas Moussa was interpreted as “a foreigner, most likely a Guinean.

The response of farmers to the animated farmer group with Fatu was positive, with a particular appreciation for Fatu. There was no discussion that the main character was a female farmer, although on various occasions women expressed their happiness to have a lead female character and even her dress received compliments. Female farmers noticed that Fatu was not only shown “as usual” with a child and a basket, but also had a cutlass, illustrated by the comment captured in the film⁴, where a female farmer explains:

I see a woman with a cutlass. Fatu wants to cultivate. I am sure that with the cutlass she wants to cultivate.

Aspects of inclusion were expressed as concerns relating to material access. To farmers, a phone is a tangible device, which needs to be charged with electricity and with a phone credit and also requires connectivity. Mobile tele-centres provide charging facilities at a cost of 1000 Leones (as at 12 January 2016) or provide a service by motorbike to a nearby town for the same price for charging a phone and 10,000 Leones for the collective transport to town. Farmers owning or hiring a phone indicated that they use their phones to stay in touch with relatives, which was much needed during the Ebola outbreak. No farmers mentioned using phones to obtain information about production or communication. The cost of communication was a sensitive issue, for example ‘beeping’ in the absence of credit was reported with a sense of shyness. Limited connectivity was more openly discussed and farmers showed an active approach towards finding connectivity, normally only in daylight as leaving the house in the evening was not considered to be safe.

Alongside the use of the DFFS for cocoa production and certification issues, farmers suggested that the DFFS could be used to support literacy and numeracy training. This motivation was explained by farmers to result from a lack of confidence in cocoa traders’ operations. Farmers have a keen interest to enhance their capacity to understand and check the transactions (i.e. weighing and recording cocoa sales) and processes of certification and cocoa sales.

⁴ *Cocoa Training in Times of Ebola. Sunday Morning Reflections of Mohamed Fofanah, 3’32”* – <https://vimeo.com/161979325>.

5. Conclusions and guidelines for further development

As the previous section focused on a presentation of the results in relation to the design principle of UI accessibility and navigation, this section analyses the results from the prototype testing for the DFFS relevance training and certification in times of Ebola and beyond following the design principles as formulated in Section 2.5.

5.1. Main conclusions

The FFS learning principles are adapted to the DFFS for training and certification for cocoa in times of Ebola and beyond.

The extraordinary situation during the Ebola epidemic demanded a situation in which drastic rethinking was needed to replace conventional cocoa extension and certification training. The test of the DFFS prototype was received positively as an alternative to conventional training by extension staff in farmer communities. The UX design of the DFFS aligns with the needs of farmers and trainers to be the main stakeholders or users. In the current design, other stakeholders such as traders and financial service providers are only represented in a limited way and only to a limited extent involved in the testing of the prototype.

Incorporating the basic learning principles of farmer field schools seems feasible and relevant. The DFFS prototype confirms the collective use of the tablet and calls for collective discussions and responses by participating farmers. On the other hand, a strength of the DFFS that also emerged during the testing was the more autonomous use of the tablet in the learning process of the farmer group without the presence of trainers or extension agents. The DFFS prototype revealed a particular appreciation by female farmers, which might result from this more autonomous use. It might as well have resulted from the design principle to make women equally visible as men in the content element exemplified by the main animated character Fatu.

The DFFS engages farmers and Jula staff members in a system that is relevant for cocoa production and certification in the context of Eastern Sierra Leone.

The main narrative structure and navigation in the prototype are assessed by both farmers and Jula staff as appropriate for cocoa production and certification practices. They align with the operational skills and strategic information skills of farmers and are attractive to create motivation and operational access. The success of content elements, such as the film *'Salamatu visits the Cocoa Processing Plant'* indicates that designing a DFFS requires creative thinking and that good ideas need to be put into practice. Using a documentary to show distant and unknown parts of a value chain to farmers is not novel. The originality lies in putting it into practice with a Sierra Leonean woman.

Based on the way the animated characters in the DFFS farmer group and back office were referred to as (virtual) colleagues and using their names from the animations seems to indicate that the animations provide identification to the users beyond the mere functional level.

The results of the DFFS prototype design suggest a DFFS approach, which is relevant for other commodities as cocoa or other situations with inhibiting or challenged contexts of long distance and security issues, which inhibit direct contact between farmers and service providers. It needs mentioning that where the UX might be transferable, the UI design requires adaptation to each specific socio-cultural context. As stated before, the tested DFFS prototype is limited in content and limited for its positioning in the wider service delivery system. Although the DFFS is designed as a closed system, linking it with other systems such as a Monitoring and Evaluation system or a Tracing and Mapping system is worthwhile to consider. Also linking up with content of public health and literacy training has been suggested as relevant.

The DFFS provides and enhances motivational access and aligns with the operational and strategic information skills of its users.

During the prototype testing and afterwards the DFFS prototype was welcomed as an alternative to the existing and paralysed system (during Ebola epidemic). The results of the testing were received with optimism and the DFFS was found to be a promising innovative strategy, which enhanced motivation for a more active cocoa production information system and knowledge sharing incorporating diverse stakeholders.

Further design and development of the DFFS seemed promising after prototype testing. However, till date Jula Consultancy continues searching for options to fund follow up activities. Although the 'Ebola momentum' has passed it is also realised that DFFS has no ambition of establishing short-term successes, which might not be sustainable in a long run. Jula Consultancy also has learnt that the many systemic implications of a full operational DFFS such as professionalism for UX and UI design, an operational back office linked to knowledge centres and the altering technological context of devices, charger options and connectivity require to rethink their current activities and approaches. These insights align with the insight that "technology projects in global development are most successful when they amplify already successful development efforts or positively inclined intent, rather than seek to fix, provide or substitute for broken or missing elements" as formulated by Toyama (2011).

Meanwhile it is recommended to further explore technological conditions and requirements of possible devices and make the enabling environment optimal for users with limited digital competences. This also relates to developing a business model for development, content creation and ensuring the life cycle of the DFFS. During the testing it was suggested that the premium price of certified cocoa would allow farmers to buy the tablet and fund additional cost of connectivity and charging. This option requires further attention. The financing of the wider system of the DFFS design and development, from the perspective of the service providers delivering content, and supporting governance is still to be defined.

During the Ebola epidemic the DFFS could not be designed in direct cooperation with the users although alternatives were put in place. For the further design, development and use of the DFFS it is imperative to continue searching for co-creation and direct participation of its users. To have an enabling environment for longer experiments in which the DFFS is in operation for both user groups in a non-incident time frame, it might be needed that in such a stage of design and development the farmer groups are

facilitated with tablets and even supported with other aspects of access and connectivity. This is maybe countervailing for the development of a ‘business model’, yet allows a certain room for participatory design.

5.2. A responsible research and innovation perspective towards the DFFS design

The RRI concept provides a framework of design and development to which designers and developers adhere for transparency, reflection and sharing the experiences obtained while designing and developing the DFFS. To align with the responsible research and innovation ambitions, the DFFS project was documented as a project report (Witteveen et al., 2016) and on film. The film provides insight into the innovation process and thereby aims to contribute to discussions and decision-making about further development of (elements of) digital farmer field schools. The film contributes to debates on rural communication, the role of extension staff and the interplay with digital interfaces.

The film ‘*Cocoa Training in Times of Ebola. Sunday Morning Reflections of Mohamed Fofanah*’ is based on an interview with the Jula Consultancy director, Mohamed Fofanah, conducted the day after testing of DFFS had finished. Interview fragments with farmers and staff members recorded during the workshops, are inserted to visualise the impact of the Ebola epidemic and the context of cocoa production and certification training and activities in Eastern Sierra Leone. The film presents the communication and knowledge sharing relationships between farmers and service delivery staff, with an account of testing of a DFFS prototype with three farmer groups and the Jula Consultancy staff. The interviews show Fofanah’s reflection on the DFFS, particularly his perspective on farmers’ knowledge and learning. The resulting film ‘*Cocoa Training in Times of Ebola. Sunday Morning Reflections of Mohamed Fofanah*’⁵ was provided to all involved and is available on the Internet. A shorter version⁶ was selected for a Pitch at an Innovation Accelerator event in Germany, June 2016.

5.3. Future prospects

To prevent the suggestion that a way forward could be a simple upscaling of the prototype, it has to be realised that the prototype tablets were meant for a short operational use during the testing workshops. The content in the prototype provided examples of the main elements of the UX and UI design. They do not reflect elaborated workflows or established content lifecycles. No governance processes for the UX and UI design have been established, except for initial concepts. The DFFS has not yet been developed further than the prototype, hampered by absence of funding. The DFFS should therefore be seen as a successful experiment in the context of cocoa production and certification in Sierra Leone requiring further design and development before operational release.

Another challenge for the further development of DFFS content creation aligns with experiences from earlier work of Witteveen and Lie (2012), where the limited realisation of visual learning practices resulted in a lack of expertise and professionalism. The authors further elaborate on the limited attention for image production and recommend more attention for the design and production process to realise the potential impact of visual learning strategies in a context of ‘wicked problems in the Global south’.

In case of the DFFS it is recommended to envision new professionals who cooperate with service providers in content creation such as short films and animations. It is recommended to explore options for training and education in the field of communication and multi-media design that could deliver professionals for designing and developing interactive platforms like the DFFS.

The replicability of major UX and UI design elements of DFFS is currently being tested with the development of a Digital Herder Service Centre (DHSC). The DHSC has been developed to cater for the knowledge and communication needs of nomadic herders in Mongolia, in response to the limited direct contacts between herders and service providers due to long distances and harsh climatic conditions. An articulated user experience design is guiding the interface design, however it also has to be acknowledged that not all experiences with interface design are documented and shared and vice versa not all documented insights are reaching the UX and UI designers working on DFFS and related efforts.

In order to be effective and appropriate in the long run further conceptual grounding and empirical understanding of such digital interfaces are required. This mirrors experiences with digital technology in similar fields such as nature conservation (Arts et al., 2015) where the authors warn against hypes, techno-fix thinking, good news narratives and unverified assumptions. They also identify a need for rigorous evaluation, assessing social exclusion, frameworks for regulation and increased multi-sector cooperation.

Based on the experience with the prototype testing the authors also call for further elaboration of Practice as Research and other strategies / methodologies, which could enhance research and learning from interface design and development experiences.

The sustainable development and use of digital extension and training interfaces asks for interdisciplinary cross-overs, horizontal communication and social accountability of all the stakeholders involved ranging from veterinarians, to researchers, filmmakers, farmers and herders, extension staff and web designers.

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⁵ *Cocoa Training in Times of Ebola. Sunday Morning Reflections of Mohamed Fofanah* – <https://vimeo.com/161979325>.

⁶ *Digital Farmer Field School, a prototype for cocoa farmers in Sierra Leone* - <https://vimeo.com/173817252>.

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