GUI for Rural Farmers in Africa

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1 Introduction

Agriculture forms the backbone of Sub-Saharan Africa's economy, employing over 60% of its workforce and providing sustenance to millions. With approximately 33 million smallholder farms driving the region's agricultural output, farmers face unprecedented challenges that threaten food security, economic stability, and sustainable development (8; 27).

For our final project in the User-Interface Construction course, we chose to focus on the specific user group of rural farmers in Sub-Saharan Africa. This decision stemmed from two key considerations:

- African farmers represent a user group that is vastly different from our personal backgrounds. This distance allows us to approach the problem space objectively, minimizing bias and enabling us to analyze their core needs and challenges more effectively.
- Farmers in Sub-Saharan Africa face significant challenges, including climate unpredictability, crop diseases, limited access to education, and technological barriers. However, recent advancements in agricultural technology demonstrate that innovation has the potential to transform this industry, boost economic growth, and improve the lives of millions across the continent.

Recognizing this potential, we identified the need for a tool that facilitates the adoption of technology in farming—a sector deeply impacted by digital illiteracy. Ensuring usability is therefore a critical factor for creating an effective and impactful solution.

To establish a solid foundation for our prototype, we conducted an in-depth study of the target users and their specific requirements. The resulting framework focuses on usability, accessibility, and contextual relevance, ensuring our design resonates with the realities of rural farmers. You can access the detailed analysis and findings through this link.

1.1 Impact of Crop Diseases and Pests

Crop production is severely impacted by pests and diseases that target critical food crops. Aphids, Mosaic Disease, locusts and fall armyworms are only few examples of pests and diseases that often devastate African's plantations. Crop losses due to pests and diseases can range from 30% to 50% in some regions, significantly impacting livelihoods and food production (26).

Livestock farming represents another critical yet often overlooked dimension of agricultural sustainability in Sub-Saharan Africa. Beyond crop production, animal husbandry is a lifeline for millions of smallholder farmers, but it is fraught with complex health challenges that threaten economic stability and food security (5).

These biological challenges are compounded by broader systemic issues. Smallholder farmers struggle with limited access to quality seeds, prohibitively expensive farm inputs, and inadequate extension services. Climate change exacerbates these challenges, introducing unpredictable rainfall patterns and increasing the frequency of devastating droughts. Poor transportation infrastructure and land tenure insecurity further restrict farmers' ability to develop sustainable agricultural practices.

1.2 Current State of Agriculture and Technology Adoption

Despite owning a significant share of the world's arable and livestock-supporting land, Sub-Saharan Africa struggles with low agricultural productivity across crop and animal farming sectors. Nevertheless, digital agriculture, including mobile-based platforms, is emerging as a potential game-changer. However, technology adoption remains uneven due to barriers such as poor infrastructure, low digital literacy, and limited smartphone access (9).

Recent trends highlight efforts to introduce climate-smart agriculture (CSA) practices, which aim to boost resilience against environmental stressors while enhancing productivity. These practices often rely on basic digital tools, which have shown promise in improving decision-making and resource management. The adoption of smart farming technologies is gaining momentum, driven by collaborations among governments, research institutions, and private organizations (16; 27).

Although smartphone penetration in Sub-Saharan Africa lags behind global averages, significant improvements in telecommunications infrastructure have been observed in recent years. Mobile phone ownership has grown exponentially, with rural areas increasingly connected via 3G and 4G networks. Affordable smartphones and solar-powered charging solutions are reducing the technology gap, enabling even smallholder farmers to access critical information on crop health and pest management (17).

Mobile learning platforms tailored to local languages and literacy levels are particularly impactful, offering farmers the ability to learn on-demand. These solutions align with broader trends in digital agriculture, aiming to bridge the knowledge gap and empower farmers to embrace sustainable practices. By investing in mobile solutions and leveraging the increasing accessibility of technology, we can drive a shift toward smarter, more efficient agricultural systems.

2 Methods

2.1 Literature Research

2.1.1 Common Pests and Diseases

Animal diseases in Africa significantly impact livestock production and rural livelihoods, especially since many of these diseases are highly contagious. Common pests and diseases affecting animals in Africa include:

- Foot and Mouth Disease (FMD): Highly contagious viral disease affecting cattle, goats, and sheep (5) (21).
- African Animal Trypanosomiasis: Parasitic disease caused by Trypanosoma species, affecting various mammals (7).
- Contagious Bovine Pleuropneumonia (CBPP): Bacterial disease primarily affecting cattle(5) (21).
- Lumpy Skin Disease (LSD): Viral disease affecting cattle, sheep, and goats(5) (21). Peste des Petits Ruminants (PPR): Viral disease affecting goats and sheep (4).
- African Swine Fever: Viral disease affecting domestic and wild suids (4).
- Rift Valley Fever: Viral disease affecting ruminants, also zoonotic(4) (22).
- Contagious Caprine Pleuropneumonia (CCPP): Bacterial disease affecting goats(5) (21).
- East Coast Fever (ECF): Tick-borne disease affecting cattle(21).
- African Horse Sickness: Viral disease primarily affecting horses(4).

Plant diseases are another challenge for small farmers in Africa, often caused by viruses, bacteria, or fungi, which affect crop yields and food security. They can be divided in pests and diseases.

Common pests in Africa (33) (20):

- Aphids – Affect crops like maize, beans, and vegetables.
- Fall Armyworm – A major pest of maize and sorghum.
- Stem Borers – Damage cereal crops like maize and millet.
- Locusts – Cause large-scale defoliation, especially during outbreaks.

- Whiteflies – Affect cassava, transmitting diseases like Cassava Mosaic Virus.

Common diseases in Africa (20):

- Maize Lethal Necrosis – Affects maize crops across East Africa.
- Cassava Mosaic Disease – Severely impacts cassava yields.
- Banana Xanthomonas Wilt – Damages banana crops.
- Rice Blast – Affects rice in humid areas.
- Groundnut Rosette Disease – A major issue for groundnut farmers.

These pests and diseases can cause substantial economic losses due to decreased productivity, trade restrictions, and the cost of prevention and control measures(5) (22).

2.1.2 Challenges Faced by Small-Holder Farmers

Smallholder farmers in Africa face different challenges that significantly impact their agricultural productivity. Among the most prominent issues are climate change, limited access to technology, financial constraints, and infrastructural deficiencies. Unpredictable weather patterns, including prolonged droughts and intense floods, increase the chance of crop failures and reduce agricultural yields (36).

Moreover, education and training gaps prevent many from adopting innovative practices, leaving them reliant on traditional and often inefficient methods (37).

The digital divide, particularly in rural areas, also limits their ability to access real-time agricultural information and weather updates, crucial for decision-making in an increasingly volatile climate (34).

In summary, small-holder farmers struggle with the following challenges in addition to the key challenges identified in the beginning:

- Financial constraints and lack of credit facilities (10)
- Post-harvest losses due to inadequate storage (34)
- Disconnection from fair markets and exploitative middlemen (34)
- Poor infrastructure and transportation systems (10)
- Knowledge and education gaps in sustainable practices (37)
- The digital divide restricting access to information (34)

Despite these challenges, solutions are emerging. Organizations and governments are promoting climate-smart agricultural practices, enhancing access to financial services, and building infrastructure to connect farmers to markets. (37)

2.2 User

The main user persona for this system is a smallholder farmer in Central-Eastern Africa. Below is the persona table summarizing key attributes:

Attribute	**Details**
Name	John Mwangi
Age	45
Location	Rural Uganda, Central-Eastern Africa
Occupation	Smallholder Farmer
Education Level	Primary school education
Technological Experience	Limited; occasional use of simple smartphone for communication
Phone	Affordable Android (17; 31)
Farming Background	John has been farming for over 20 years, focusing on maize, beans, and poultry. He relies on traditional farming methods, with limited exposure to modern agricultural technologies.
Mental model	John prefers straightforward, cause-and-effect workflows and values practical advice that he can immediately apply to his farming practices. His mental model is grounded in understanding seasonal patterns and their impact on crops and livestock.
Challenges	• Limited access to reliable farming information, especially concerning pests and diseases. • Financial constraints
Goals and Needs	• Quick access to disease-related information • Simple and lightweight system • Support for decision-making

Table 1: User Persona: John Mwangi

2.3 Competitor Analysis

In order to analyze what existing mLearning apps in the fields of farming, plants, and animals offer as functionalities, we examined various existing or planned app projects as part of an adjusted competitor analysis.

Generally, a competitor analysis can help to understand the market and identify gaps, also from a marketing point of view (18). However, we mainly focused on using this tool by analyzing different functionalities.

In total, we collected ten applications and identified their key functionalities. The applications are the following:

- Agri ChatBot (6)
- PictureThis (28)
- Agriguru EdTech (2)
- CCARDESA (13)
- Haler Farmers (14)
- PlantVillage Nuru (32)
- Plantix - your crop doctor (15)
- Agrobase (12)
- Agrio (11)
- CattleEye (3)

A general finding was that there are many tools available for mLearning about plants but not about animals. The only software solution targeting animals is the last of the list, CattleEye (3), which uses cameras to detect a cow herd and abnormalities in their health through machine learning.

Of the nine other services, we identified that many offered some sort of messaging option with other farmers or experts in the form of chats or discussion forums, as, for example, seen in CCARDESA (13) or Haller Farmers (14). Agri ChatBot (6) also included weather information, while services such as PictureThis (28) or Plantix - Your crop doctor (15) focus on identifying plant diseases through pictures and providing tips on how to handle plants. Some also planned to use interactive courses or tutorials (6). Services such as Haller Farmers (14) or CCARDESA (13) offer learning through text, while the latter also uses quizzes. Plantix - Your crop doctor (15) helps you calculate the amount of fertilizer you need and also provides cultivation tips.

This competitor analysis helped us in understanding what features can be implemented and how we want to settle our own key tasks for the section 2.5.

2.4 Interaction Tool

Since rural farmers like our persona, John Mwangi, in Africa mainly buy more affordable Android models (17; 31) and based on technology experience, are mostly used to using these devices, the chosen interaction tool will be a GUI implemented for Android phone users. This ensures easy access for a high percentage of our user base.

2.5 Key Tasks

Based on the findings presented so far, we conclude that we will focus on an mLearning app for farmers about animals. We therefore do not focus on plants since there are already multiple solutions on the market, as seen in section 2.3.

To understand the key tasks, we created a basic Use Case diagram (fig. 1), which is informal and imprecise but defines the high level user functional requirements of a system (25). It is based on a scenario of our persona farmer John who wants to learn something about diseases every day, but also has a sick chicken where he wants to find out what might be wrong with it.

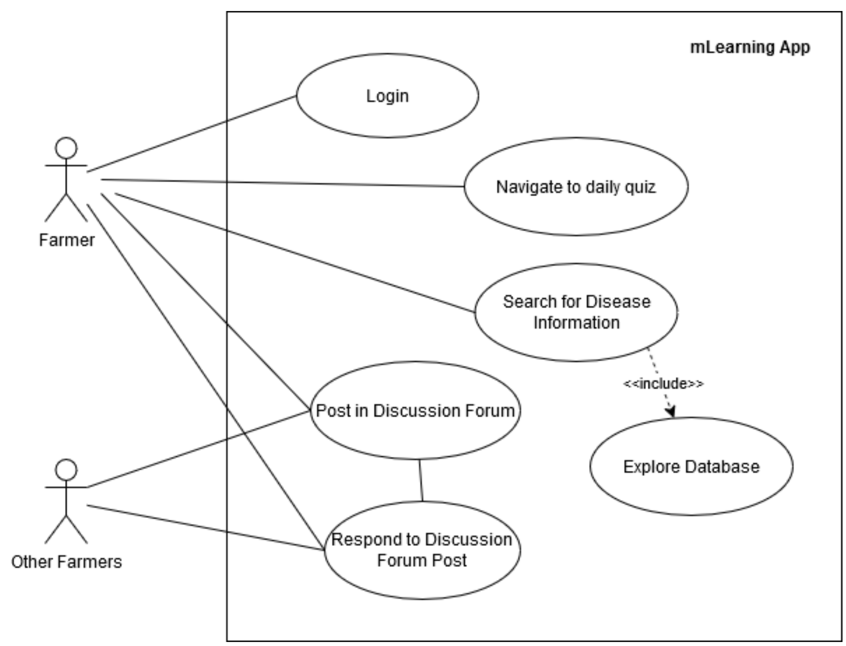

Figure 1: Use Case Diagram

The main tasks therefore include logging into the app, taking a daily quiz to learn about a specific disease where the user has to navigate to, browsing a database of collected diseases if specific information wants to be searched for and reading informational articles as part of the database, as well as participating in a discussion forum to reply to other farmer's posts and publish own posts.

Hence, we focus heavily on the learning aspects through gamification, reading information, and connecting with other farmers. The latter is important because, as described in the challenges, there is a shortage of veterinarians in Africa and farmers can help each other in this way.

2.6 Design Principles and Guidelines

Before starting our individual UI designs, we agreed to keep in mind the following design principles and guidelines.

2.6.1 Aesthetic and Minimalist Design (24)

Small-holder farmers may have limited experience with technology and are more likely to engage with an app that avoids clutter and focuses on essential tasks. Minimalism ensures that only the most critical information (e.g., pest identification or disease treatment) is presented, preventing cognitive overload.

2.6.2 Consistency (29)

Consistency helps users predict interactions and reduces learning time. Farmers who may not be familiar with apps benefit from uniform icons, buttons, and language, making navigation feel natural and intuitive.

2.6.3 Recognition Over Recall (24)

Many farmers may not remember pest names or technical terms, especially in a second language. A recognition-based UI allows users to recognize information (e.g., images of pests) rather than recall names or data. This reduces the cognitive burden on users with limited literacy or technological experience.

2.6.4 Visibility of System Status (24)

Providing feedback on user actions helps build trust and confidence in the system. Farmers need to know what the app is doing, especially when dealing with slow internet connections or processing delays. Visibility prevents frustration caused by uncertainty.

2.6.5 Error Prevention and Recovery (29)

Mistakes are inevitable, especially for users unfamiliar with technology. Designing to prevent errors or allow easy recovery ensures a smoother user experience. Farmers can quickly fix mistakes (like selecting the wrong pest) without restarting, reducing frustration.

2.6.6 Match Between System and the Real World (24)

Farmers are familiar with specific tools, crops, and pests in their everyday lives. By mimicking these real-world concepts in the UI, the app becomes more intuitive and relatable. This bridges the gap between their mental model and the app's design.

2.6.7 Minimal Input Actions by User (30)

Many farmers may struggle with typing on a mobile device, especially in rural environments where precise input is difficult. Minimizing input complexity ensures that users can interact with the app effectively. Simplifies the interaction for users with varying levels of literacy and tech skills.

2.6.8 Offer informative feedback (29)

Farmers may face uncertainty when using the app for the first time. Providing clear feedback and accessible help ensures they can complete tasks without external assistance. This builds confidence and encourages continued use of the app.

2.6.9 Summary

These principles were chosen because they directly address the key challenges faced by small-holder farmers. Low literacy levels are addressed through principles like Recognition Over Recall, which make the app accessible to users regardless of their reading or writing skills. Limited technology experience is mitigated by principles such as Minimal Input Actions by User, Aesthetic and Minimalist Design, and Consistency, which help reduce cognitive load and make the interface more intuitive. Minimal Input Actions by User is needed to streamline workflows and allow users to complete essential actions efficiently. Real-world constraints, such as limited access to advanced devices, are tackled through Error Prevention and Visibility of System Status, ensuring a more seamless experience in rural environments. By focusing on these principles, the mLearning app will effectively meet the needs of small-holder farmers while promoting ease of adoption, long-term usability, and meaningful outcomes.

Although we mainly focused on these aspects at the beginning, it was inevitable that each one of us might have followed other design principles and guidelines. If that is the case, it will be possible to read about more details in our individual projects.

3 Results

3.1 Interaction Solution

Our interaction solution was designed with the user interface development environment Figma and will be described in sections based on the key main features.

The clickable prototype can be found through this link: Figma Link

3.1.1 Authentication and Profile

The description of the applied design principles and guidelines for the authentication page and profile page is based on Gianluca Romeo's individual report.

All the page's layouts were revised for Android Compact compatibility, with updates to fonts, icons, and colors to improve clarity and maintain the app's visual identity.

The Login Page (Fig. 2) adheres to principles of Feedback (24), Visibility of System Status (24), and Consistency (29). In redesigning these screen, the focus was on ensuring clear, actionable feedback for users. For example, consistent visual cues such as uniform icons and a minimalist layout were implemented to enhance Learnability (35). Fonts, colors, and icons were refined to align with the app's aesthetic, providing a more visually cohesive experience.

The Sign-up Page follows the principles of Error Prevention (29), Feedback (24), Consistency (29), and progressive disclosure. By limiting the input fields to essential information (name, email, and password), the interface requires Minimal Input Actions by User (30).

The Code Confirmation Page incorporates Feedback (24), Error Prevention (29), Visibility of System Status (24). To ensure users understand their progress and any errors encountered, descriptive text and clear status updates were added. This approach aligns with the principle of offering informative Feedback (24), helping users navigate the process confidently.

The Profile Page (Fig. 3) applies the principles of Feedback (24), Visibility of System Status (24), and Consistency (29). The design highlights key user details while ensuring a clean layout. Consistent visual elements such as fonts and colors were updated to enhance usability. Adjustments included removing unnecessary features like "Saved Articles" and "Saved Discussions" to maintain focus on essential tasks.

The Logout Mechanism (Fig. 3) emphasizes Feedback (24). Users are given clear and immediate Feedback (24) upon initiating the logout process, ensuring transparency and control. The layout's minimalism reduces potential confusion while retaining essential functionality. Updates included refining fonts and colors to ensure Consistency (29) with other screens.

The Personal Data Page (Fig. 4) adheres to principles of Visibility of System Status (24), Feedback (24), and Consistency (29). Users can view and verify their information with system Feedback (24) ensuring clarity.

The Edit Personal Data Page (Fig. 4) focuses on Error Prevention (29), Feedback (24), and Visibility of System Status (24). Inline Feedback (24) and clear prompts were incorporated to guide users while editing their details. The design prioritizes Error Prevention (29) by validating inputs in real-time. Visual updates, including adjustments to fonts and colors, enhance readability and ensure Consistency (29) with other pages.

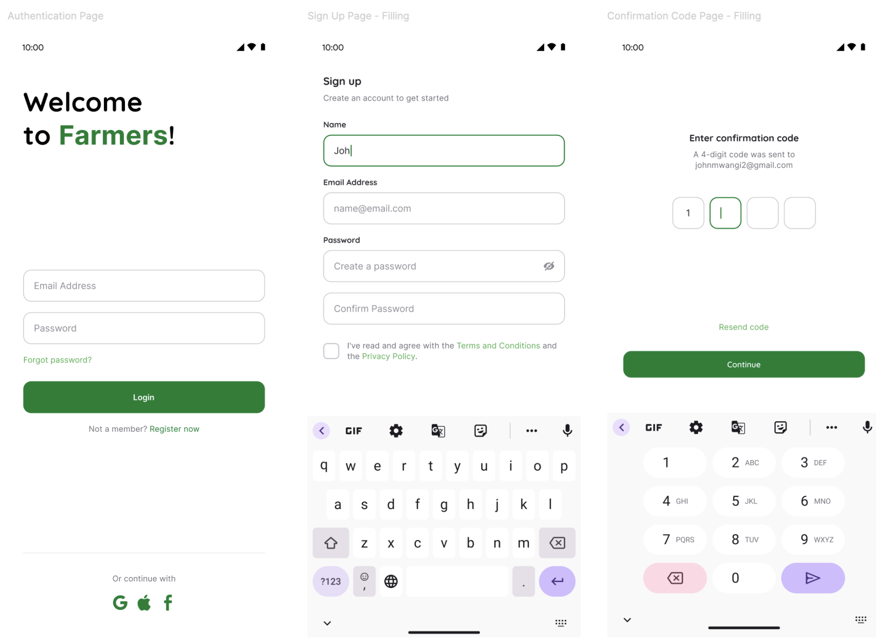

Figure 2: Authentication Page (left to right: Login, Sign-up, Code Confirmation)

3.1.2 Home Page and Database Search

The description of the applied design principles and guidelines for the home page and database is based on Kristina Todorova's individual report.

The challenge for designing the main page of the app was to find a way to present the information and available services in a simple and intuitive way that would correspond to the chosen persona's mental model.

For the cards displaying the different animal categories, the Law of Proximity was applied to group related items under distinct visual cards. This makes it easier for users to scan and associate images and labels (40). In the same component, the Law of Common Region was also used by placing each animal within clearly defined cards with a consistent green outline when selected. This creates a visual boundary to ensure the users recognize the selected state effectively, which also corresponds to the heuristic of Visibility of System Status (24). This heuristic applies as well to the feature of adding favorite animals, which changes the color of the heart icon when selected to inform the user about the current state.

In the filter selection screen, Gestalt principles were applied by using check boxes and consistent icons for "Animals" and "Symptoms," making it easy for users to recognize interactive elements as part of the same category (40). Furthermore, Shneiderman's principle of Shortcuts for Frequent Users was imple-

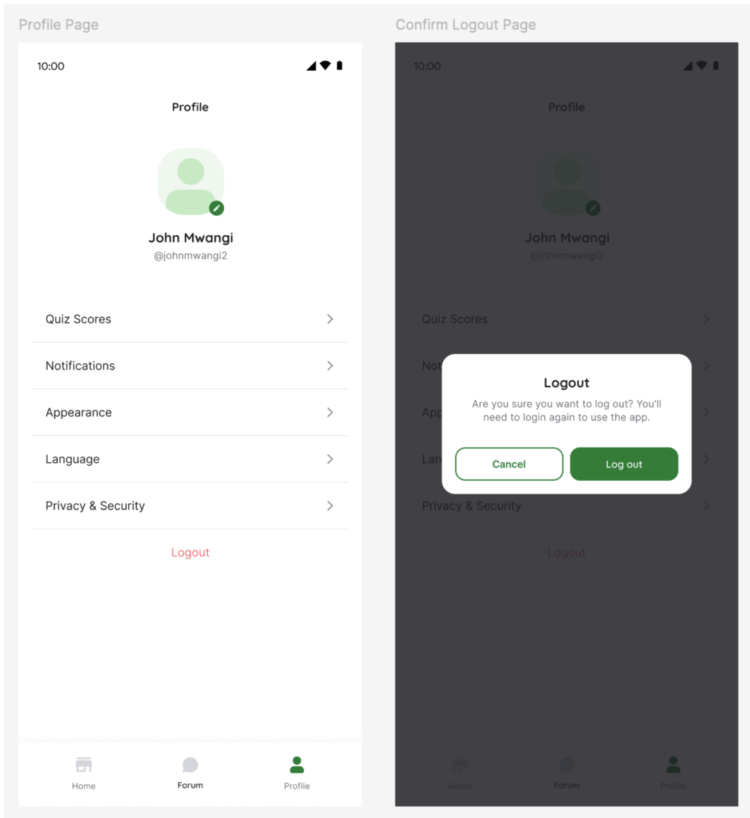

Figure 3: Profile Page (left to right: Profile, Logout Confirmation)

mented with the "Clear all" button, which allows users to reset filters quickly instead of manually deselecting each one (29). Error prevention was also considered and the page is clearly indicating which filters are active through green highlights and check marks. This minimizes confusion about applied filters. (24)

Finally, for displaying the search results, the consistency in the design was maintained by using the same card structure, filter tags and spacing throughout the results. This consistency aligns with Shneiderman's rule to keep the interface predictable. (29)

The selected filters from the previous page are shown on this page as well in order to minimize the cognitive load and support recognition rather than recall - users do not have to remember which filters were applied, as they are always visible (24).

In general, the design follows a minimalist and clean design that prioritizes clear information hierarchy by using critical elements such as search results, tags, and filters using font size, color, and spacing to make sure users focus on

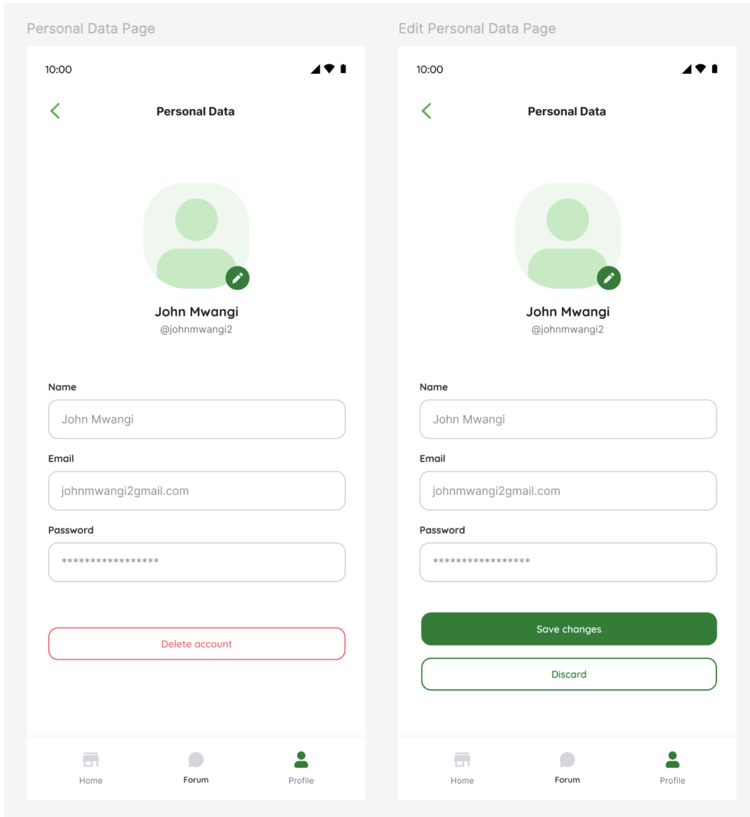

Figure 4: Personal Data Page (left to right: Overview, Edit)

the most important content first.

3.1.3 Articles

The description of the applied design principles and guidelines for the discussion forum is based on Andrea Micheli's individual report.

The main challenge for this screen (fig. 8) was to properly organize the content, which had several different domains and hierarchies.

The core concept was to design the interface as a simple vertical page displaying static information, emphasizing contemplation over interaction. This approach highlights the learning purpose of the page and establishes its role as the "ending point" of the application's overall flow. Vertical scrolling without significant interactions aligns with the mental model(29) of reading a book, newspaper(19), or message—activities familiar to the user group and more intuitive compared to engaging with dynamic technology(8).

Gestalt rules(29) have been implemented to help the user identifying different

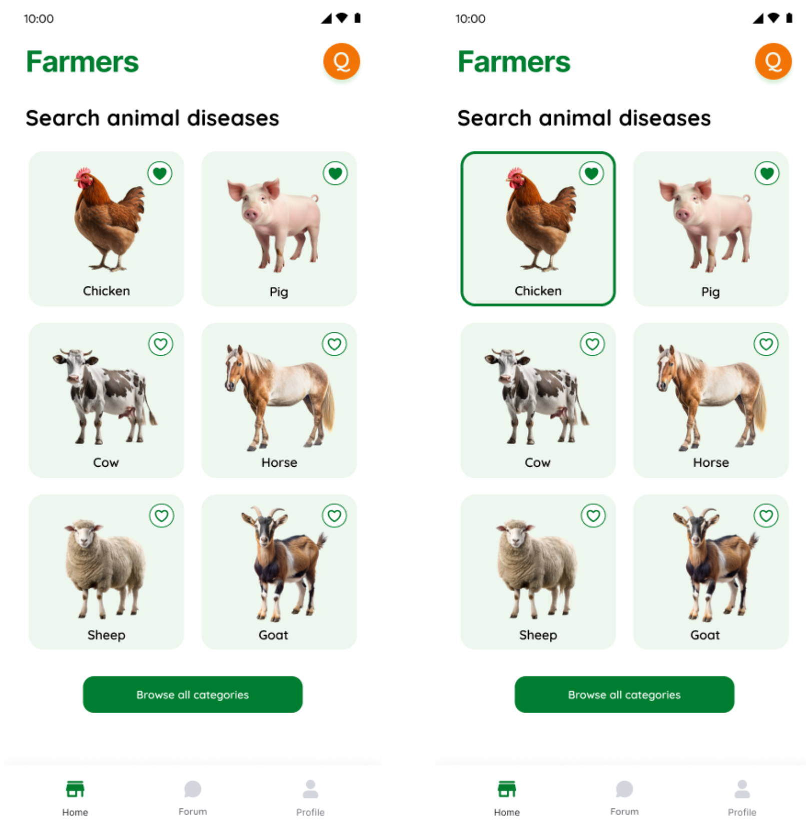

Figure 5: Home page

elements of the interface, with emphasis on the margin between components that creates whitespace, essential for establishing hierarchy of contents. This layout approach also converges with Nielsen's Aesthetic and Minimalist Design(24), excluding unneces- sary elements.

To further emphasize the separation of contexts, three different but complementary guidelines were leveraged: Law of Common Region(39), Law of Proximity(40), Law of Similarity(41). The law of Common Region states that when components are located within the same closed region, they are seen as a group, and "Adding a border around an element or group of elements is an easy way to create common region". The law of Proximity states that when components are close to each other, they are seen as a group. The law of Similarity, lastly, states that components that look the same are considered to be a group. All of these concepts helped to give more structure and readability to the layout, especially to the last sections, that were broken down in modular cards that enhance clarity and recognition, fundamental in a mobile learning app.

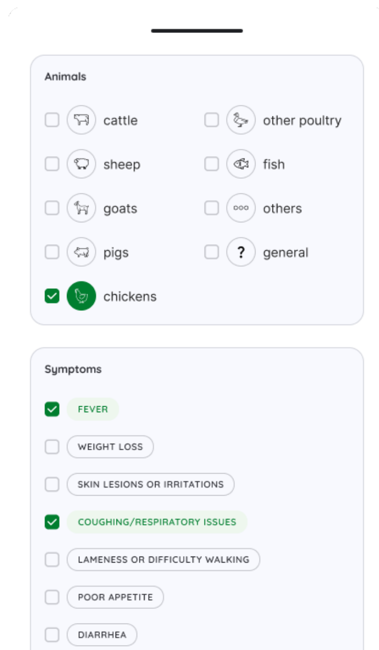

Figure 6: Filter selection screen

The implementation of visual sliders to represent complex data such as danger level, contagion risk and rarity of the disease has been guided by Tufte's 'The Visual Display of Quantitative Information'(**?**), which affirms that sliders enable users to understand multi-dimensional data through visual cues, such as color coding and level indicators, which can convey trends and relationships more effectively than static numbers or text. This visual solution addresses also the "Recognition Over Recall" Heuristic (24), a fundamental aspect for the gamified approach of the application.

Lastly, incorporating multiple images enhances content organization, particularly when the text may become overly detailed or dense. The text itself has been carefully designed to remain simple and clear, adhering to Morville and Rosenfeld's(23) guidelines for using jargon-free language. This approach is especially crucial for this specific user group.

3.1.4 Discussion Forum

The description of the applied design principles and guidelines for the discussion forum is based on Sarah Sommerschuh's individual report.

In the overview screen of the discussion forum (Fig. 9), Aesthetic and Minimalist Design (24) is applied by avoiding clutter and highlighting only the

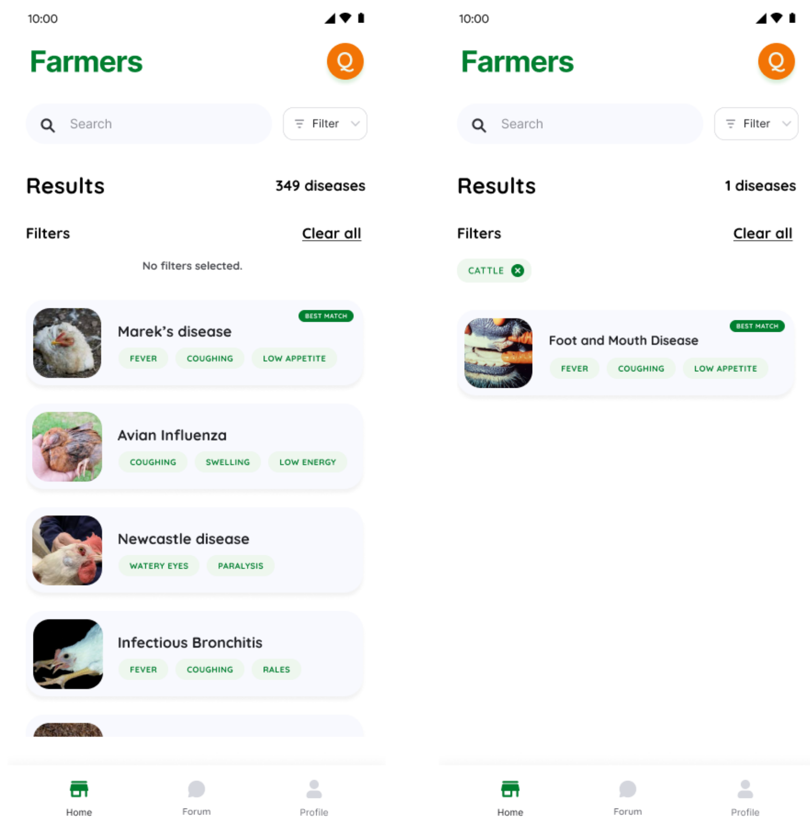

Figure 7: Search results page

important aspects. If there is no post available yet, a text in the center of the display will let the user know. If there is a post, the reduced clutter highlights the selected symptoms, the selected animal category, the title and the image of each post to stand out in the hierarchy.

Moreover, the chosen color coding of light green highlighting a symptom and dark green highlighting an animal category helps in linking colors to user tasks and group them as related items (29). Additionally, the primary "+ New" button is being filled with the dark green color as well, which supports Visibility of System Status since the it conveys an enabled style (24).

Giving the user both the option to search with free text and select filters also follows the Match Between System and the Real World (24) since it can address and help users with low literacy.

This aspect is also highlighted in the filter modal that shows the different animal categories and symptoms that can be filtered on (Fig. 10). Selecting items by simple finger presses instead of heaving to type them in the search bar also supports Minimal Input Actions by Users (29). Having a selected item's

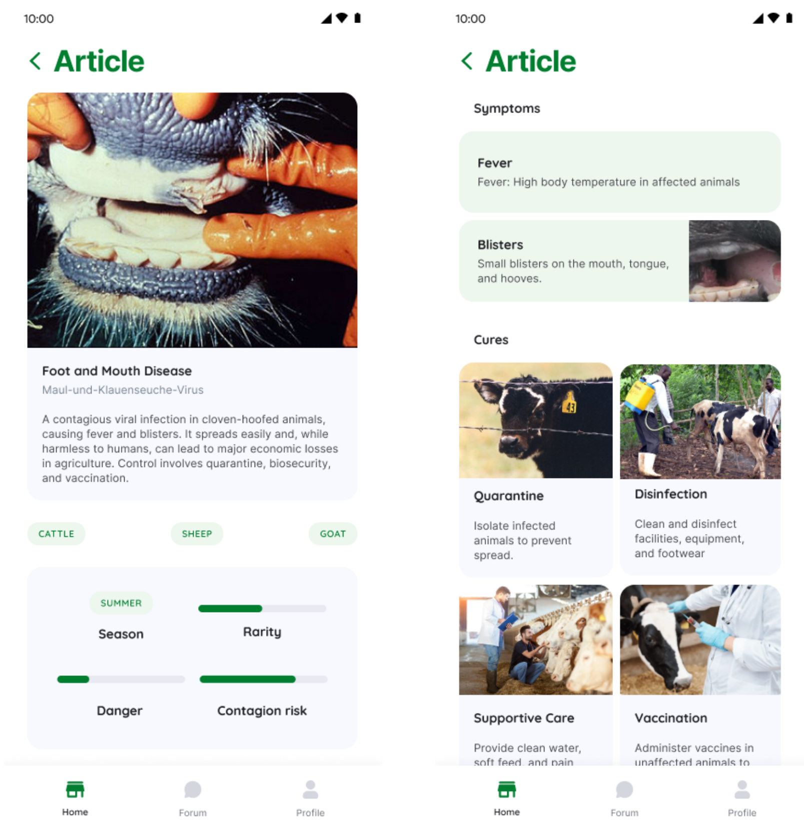

Figure 8: Article view

color change and using the checkbox as a common component offers Informative Feedback on what has been selected (38).

Reusing the same color coding and icons also supports Consistency in the design, which is an important design principle highlighted by many such as by Shneiderman's 8 Golden Rules (38) or Tog's principles (35), which reduces learning over time.

Placing related items closer together in proximity and using a similar design also helps in grouping them together visually, thereby following the Gestalt Rules (1).

When creating a new post (Fig. 11), a position marker on top is used to provide a visual representation of where the user is in the linear sequence of the menu (29).

For entering a title, a description, and uploading picture(s), the design is very minimal and reduced (24), which helps in focusing the user's attention to the necessary input and uploading fields. Errors are being prevented by showing how many characters are still available and successfully uploaded pictures are

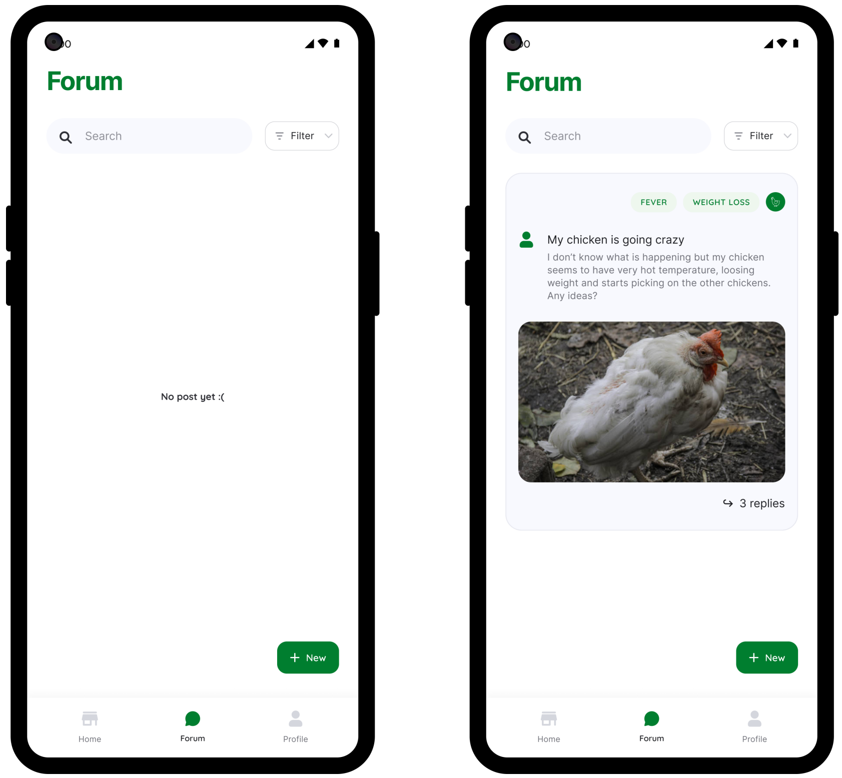

Figure 9: Discussion Forum: Overview

shown with a green dashed boarder, supporting the Visibility of System Status (29; 24).

Additionally, the “Continue” button on the bottom right is initially grayed out to visually show it is disabled. This helps in preventing errors (29). Only when at least a title and description have been given will the button turn enabled.

Canceling the create post process by either clicking on the chevron on the left top corner or clicking on the ”Cancel” button will immediately lead back to the forum overview if no data was provided. The moment one of the input fields has entered text or an image has been uploaded, a popup (Fig. 12) will ask if the action really wants to be canceled. This is to prevent the users from errors (29).

For selecting the categories (Fig. 13), the same structure as for the filter is used, apart from different title labels. This enhances consistency (38; 35).

The last step of creating a new post as seen on the left side of Fig. 14 features a summary of the entered data by showing how a preview of the post would look like and allowing the user to go back if necessary to edit parts. This

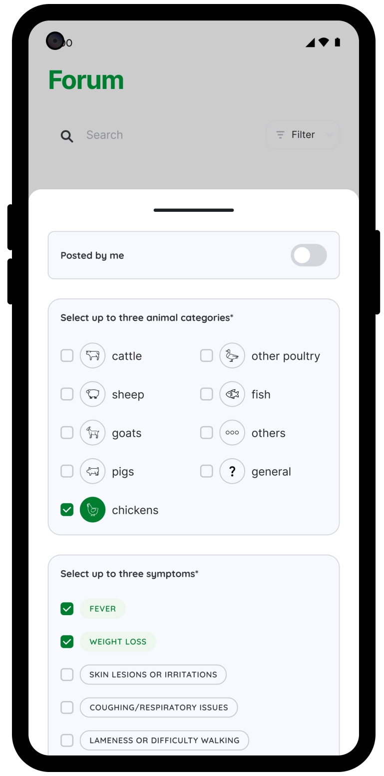

Figure 10: Discussion Forum: Filters

again highlights error prevention and consistency in visually displaying how the post will look like (29; 24).

When clicked on a specific blog post as seen on the right side of Fig. 14, the user sees the same layout but with the replies listed below. The replies have a similar visual appearance as the actual title and description of the post but are shown as cards with a different background color.

The "Reply" field has the same visual appearance as the input field for the title of a post which supports consistency (Wong, 2024; Tognazzini, 2014). A picture icon as similarily used in popular chat apps builds on the knowledge and mental user of the model and therefore Matches Between System and the Real World (24).

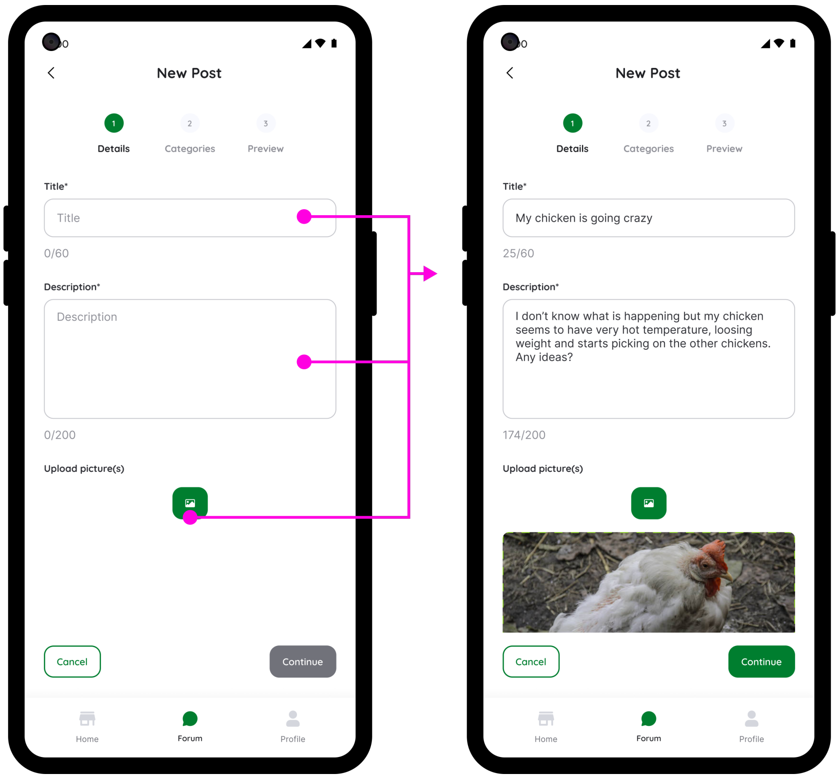

Figure 11: Discussion Forum: Details of New Post

3.1.5 Quiz

The description of the applied design principles and guidelines for the discussion forum is based on Christina Wanke's individual report.
The Start Screen (figure 15) introduces the Daily Quiz feature in a visually engaging and minimalistic way. It uses vibrant orange to distinguish this section from the rest of the app, adding a sense of fun while maintaining the familiar button styles and green color scheme for consistency (29). The interface avoids clutter and highlights only essential elements, such as the "Let's Go" button and a brief welcome message, adhering to the principle of Aesthetic and Minimalist Design (24). This reduces cognitive overload for farmers with limited technological experience and ensures clarity. Additionally, the floating action bubble on the home page provides easy access to the Daily Quiz, aligning with Minimal Input Actions by User to streamline navigation (30).
In order to not overwhelm the users with sudden questions there is a screen (figure 16) where a brief introduction to the asked about topic can be found. To finally start the quiz the "Start Quiz" button has to be pressed.

The quiz questions (figure 17) are designed to promote learning through sim-

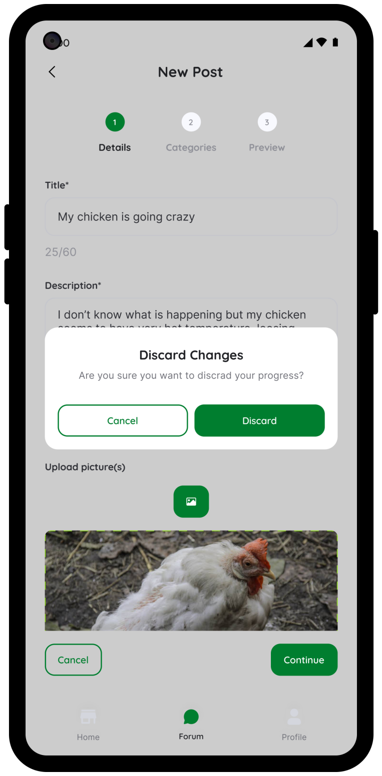

Figure 12: Discussion Forum: Popup

ple, interactive multiple-choice formats with image-based options. This applies the principle of Recognition Over Recall(24), as farmers can recognize visual cues (e.g., images of pests or diseases) rather than needing to remember technical terms. Each question screen maintains a consistent layout with uniform button styles and navigation indicators, supporting the principle of Consistency (29). By presenting one question at a time, the interface prevents overwhelming users. This approach ensures a smooth and predictable experience while reducing the cognitive burden for users (24).

Once a farmer submits an answer, immediate feedback is provided through a modal (figure 18), highlighting whether the response was correct or incorrect. This adheres to the principle of Visibility of System Status (24), as farmers can see the system's response to their input in real time, building trust and confidence. Detailed explanations, including images and concise text, are presented after each question. This bridges the gap between the system and the real world by using familiar visuals and relatable content. By offering informative feedback, the app supports learning while minimizing frustration.

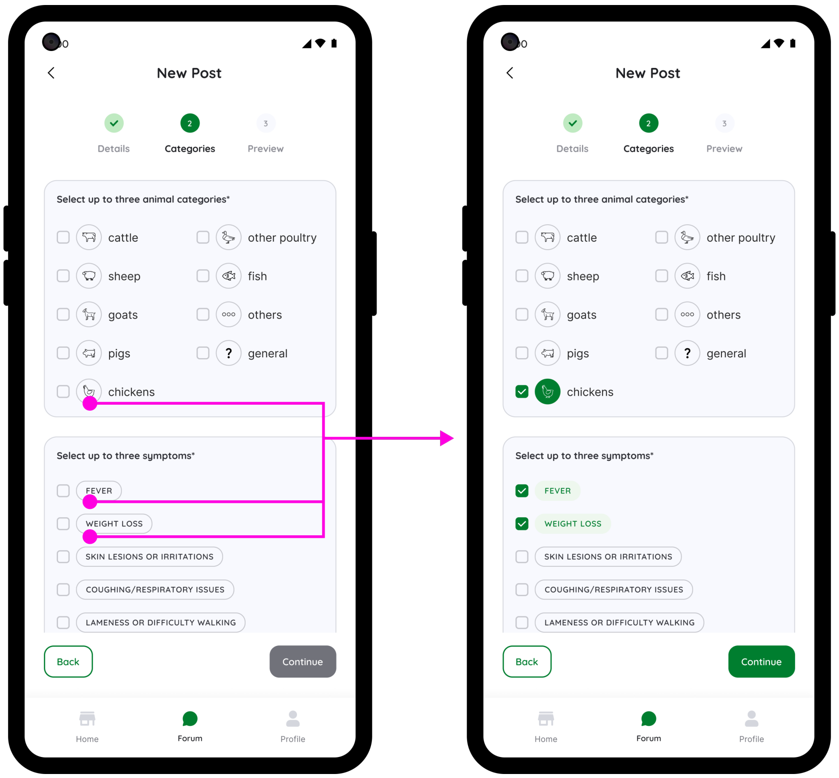

Figure 13: Discussion Forum: Categories of New Post

The final screen (figure 19) congratulates users upon completing the quiz and reinforces their learning streak. A "Well Done!" message, combined with celebratory visuals, provides positive reinforcement and motivates continued use of the feature. This incorporates the principle of Offer Informative Feedback (29) by summarizing the user's progress and encouraging further engagement. Additionally, farmers are prompted to read a relevant article about the quiz topic, offering an opportunity to explore deeper learning. This design keeps actions simple and aligns with Minimal Input Actions by User (30), allowing users to continue learning without complex navigation or extra effort.

3.2 Individual Contributions

We decided to divide the work by the key main features and assigned one feature per person.

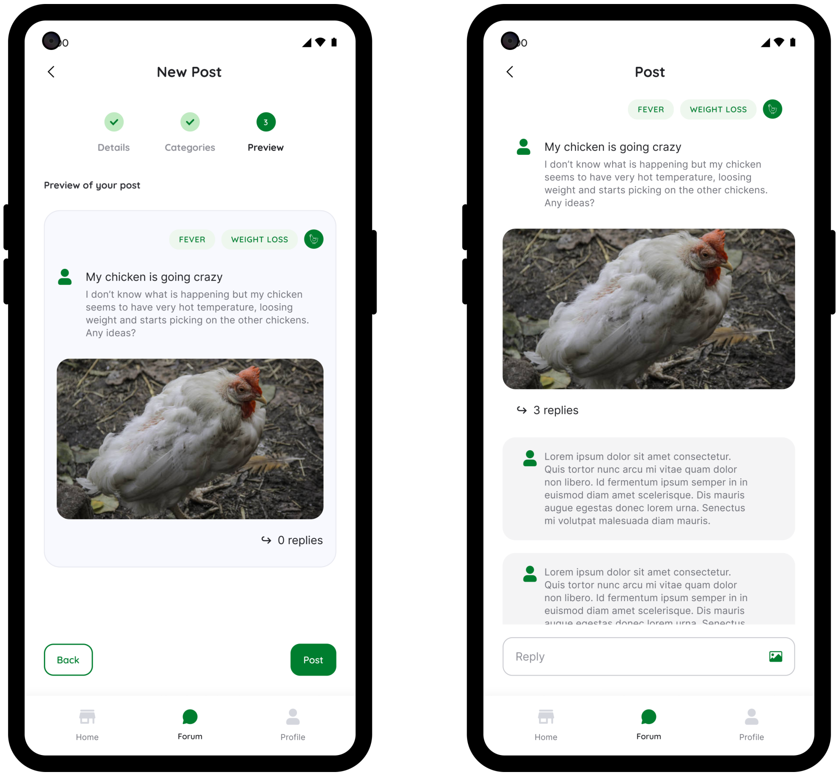

Figure 14: Discussion Forum: Preview of New Post and Clicking on Existing Post

3.2.1 Features

Each team member played a critical role in both the development and refinement of our platform, bringing strengths and perspectives that contributed to the final outcome.

Gianluca Romeo focused on implementing the authentication and user profile features. In addition to this technical contribution, Gianluca initiated the design system by sourcing resources such as libraries, components, and color palettes in Figma. This served as the base for creating a consistent and visually appealing interface.

Kristina Todorova was responsible for setting up the database page. Beyond the technical scope, Kristina conducted literature research on the common challenges and needs of our target audience, which provided a strong foundation for aligning the app's features with user requirements.

Andrea Micheli developed the articles section, enabling users to access relevant content seamlessly. Andrea also took the lead in defining our target group, creating detailed personas to guide the design process. This user-centric ap-

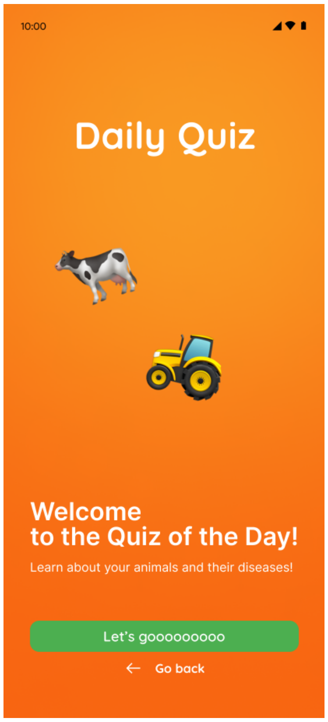

Figure 15: Quiz: Start Screen

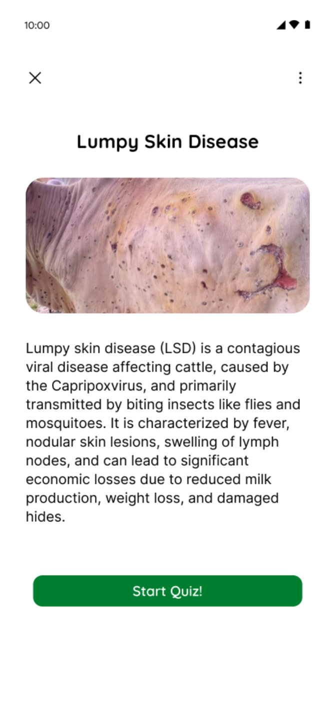

Figure 16: Quiz: Quick Topic Explanation

proach ensured that our design decisions were informed by a clear understanding of end-user needs and expectations.

Sarah Sommerschuh managed the forum functionality, allowing users to engage in discussions and share experiences. Additionally, Sarah played a pivotal role in project management, organizing group meetings, dividing tasks to maintain workflow efficiency, and providing other members with feedback and areas of improvements.

Christina Wanke designed the quiz feature, an interactive and educational component of the app. She also updated the design system and set up the collaborative Figma workspace, ensuring that all team members had access to a well-organized platform for design collaboration and asset creation.

3.2.2 Group work

Our collective efforts extended beyond individual assignments, as the team actively collaborated to ensure cohesion across the platform. For example, we combined multiple viewpoints to create a logical and user-friendly layout in designing the navigation bar. Also, we agreed to include the quiz as a fixed icon button in the top-right corner, ensuring easy access for users.

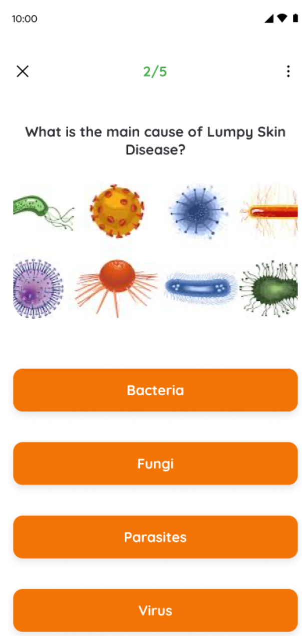

Figure 17: Quiz: Question

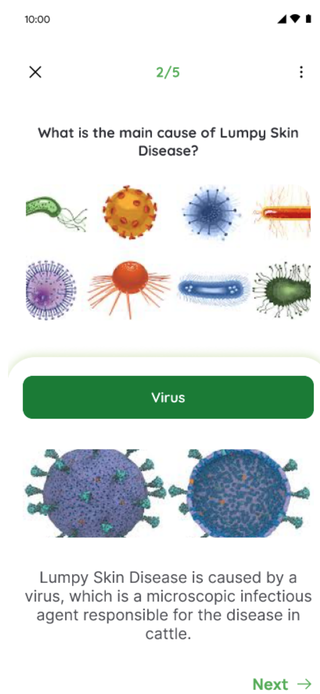

Figure 18: Quiz: Explanation to Question

Throughout the process, we followed a shared style guide to maintain consistency across all sections. Regular feedback sessions allowed us to critique and refine each other's work, highlighting areas for improvement and recognizing what already aligned well. Helping each other with Figma tasks, such as working with components or sharing design recommendations, strengthened our teamwork and accelerated progress.

By incorporating diverse perspectives and fostering an environment of collaboration, we delivered a platform that reflects the strengths and input of every team member. The combination of individual expertise and collective decisions resulted in a well-rounded, user-focused product.

3.3 Video

A video showcasing our interaction can be found here: https://youtu.be/YJ1XL3XhtDA

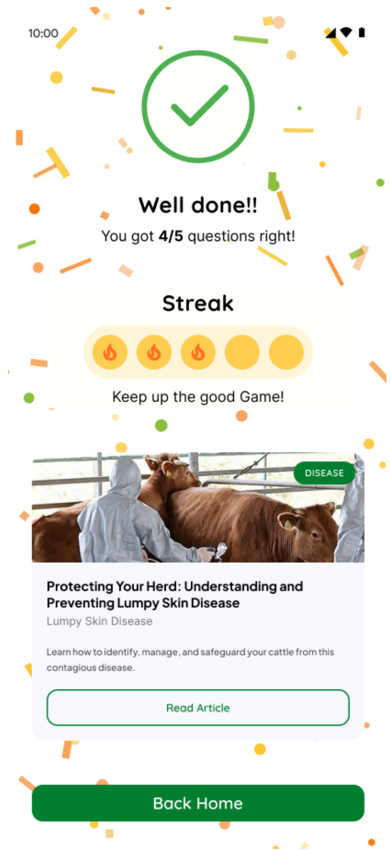

Figure 19: Quiz: Final Screen

4 Discussion

4.1 Limitations

The project faced several notable limitations that impacted its ability to fully align with the needs of the target user group—rural farmers in Sub-Saharan Africa. One significant limitation stems from the reliance on secondary data to model the user group, as logistical and technical challenges prevented direct interaction with African farmers. Developing an accurate understanding of user needs requires iterative contact with the end users to reduce biases and ensure alignment with their real-world challenges (29). This gap is particularly evident in the 2.b Persona section, where the farmers' characteristics and behaviors were inferred solely from online resources. As a result, there is a risk that certain assumptions about user needs or priorities may be misaligned with reality, limiting the project's practical relevance.

Another key limitation lies in the lack of field testing during the development phase. The interaction solutions presented in the project were conceptualized without conducting field studies or gathering feedback directly from farmers. HCI literature emphasizes the importance of iterative design processes, which include repeated validation with the user group to ensure usability and relevance. Without these critical feedback loops, the proposed solutions remain untested against the actual contexts in which they are meant to operate. This limits confidence in the design's ability to meet user expectations effectively.

Finally, the technological landscape in Sub-Saharan Africa presents a significant challenge. While the introduction acknowledges recent technological advancements in the region, the reality remains that limited internet access, low smartphone penetration, and poor infrastructure continue to constrain widespread adoption of technology. The development of a graphical user interface (GUI), though aligned with course requirements, may not be the most feasible solution for immediate implementation. The current technological limitations suggest that while the GUI is forward-thinking, it may not address the pressing needs of farmers today and is better suited to a future where digital literacy and infrastructure show further improvement (17).

4.2 Further Developments

To address the aforementioned limitations and enhance the project's scalability and impact, several developments are proposed for future iterations. Implementing offline support for the GUI would significantly enhance usability. Allowing users to download relevant data for offline access would reduce dependence on unstable or limited internet connectivity. This functionality would ensure that farmers in remote areas could still benefit from the tool without constant reliance on network availability, addressing a core infrastructural barrier.

Beyond accessibility improvements, several features could further enhance the tool's usability and engagement. The ability to save and access articles would enable farmers to revisit important information at their convenience, improving knowledge retention. A feature for connecting with practitioners or experts in the field—potentially integrated with the project's forum section—could create opportunities for direct communication and problem-solving. This would help bridge the gap between theory and practice, offering farmers actionable support tailored to their specific challenges.

Lastly, enhancing the project's gamification approach could encourage sustained user engagement. Introducing elements such as leaderboards, team challenges, and opportunities for interaction with other users could make the tool more engaging and dynamic. By fostering a sense of competition and community, these features could incentivize farmers to use the tool more consistently, thereby maximizing its impact.

To ensure long-term success, future iterations of the project should include field validation and iterative design processes. Conducting on-site studies and engaging directly with rural farmers would provide invaluable insights into their needs, behaviors, and challenges. Feedback gathered through these interactions would enable the team to refine the design, ensuring it aligns more closely with the realities of the user group. This approach would not only improve usability but also increase the likelihood of the tool being widely adopted and delivering meaningful impact.

By addressing these limitations and pursuing the proposed developments, the project has the potential to evolve into a practical, scalable solution that empowers rural farmers in Sub-Saharan Africa to overcome challenges and embrace technological advancements in their work.

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