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Homegrown: Design and Development of a Technology Solution for Farm Management in an Emergent Local Food Network

A thesis submitted to the Graduate School of the University of Cincinnati in partial fulfillment of the requirements for the degree of

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By
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Abstract

In today's increasingly urbanized world, the intersection of technology and agriculture presents opportunities to design innovative solutions to address food insecurity and promote community wellness. Within this context, urban farming emerges as a promising avenue, particularly for marginalized communities seeking to reclaim control over their food systems and to foster sustainability. This study lies at the intersection the technology, urban farming, and wellness. Through this study, we aim to co-design a technology solution with Black urban farmers in Cincinnati to meet the nutritional needs of Black pregnant individuals in the area. First, we conducted needs assessment activities with the farmers to identify key pain points. Then, we designed and developed a technology solution - Homegrown Dashboards. These interactive dashboards, with a web front-end, enables farmers to track crops and land usage, manage events and contracts, and share crops based on demand and supply within the network. Multiple iterations, from paper prototyping to implementation of the dashboards, we incorporated feedback from farmers to ensure usability and user experience. The interactive dashboards promote collaboration, streamline operations, and enhance efficiency, contributing to improved sustainability and resilience within the local food network. This study demonstrates a novel approach of co-designing technology solution with Black urban farmers to address their specific needs and challenges, highlighting the importance of participatory approaches in technology development for social impact.

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Chapter 1

Introduction

1.1 Background

The integration of technology into various facets of society presents boundless opportunities for addressing pressing social issues. Among these, urban agriculture stands out as a domain ripe for technological innovation. It helps with mitigating the logistical and equity challenges faced by marginalized urban farmers, including BIPOC (Black, Indigenous, and People of Color) individuals and novice growers. These stakeholders encounter multifaceted barriers stemming from social, political, and economic factors that hinder their ability to establish and sustainably operate within competitive urban landscapes. Structural impediments such as limited access to capital, insecure land tenure, and restricted market entry exacerbate their plight, perpetuating a cycle of marginalization and resource scarcity [1].

Urban agriculture is emerging as a promising avenue for addressing food justice [2]. In today's rapidly advancing technological landscape, integrating innovative solutions becomes imperative for enhancing agricultural practices. Technology has proven itself to be an accelerator for improved efficiency and strategic planning, offering tools for streamlined operations and resource optimization [3] [4]. Leverag-

ing technological advancements can help Black urban farmers overcome challenges in farm management. Hence, it becomes a priority to explore how technology can support the efforts of Black urban farmers in navigating the complexities of farm management. While urban agriculture offers various social benefits, including food security and community development, its potential to promote food justice hinges on equitable access and empowerment for all communities [2].

However, without careful consideration, urban agriculture initiatives may unintentionally worsen existing inequalities, particularly for marginalized groups. The intersection of planning, food justice, and urban agriculture underscores the need for technology solutions that prioritize the needs and challenges faced by Black urban farmers. By applying technology, we can enhance farm management practices, streamline operations, and empower farmers to navigate systemic barriers while promoting economic autonomy and social equity within urban agricultural spaces.

In many cities across the United States, Black-led urban farms play a crucial role in addressing inequitable conditions within low-income Black communities. These farms serve as pillars of community resilience and empowerment, utilizing food cultivation as a tool for social change. As highlighted in recent research [5], Black-led urban farms enhance community survival and well-being by inculcating local Black place-making, boosting racial and personal healing, and opposing systems of exploitation such as racial capitalism.

This study delves into the potential of technology in supporting farm management and sustainable collaboration among Black urban farms. An emerging local food network (LFN) is taking root in the heart of Cincinnati, Ohio, with the collective efforts of 3 Black urban farmers. These farmers are working towards shared goals, aiming to improve access to fresh and nutritious food for local pregnant Black individuals. However, several challenges hinder their sustainable collaboration. Through this study, our humble effort is to contribute towards enhanced farm and inventory management practices and improved collaboration between the farm-

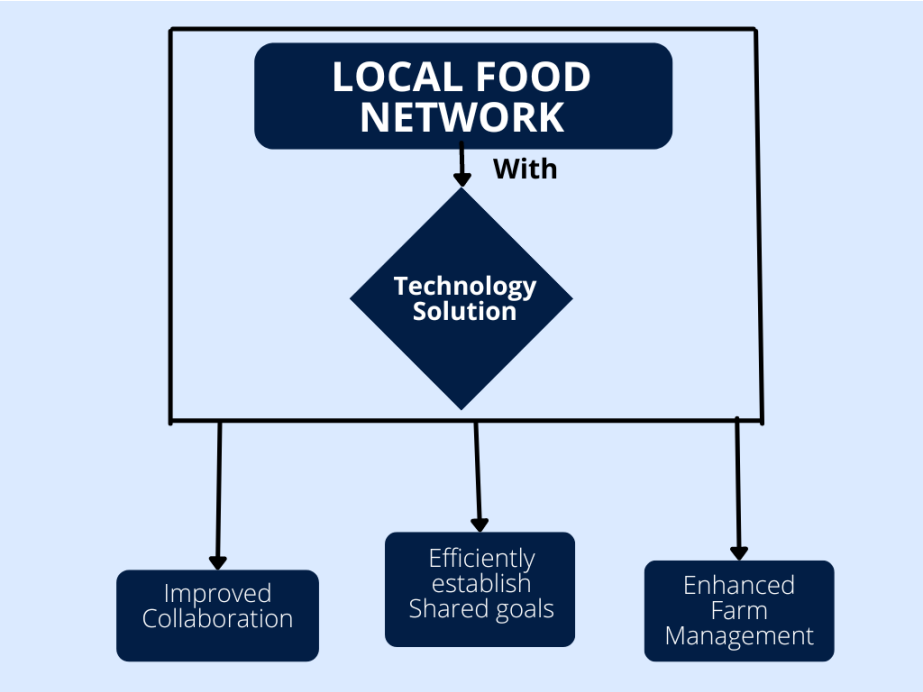


Figure 1.1: Overview of the Research Study

ers to help them easily fulfill their goals. Figure 1.1 shows the visual representation of the overview of our study.

The primary objective is the design of a technology solution tailored to facilitate individual farm management and enhance communication and collaboration across this LFN, thus contributing to the key goals of a groundbreaking research study - *Homegrown: Cultivating Black Maternal Agency and Community Capacity for Healthy Futures*. Homegrown, an applied research study led by an interdisciplinary team of researchers at the University of Cinicinnati, encompasses three core components: the Nutrition Education Program (NEP), aimed at improving Black maternal and birth outcomes; the LFN, for supporting enhanced farm management and sustainable collaboration among Black urban farmers in Cincinnati; and the Community Advisory Board (CAB), which organizes local residents for collective action. Our study primarily focuses on supporting the LFN in effectively executing the Homegrown produce procurement contract and improving farm management and collaboration within the network. Furthermore, our study adopts a co-design approach, actively engaging Black urban farmers throughout the research process

to ensure their needs and inputs are central to the development of the technology solution. By fostering a collaborative environment, the voices and experiences of the farmers are prioritized, emphasizing their integral role in shaping the direction and outcomes of the research. A detailed overview of the Homegrown study has been provided in the following subsection.

1.1.1 Homegrown Study

At its core, the Homegrown study embodies a noble endeavor to empower Black pregnant people with access to nutritious food essential for their well-being. While the study primarily focuses on maternal and birth outcomes of these pregnant people, it inherently recognizes the vital role played by this emerging LFN, particularly the Black urban farmers who indirectly contribute to their nourishment by providing essential ingredients. One pivotal aspect of the Homegrown study lies in its commitment to supporting and uplifting Black urban farmers, recognizing them as integral stakeholders in the broader mission of community health and empowerment.

Through the lens of technology, the study seeks to enhance farm management practices and facilitate effective collaboration among these farmers, thereby strengthening the foundations of the LFN and amplifying its impact on community well-being. By utilizing the power of technology to boost the efforts of Black urban farmers, we not only advance the goals of the Homegrown study but also pave the way for a more sustained and efficient farm management for this LFN. The development of technology solutions tailored to the needs of Black urban farmers has the potential to support and enhance the social impact of these vital communities.

1.1.2 Importance of Technology in Agriculture

Drawing inspiration from the historical resilience of Black farmers like Fannie Lou Hamer [6], who utilized collective action and agricultural cooperatives to resist oppression and build community, this research underscores the significance of technology in advancing the modern-day struggles of Black urban farmers. By leveraging technology, we can empower Black farmers with tools for efficient farm management, fostering economic autonomy, and community resilience. Just as Freedom Farms Cooperative (FFC) utilized agricultural knowledge as a form of resistance and power [6], modern technology offers a pathway for Black urban farmers to navigate challenges, enhance productivity, and assert their rights within the agricultural landscape.

Earlier investigations serve as a foundation for the efforts of the Detroit Black Community Food Security Network (DBCFSN) [7], which utilizes farming as a form of confrontation against food insecurity in Detroit's predominantly African American communities. By reclaiming vacant urban spaces for agriculture, DBCFSN not only addressed the immediate need for fresh produce but also fostered community building and empowerment. Their innovative approach underscores the critical role of technology in enhancing farm management and sustainability for Black urban farmers. Just as DBCFSN used farming as a strategy for community resilience and political agency, modern technology can also offer a pathway for Black urban farmers to optimize their operations, improve the accessibility to healthy food, and assert power over their livelihoods. Through the design and implementation of technology solutions customized to the unique requirements of Black farmers, they can be empowered to navigate challenges such as resource management, and market access, thereby advancing economic autonomy and social equity within urban agricultural spaces.

As urban agriculture continues to gain attention for its potential to both

challenge and perpetuate capitalist structures, there is a pressing need to understand its intricate dynamics, particularly concerning racial inequalities. Insights from one of the preceding studies [8] emphasizes the importance of technology in addressing the complex intersection of urban agriculture, racial capitalism, and resistance faced by Black urban farmers. By adopting the lens of racial capitalism, which examines how capitalism exploits racial differences and colonization, we can better comprehend the challenges and opportunities encountered by Black urban farmers. As such, this research seeks to shed light on the critical role of technology in enhancing farm management, improving resilience, and promoting equitable access to resources within urban agricultural contexts.

Furthermore, we find motivation from the Gardens and Green Spaces (GGS) project in Cleveland, Ohio [9] that demonstrates the potential of resident-driven community development initiatives. GGS, rooted in the Kinsman neighborhood, a predominantly Black area, combines place-making and entrepreneurial strategies to address various social and economic challenges. By examining the success of GGS in promoting community engagement, we recognize the critical role of technology in supporting similar endeavors for Black urban farmers.

Additionally, we are spurred on by Dig Deep Farms and Produce, an organization in the East Bay Area of California [10], which exemplifies the principles of food justice and self-determination. By prioritizing local economic development, job creation, and improved food accessibility in under-served communities, Dig Deep Farms underscores the critical need for innovative solutions to support Black urban farmers. Despite their commitment to self-determination, these farmers often grapple with the challenges posed by dominant foodie logics prevalent in their region. By crafting a technology that caters to the distinct needs, it becomes effortless in navigating these complexities while advancing the goals of food justice. Through the lens of Dig Deep Farms and Produce, we recognize the potential of technology in enhancing farm management practices, and promoting equitable access to resources

within urban agricultural spaces.

This study aims to understand the needs of the Black urban farmers to inform the design and development of an innovative technological solution tailored to address their specific challenges. By targeting barriers to effective collaboration within the community, this research aims to facilitate greater cohesion and cooperation among Black farmers in Cincinnati, Ohio. Through the implementation of the technology solution, we aspire to foster a supportive environment that enhances the resilience and sustainability of Black urban farms. Ultimately, by harnessing the power of technology to overcome obstacles and promote collaboration, this study seeks to contribute to the long-term success and prosperity of Black farmers and their communities and thus make fresh produce more accessible to pregnant Black people in the community by enhancing Black maternal agency and community capacity for healthy futures.

1.2 Research Questions

The purpose of this research is to design and develop a technology solution for the farmers of the LFN, enhancing inventory management and contributing to the Homegrown program's goals. The study focuses on the integration of technology for sustainable urban agriculture with a focus on providing optimal usability and user experience for the farmers. The research questions of this study include:

- What are the current needs and pain points of the local farmers for inventory management?
- How might we incorporate technology to enhance inventory management for farmers of the LFN by addressing their needs and pain points?
- What are the usability and user experience considerations in developing a technology solution for the farm and inventory management?

- What are the broader implications of insights and lessons learned from designing and developing technology solutions for local farmers with a focus on contributing to sustainable urban agriculture and wellness?

Chapter 2

Related Work

The objective of this study is to develop a technology solution that addresses the identified needs and challenges of Black urban farmers in coordinating their activities, collaborating effectively, and managing their farms. The potential solution aims to facilitate communication, streamline logistics, and support farm management tasks to improve the efficiency and productivity of urban farming initiatives. We build upon previous research that provides the historical context of urban agriculture, Black farming, racial capitalism, and food insecurity in the context of designing a technology solution for farmers to facilitate improved nutritional support for urban Black pregnant people. Concerning technology design and development, we draw from prior work on user-centered design approaches and usability evaluation methods. By examining the historical context and contemporary challenges faced by Black urban farmers, this chapter aims to illuminate the potential of technology in addressing the challenges within urban agricultural landscapes.

2.1 Urban Agriculture and Black farming

Recently, urban agriculture has garnered increasing attention as a means to deal with various urban challenges, including environmental sustainability and food insecurity. Earlier studies have highlighted the diverse range of urban farming, which encompass initiatives like community gardens, relief gardens, and job-training gardens [11]. These initiatives provide space and resources for individuals and communities to grow vegetables and flowers, primarily in urban settings. While urban agriculture initiatives have traditionally focused on food production, some investigations have delved into their broader social missions and impacts [12]. Surveys of the urban farmers in USA have revealed that while food production remains a core mission, many urban farms also prioritize goals related to community building, and food security [12].

Moreover, the motivations driving engagement in urban agriculture initiatives vary widely, reflecting different goals and beliefs within the urban farming community [13]. These motivations can range from entrepreneurial pursuits to radical challenges against existing systems, shaping the objectives and outcomes of the urban agriculture. However, despite the potential of the urban agriculture to address economic and environmental injustices, existing studies suggest that its implementation can be influenced by broader political and socio-economic factors [14]. The involvement of local governments in promoting urban agriculture as part of narratives of economic development and sustainability has raised questions about the true drivers behind these initiatives and their potential impact on marginalized communities.

Furthermore, as urban agriculture continues to expand, it is essential to recognize the complexities surrounding its adoption and implementation [15]. While urban agriculture promises to address the urban challenges, it also faces co-option by local governments and potential implications for social justice and equity. Under-

standing the historical contexts within which urban agriculture initiatives operate is crucial for fostering more inclusive urban food systems. By synthesizing insights from various studies, a detailed understanding of the role of urban agriculture in addressing urban challenges and advancing social justice can be gained.

2.2 Racial Capitalism and Urban Food Insecurity

In the world of urban food insecurity, scholars have delved into the multifaceted challenges faced by marginalized communities, particularly Black populations [16]. Despite efforts within the framework of food justice, disparities persist, raising questions about the efficacy of the urban agriculture as the potential solution for social injustices [17]. Studies underscore the need to confront historical legacies of racism, as evidenced in the experiences of Black communities engaged in food justice activism [18]. Concurrently, large-scale urban development projects demonstrate the contradictory impact of sustainability initiatives, escalating the housing affordability issues for low-income families [1].

Furthermore, investigations into alternative food movements reveal complexities surrounding inclusivity and community engagement. Despite intentions to provide fresh produce to underserved populations, such initiatives may unintentionally spread cultural domination and fail to resonate with the communities they aim to support [19]. Moreover, the oversight of Whiteness within urban planning processes underscores the need to reevaluate approaches to addressing racial inequities in urban contexts [20]. Critically, discussions on the racial wealth gap challenge the idea that education and financial literacy alone can rectify systemic barriers, calling attention to the structural foundations of inequality [21]. Through a comprehensive analysis of these interrelated factors, earlier studies reveal the complicated dynamics of racial capitalism in perpetuating urban food insecurity, underscoring the imperative for nuanced approaches to achieving food justice and equitable urban

development.

2.3 Technology for Agriculture

In many parts of the world, including India, small-scale rural farmers face significant challenges in accessing crucial agricultural information necessary for effective farm management. Despite possessing valuable traditional knowledge, these farmers often lack immediate access to vital updates on market conditions, pest management strategies, weather forecasts, and emerging agricultural practices. Once of the preceding studies [4] explains the pressing need to develop technology solutions tailored to address these information gaps and enhance the productivity and resilience of small-scale rural farming communities. Understanding the information needs of these farmers through contextual user research is essential for guiding the human-centered design of technology solutions aimed at improving farm management and ultimately contributing to the socioeconomic well-being of rural farming communities. Furthermore, the existing research [22] sheds light on a real-time experience of designing an online map tool for Dutch farmers, highlighting the significance of creating user-friendly interfaces for complex agricultural technologies.

The innovation of 'CalcuCafé', a web-based application for smallholder coffee farmers and cooperative technicians in Latin America [3], addressed the challenge of understanding production costs in the context of sustainable coffee farming, crucial for participating in global markets. Through iterative development and evaluation with coffee cooperatives in Peru, the researchers uncovered differing expectations between technicians and farmers, highlighting the importance of collaborative technology solutions. Also, the pivotal role of technology is highlighted in advancing agricultural development [23], particularly in providing crucial knowledge and information to farmers. Technology has proven instrumental in disseminating agricultural information, facilitating direct communication between farmers and buyers,

and offering access to global market prices and weather forecasts. These have significantly reduced barriers for farmers, enabling them to make informed decisions and improve their farm management practices.

There are persistent challenges faced by farmers in maximizing crop productivity, particularly the lack of timely access to expert agricultural advice. This underscores the importance of leveraging information technology to connect the gap between the research findings and practical implementation. The proposed Agricultural Information Dissemination System (AgriDS) [24] offers a scalable and cost-effective solution to provide personalized and timely expert advice to farmers, with the potential to significantly improve crop productivity. In modern agriculture, the effective utilization of technology is imperative for accelerating production and ensuring employability within the sector. Integrating various technological advancements is significant to enhance agricultural productivity [25]. This underscores the importance of developing technology solutions to the specific needs of farmers, particularly those in urban settings like Black urban farmers, to empower them in farm management and overcome existing limitations.

2.4 Role of Nutrition in Pregnancy

In the context of maternal and offspring health, nutrition during pregnancy plays a critical role, influencing long-term outcomes such as the risk of diseases like diabetes, hypertension, and coronary heart disease [26]. The quality and quantity of nutrients consumed during pregnancy directly impact fetal growth and development, with implications for future health trajectories. Understanding the nutritional requirements outlined by international bodies like the International Federation of Gynecology and Obstetrics (FIGO) and the Royal College of Obstetricians and Gynecologists (RCOG) is crucial to promoting optimal maternal and fetal well-being.

The existing research emphasizes the significance of maintaining a balanced

and nutrient-rich diet during pregnancy and lactation, emphasizing the importance of foods like vegetables, fruits, whole grains, legumes, and healthy fats [27]. It suggests that adhering to a "prudent" or "health-conscious" eating pattern during these periods may mitigate the risk of complications and worst health outcomes for both mother and child. Additionally, comprehensive nutritional supplementation for women with inadequate nutrition is recommended to enhance birth outcomes.

2.5 User-centered Design

User-Centered Design is a comprehensive approach, which emphasizes the active participation of users into the design process to make sure that products meet their preferences and needs effectively. This methodology, rooted in understanding the requirements of user and task through iterative design and evaluation, is widely recognized as instrumental in enhancing the usability and utility of products [28]. Despite its acknowledged importance, the adoption of user-centered design principles in practice remains inconsistent, with various barriers hindering its implementation. Research literature extensively discusses user-centered design methodologies and techniques, highlighting both their potential benefits and the challenges associated with their practical application [29] [28].

2.5.1 Participatory Design

Participatory design is a methodological approach, which involves active user involvement in the design process, rather than merely being characterized by it. It follows grounded methodological principles, reflecting a commitment to sustained, methodical investigation [30]. Unlike traditional research conducted by technical communicators, participatory design emphasizes the dual aspect of design and research, where design activities contribute to the generation of research findings [31].

This approach integrates various research methods, such as ethnographic observations and interviews, into the iterative construction of the emerging design, leading to co-interpretation of results by both designer-researchers and participants [30].

2.5.1.1 Co-design

Co-design, also known as participatory design or cooperative design or co-creation, is a collaborative approach to design that involves the active participation of all stakeholders, including users, designers, and other relevant parties [32]. Stemming from the principles of user-centered design, co-design emphasizes the importance of involving individuals with diverse expertise, competencies, and abilities in the design process [31]. This inclusive approach aims to make sure that the final outcome meets the requirements and needs of all involved parties, ultimately leading to more effective and user-friendly solutions [33] [34].

2.6 Usability and User Experience

Usability, initially introduced as an alternative to the subjective notion of "user-friendly," has evolved over time with varied interpretations and approaches [35]. Usability acts as a central focus in product design, with numerous perspectives shaping its understanding and implementation. On the other hand, user experience is a concept that encompasses not only the usability and functionality of interactive products but also their emotional and aesthetic appeal [36]. It is regarded as a holistic approach to understanding and enhancing the overall quality of human-computer interaction, reflecting a shift from a narrow focus on utility to a broader consideration of user satisfaction and engagement.The widely used usability and user experience methodologies are - Cognitive walkthrough, and Think Aloud. These are described in the following sub sections.

2.6.1 Cognitive Walkthrough

The Cognitive Walkthrough method is an approach to evaluating the usability of a system, particularly focusing on ease of learning. This method allows designers to anticipate learnability issues early in the design process, without the need for empirical testing with representative users. It applies cognitive theory to the evaluation process, similar to other design walkthroughs, and focuses on the cognitive processes required to perform tasks with the system as designed [37].

The goal of the evaluation is to assess how easily users can perform tasks with minimal instruction. Input to a Cognitive Walkthrough session includes a detailed design description, task scenarios, assumptions about users and context, and a sequence of actions [38].

During the walkthrough process, reviewers analyze the interface behavior and its impact on users, identifying actions that may be difficult for the average user to execute. Claims about ease or difficulty must be supported by theoretical arguments, empirical data, or relevant experience [37]. Essentially, the Cognitive Walkthrough method involves simulating the cognitive processes necessary for task completion, providing valuable insights into usability issues early in the design process.

2.6.2 Think Aloud

The Think Aloud method in usability testing is a technique where participants vocalize their thoughts, feelings, and actions as they interact with a product or system [39]. During a Think Aloud session, participants are encouraged to verbalize their internal monologue, articulating their reactions, perceptions, and decision-making processes in real-time. This method provides researchers with valuable insights into users' cognitive processes, allowing them to understand how users approach tasks,

interpret interface elements, and navigate through the system. By capturing users' thoughts and reactions as they occur, the Think Aloud method helps identify usability issues, uncover user preferences, and evaluate the overall user experience. This technique is particularly useful in early-stage evaluations of prototypes or interfaces, as it allows researchers to gather qualitative feedback directly from users, which can inform design decisions and improvements [39].

Chapter 3

Methodology

The methodology section outlines the systematic approach employed to address the research objectives and develop a technology solution aimed at enhancing farm management practices for Black urban farmers of the LFN. By integrating qualitative research methods, user-centered design principles, and iterative prototyping, we investigated the unique needs and challenges faced by urban farmers, translated these insights into actionable design criteria, and iteratively developed and refined a technology solution centered around user needs.

3.1 Needs Assessment

The first phase of the study, the needs assessment, conducted among Black urban farmers of the emerging LFN, unveiled critical insights into the challenges and opportunities shaping their agricultural endeavors. We employed semi-structured interviews and direct observation to gain insights into the specific requirements, pain points, and aspirations of Black urban farmers. The findings shed light on the multifaceted landscape of urban agriculture; the fragmented nature of existing practices, challenges related to resource allocation, and the critical importance of community

identity and collaboration, illuminating areas of both strength and vulnerability. These findings informed subsequent phases of the methodology, guiding the formulation of design criteria and the development of a technology solution tailored to the unique needs of the target user group. These insights underscored the intricate web of factors influencing farm operations, ranging from resource allocation and community dynamics to technological capacity and collaborative potential. Amidst the backdrop of siloed efforts, resource competition, and community reliance, the centrality of identity, history, and culture emerged as foundational elements guiding farmers' pursuits. With a focus on enhancing collaboration, addressing challenges with land utilization, and leveraging community partnerships, the findings serve as a compass for designing tailored interventions aimed at fostering sustainable agricultural practices and empowering urban farming communities. This section delves into the nuanced exploration of these key findings, presenting a comprehensive analysis of the needs and aspirations voiced by the farmers, ultimately informing the development of a technology-driven solution tailored to their unique challenges and objectives.

3.1.1 Semi-structured Interviews

The semi-structured interviews were designed to provide a flexible framework for exploring the experiences, perspectives, and needs of the participating Black urban farmers. The researchers developed an interview guide containing open-ended questions and prompts to facilitate in-depth discussions while allowing for emergent themes to surface naturally.

Before conducting the interviews, the researchers established a rapport with the participants to create a comfortable and trusting environment conducive to open dialogue. The interviews were conducted in person, based on the preferences and availability of the farmers. Each interview session persisted approximately 60-90 minutes, giving sufficient amount of time for the participants to reveal their

perceptions and elaborate on their experiences.

During the interviews, the researchers employed active listening techniques to encourage the farmers to express themselves freely and provide rich, detailed responses. Probing questions were used to delve deeper into specific topics of interest, such as challenges encountered in farm management, barriers to collaboration, and desired features for a technology solution. The researchers also encouraged the farmers to share any relevant stories, examples, or anecdotes that illustrated their points and provided context to their experiences. This qualitative approach allowed for a nuanced understanding of the complex factors influencing urban farming practices.

Following each interview session, the researchers transcribed the audio recordings and conducted initial data coding to identify key themes and patterns. These preliminary findings were then used to refine the interview guide for subsequent interviews, ensuring that all relevant topics were adequately explored. The semi-structured interviews served as a valuable method for collecting rich qualitative data and gaining insights into the needs, challenges, and aspirations of the Black urban farmers participating in the study.

3.1.2 Participants

All participants were urban farmers based in Cincinnati. The group consisted of a mix of genders, with a slight majority identifying as male and the remaining as female. Each participant was of African American ethnicity, originating from the Midwest region, and fell within the age range of 41 to 50 years. While the sample demonstrated moderate levels of technology experience and usage, all participants had regular access to technology. The primary mode of internet access for all participants was through mobile phones, although they had also accessed the internet using laptops. Demographic details of the participants are presented in Table 3.1.

Characteristics	Total (N=3), n(%)
Gender	
Male	2 (66.67%)
Female	1 (33.33%)
Age range	
41 - 50	3 (100%)
Ethnicity	
African American or Black	3 (100%)
Technical Knowledge	
Moderate	3 (100%)

Table 3.1: Participants' Demographics

3.1.3 Data Analysis

The process of data analysis involved coding and transcribing the semi-structured interviews to extract meaningful insights and identify recurring themes related to the needs and challenges of the Black urban farmers. We employed a thematic analysis approach, which involved systematically organizing and interpreting the qualitative data to uncover patterns and trends [40].

Initially, we familiarized ourselves with the interview transcripts by reading through them multiple times to gain a comprehensive understanding of the content. Next, we began the process of coding, where segments of text were assigned descriptive labels or codes representing key concepts, ideas, or topics discussed by the participants. As coding progressed, similar codes were grouped together into broader themes that captured main concepts or categories. These themes were refined through iterative discussions among the research team to ensure consistency

and accuracy in interpretation.

Once the themes were established, the researchers conducted a deeper analysis to explore the relationships between them and identify any sub-themes or patterns within each main category. This process involved comparing the perspectives of different participants to gain a holistic understanding of the issues at hand. Throughout the analysis, the researchers maintained detailed notes and documentation to track their decision-making process and ensure transparency in their findings. They also paid particular attention to any divergent or contradictory viewpoints expressed by the participants, recognizing the complexity in the data.

Ultimately, the data analysis process culminated in the identification of key findings that encapsulated the needs, challenges, and aspirations of the Black urban farmers. These findings served as the foundation for guiding the design and development of the technology solution aimed at addressing the identified issues and supporting the farmers in their endeavors.

3.1.4 Findings

The findings of the semi-structured interviews with three Black urban farmers reveal crucial insights into the challenges, needs, and aspirations of individuals involved in this LFN. Through in-depth discussions, participants shed light on various aspects of their experiences, ranging from coordination and collaboration to farm management and community engagement. This section presents the key findings derived from the interviews and observations, offering valuable insights into the complexities of urban farming in under-resourced communities. Through thematic analysis, user persona development, and mind-mapping techniques, this section delves into the nuances of the participants' experiences, providing a foundation for the design and implementation of a technology solution aimed at supporting and empowering Black urban farmers.

Below are the key findings from the semi-structured interviews conducted with the farmers:

3.1.4.1 Lack of Collaboration

The findings revealed a concerning trend among the farmers, a lack of collaboration within the LFN. This is a potential barrier to collective action and shared decision-making. Currently each farmer operates independently, without actively engaging or collaborating with others in the network. This fragmented approach may hinder the efficiency and effectiveness of efforts aimed at addressing common challenges and maximizing opportunities within the local agricultural community. Addressing this issue is crucial for fostering a more cohesive and interconnected network that can collectively address shared goals and challenges in a more coordinated manner. One of the participants expressed this as,

"A farmer is taking his stuff, putting it in his truck, and going to a farmer's market. Most of these farmer's markets don't even exist in the neighborhoods that we're talking about need the help. So even if we want to create a farmer's market in Walnut Hill, or Bond Hill, there needs to be an easier way to communicate with the other urban farmers. To be able to say, " Hey, you know what? I've got 20 tomatoes over here that we're not gonna be able to get rid of. Does anybody have use for them?"

3.1.4.2 Competition for Resources

The observations revealed a notable competition among nonprofits for funding and resources, underscoring the necessity for enhanced collaboration and resource sharing within the community. Furthermore, it became evident that the individual goals of each farmer necessitated integration and a more systematic approach to collaboration, pointing towards the importance of adopting a unified strategy to collectively

pursue shared objectives. These findings emphasize the critical role of cooperation and joint efforts in maximizing the effectiveness and impact of initiatives within the farming community. One participant vividly expressed,

"We're not here to compete with anybody. There shouldn't be any competition in feeding people, first of all. But there is because the funding we're going after makes it competitive. If there's only 100 grand going around, and 10 people asking for 25, somebody's getting left out. It ain't gonna be me."

3.1.4.3 Dependence on Volunteers

The findings of the study revealed a significant reliance on community volunteers for the operations of the urban farms, highlighting the critical role these volunteers play in supporting the functioning of the farms. This heavy dependence underscores the necessity of streamlining processes and enhancing operational efficiency within the farming initiatives. By optimizing workflows and implementing more efficient practices, the farms can better utilize the contributions of volunteers and maximize their impact on farm operations. This insight emphasizes the need for strategic planning and organizational development efforts to ensure the effective utilization of available resources and the sustainable functioning of the urban farming endeavors.

3.1.4.4 Challenges with Land Utilization

Inefficient land utilization, highlighted through the interviews with Black urban farmers, underscores a pressing challenge within the realm of urban farming initiatives. This poses a substantial barrier, compelling the urgent exploration of viable solutions to effectively utilize available land for the farming initiatives. The interviews illuminated the struggles faced by farmers in maintaining land for cultivation, pointing towards systemic issues that hinder their ability to establish sustainable farming operations. Addressing this challenge is imperative for fostering the growth

and resilience of urban farming initiatives. One participant commented,

"We are struggling to figure out what land's free to plant and what ain't. It's like to find a needle in a haystack. We need something organized, something to tell us what's available so we can get our crops in the ground."

3.1.4.5 Lack of Synergy in Goal Setting

The goals of each farmer emerged as pivotal points that necessitated integration and greater systematic collaboration, underscoring the imperative for a unified approach towards accomplishing shared objectives. The findings underscored that while individual farmers harbored distinct aspirations and priorities, such as enhancing crop yields, improving community engagement, or achieving sustainability targets, these goals intersected at various points, highlighting the interconnectedness of their endeavors. Consequently, it became apparent that achieving optimal outcomes necessitated transcending individual agendas and fostering synergistic collaboration among farmers. This collective approach not only promoted efficiency but also facilitated the pooling of resources, expertise, and knowledge, thereby enhancing the overall effectiveness of their initiatives. A participant responded,

"it could be easier if I could just get on my website – or get on my iPad while I'm walking through the far and be able to communicate what needs to be harvested. Like, "Hey.... Send someone over here to harvest the – this okra." Right?"

3.1.4.6 Cultivating Community Partnerships

The findings underscored the critical importance of community partnerships involving residents and various organizations in fostering the success and sustainability of urban farming initiatives. Through collaborative endeavors, urban farmers can leverage the collective resources, expertise, and support of local residents and

community-based organizations. These partnerships facilitate the sharing of knowledge, access to land and resources, and the establishment of mutually beneficial relationships that contribute to the overall resilience and viability of urban farming projects. By engaging with residents and community organizations, urban farmers can enhance community involvement, promote social cohesion, and address pressing issues such as food insecurity and environmental sustainability. Thus, community partnerships emerge as indispensable elements in the realization of urban farming goals and the cultivation of vibrant and resilient urban agricultural ecosystems. One participant stated,

"I think that there's a huge benefit to that if all the growers can partner up and create enough of a working model for the work to be there, right?"

3.1.4.7 Logistical Challenges

Addressing logistical challenges emerged as a pivotal hurdle hindering effective collaboration among the stakeholders. The complexities involved in scheduling meetings and orchestrating various activities were highlighted as significant barriers. These logistical obstacles impeded the seamless coordination necessary for fruitful collaboration. The participants emphasized the need for streamlined processes and efficient communication channels to overcome these challenges and foster more productive collaboration. A participant explained,

"So is it really beneficial when I'm logging my tomatoes on there and 15 other people are too? I think there needs to a system where – and I honestly think that all the urban farmers need to start thinking this way. Because I've started creating my sites to just be crops-specific. Like I said, Bond Hills is going to be tomatoes and cucumbers. 'Cause I know I can grow so much there, there's no need to waste that spot at any of my sites. But if you can get one farmer in Walnut Hills to get really good at growing something, then that creates less work for me because

I don't have to worry about cucumbers if someone's the best cucumber grower in the city. And I don't have to worry about growing tomatoes if the [farm name - removed for anonymity] kids are the best people growing tomatoes. And imagine that system if they get on there and the tomatoes are all coming from the same source. Or the potatoes are all coming from the same source. That's a lot more impactful then just saying, 'Anybody's that got potatoes, put it on this website'."

3.1.4.8 Technical Challenges

The interviews with the Black urban farmers underscored the significance of addressing tech capacity limitations and internet access concerns in the design of the proposed technology solution. The participants emphasized the need for a user-friendly and accessible platform that accommodates varying levels of technological proficiency and ensures seamless navigation even in environments with limited internet connectivity. This finding underscores the importance of prioritizing accessibility and usability in the development process to ensure that all stakeholders can effectively engage with the technology solution, regardless of their technological background or access to reliable internet infrastructure. Participants responded on this as,

"it could be easier if I could just get on my website – or get on my iPad while I'm walking through the far and be able to communicate what needs to be harvested. Like, "Hey.... Send someone over here to harvest the – this okra." Right?"

"Yeah, it's like to run a farm with one hand tied behind your back. We need some tech that's right there with us in the fields, you know? Like, if I could just pull out my phone and tell what needs picking, that'd save us a heap of time. We gotta keep up with the times, make farm management as easy as checking emails."

The below table 3.2 illustrates the pain points of the farmers, and how it can be converted into gains through a technology solution.

Pain Points Identified	**Technology Design Considerations To Resolve the Pain points**
1. Lack of Collaboration	Facilitate collaboration and coordination within the network
2. Competition for Resources	Improved collaboration in seeking funds and sharing resources
3. Dependence on Volunteers	Streamlined processes and improved operational efficiency
4. Challenges with Land Utilization	Efficient land utilization for urban farming initiatives
5. Lack of Synergy in Goal Setting	Unified approach to achieving common objectives
6. Cultivating Community Partnerships	Enhanced support and engagement
7. Logistical Challenges	Efficient scheduling and activity coordination
8. Technical Challenges	User-friendly and accessible technology solution

Table 3.2: Pains to Gains through Technology

Informed by the findings from the needs assessment, we moved on to the next phase of the study - design. To generate empathy in designers towards the users and to better summarize user needs, we developed user personas and mind maps based on the data from the needs assessment activities.

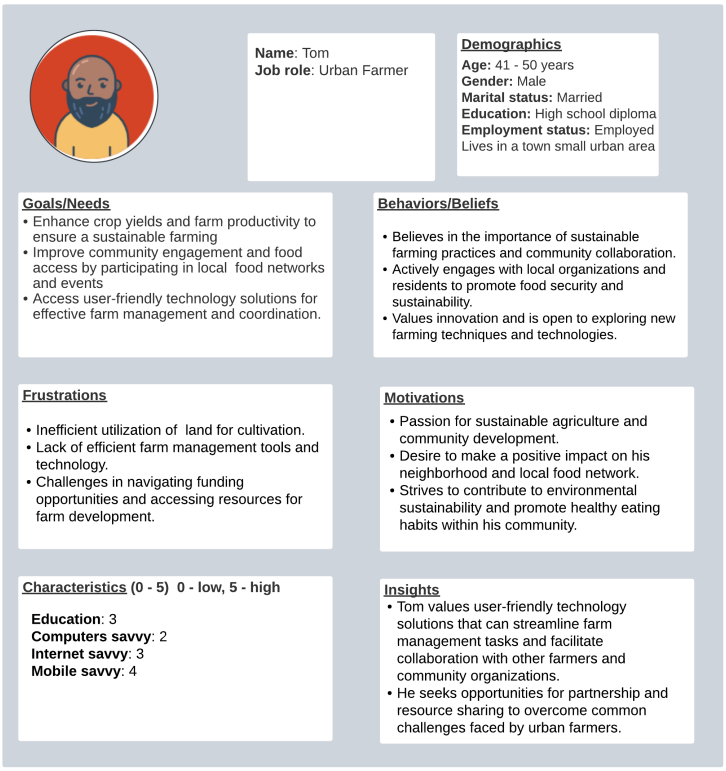


Figure 3.1: User Persona of an Urban Farmer

3.1.5 User Persona

User personas, inspired by Alan Cooper's Goal-directed design approach, are representations of user behavior and goals [41]. Unlike traditional user profiles, personas are fictional descriptions of individual users, enhanced with personal details to improve their relatability for development. Based on the interview data, direct and indirect user persona were developed to represent the typical characteristics, challenges, and goals of the users involved in the study. These serve as a reference point for designing the technology solution. Figure 3.1 demonstrates the user persona developed for an Urban Farmer.

3.1.6 Mind-map

Mind map is a visual representation of ideas and concepts to organize and visualize information. It is an effective tool for brainstorming, planning, and structuring

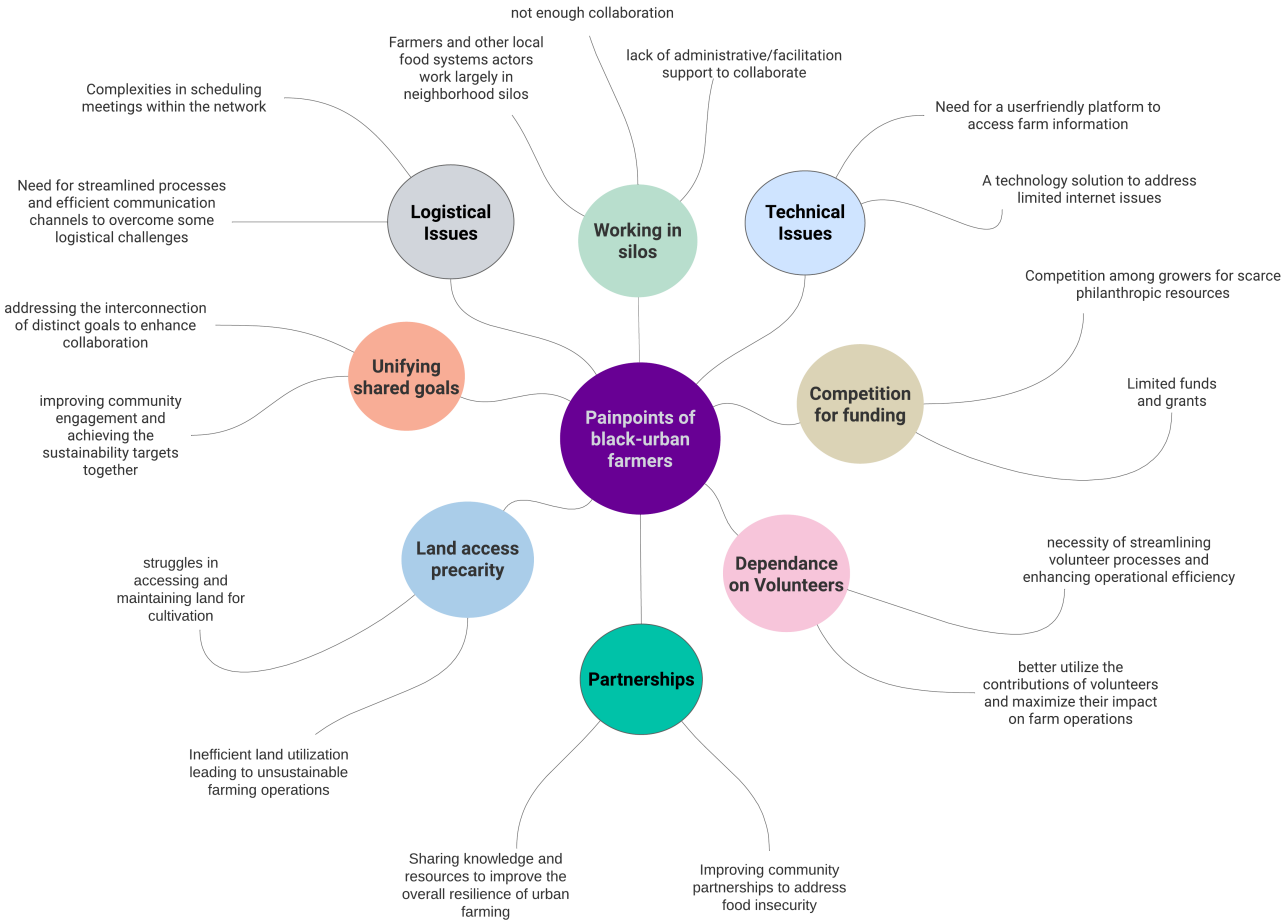


Figure 3.2: Mind-map of the needs of the farmers

complex concepts or relationships [42]. A mind-map has been created to visually represent the interconnected needs and challenges identified during the interviews. This visualization helps in understanding the complex relationships between different aspects of farm management and collaboration within the LFN. Figure 3.2 shows the needs assessed through the interviews with the farmers.

3.2 Study Design

Based on the key findings from the needs assessment, several implications for design and design criteria emerge, informing the design and development of the technology solution for Black urban farmers. By considering these implications for design and design criteria, the development of the technology solution can meet the

specific needs and priorities identified through the needs assessment process. The sub-sections will explain the design criteria and its implications for design.

3.2.1 Design Criteria

In crafting our study design, a fundamental aspect lies in establishing clear design criteria that directly address the identified pain points and needs of the farmers within the urban agricultural community. These design criteria serve as guiding principles that inform the development of our technology solution, ensuring its effectiveness and relevance in meeting the demands of the end-users. By meticulously analyzing the insights gleaned from the needs assessment and drawing upon the implications derived from our findings, we delineate specific parameters and objectives that our solution must fulfill. These criteria encompass various facets, including usability, accessibility, functionality, and scalability, among others, all aimed at creating a robust and user-centric technology platform. Thus, the design criteria not only provide a structured framework for the development process but also serve as a bridge between the research objectives and the practical application of our technological intervention within the target community. The subsequent sub-sections will delve into the implications derived from the findings and how these implications inform the design of the solution.

3.2.1.1 Collaboration Among Farmers

The identified need for greater collaboration among farmers and community organizations suggests that the technology solution should prioritize features that facilitate communication, coordination, and joint decision-making. This includes features such as shared dashboards that enable seamless interaction and collaboration.

3.2.1.2 Ease of Use and Accessibility

Given the variation in administrative and technological capacity among users, it is essential to design the platform with simplicity and accessibility in mind. The technology solution should be user-friendly, intuitive, and accessible across different devices and internet access levels to ensure widespread adoption and usability.

3.2.1.3 Customization and Scalability

Recognizing the diverse goals and needs of individual farmers and organizations, the technology solution should be customizable and scalable to accommodate varying requirements. This entails the flexibility to tailor features and functionalities to specific user preferences and the capacity to expand and adapt the platform as the network grows or evolves.

3.2.1.4 Data Management and Evaluation

Addressing the need for effective farm management support and data management/ evaluation, the technology solution should incorporate robust data management capabilities. This includes features for tracking growing and harvest logistics, managing volunteer schedules, and evaluating program outcomes to inform decision-making and optimize operations.

3.2.1.5 Community Engagement and Empowerment

Community partnerships and resident involvement are integral to the success of urban farming initiatives. Therefore, the technology solution should foster community engagement and empowerment by facilitating communication, participation, and feedback mechanisms. Features such as community forums, feedback loops, and

education resources can promote inclusivity and ownership within the local community.

3.2.2 Design of solution

In the design of the solution, we leveraged the insights gathered from the needs assessment phase and the identified implications for design criteria to develop a tailored technology solution for Black urban farmers. Building upon the demographic attributes and specific requirements outlined in the needs assessment findings, our approach focused on creating Tableau dashboards as the central component of the solution. The design of the solution centered on harnessing the power of Tableau dashboards to create a user-centric, data-driven platform that empowers Black urban farmers to manage their farms, collaborate with stakeholders, and drive sustainable agricultural practices forward.

3.2.2.1 Brainstorming and Ideation

Drawing from the key findings of the needs assessment study, our team engaged in extensive brainstorming sessions to generate potential solutions that address the identified needs and challenges faced by Black urban farmers. These sessions fostered creativity and collaboration, allowing us to explore diverse ideas and concepts for the technology solution.

3.2.2.2 Alignment with Demographic Attributes

Considering the demographic attributes of the target users, including age range, cultural background, and technological proficiency, we opted for Tableau dashboards as the primary interface for the solution. Tableau's intuitive visual analytics platform offers a user-friendly interface that caters to a wide range of users, from novice to

advanced, ensuring accessibility and ease of use for all participants.

3.2.2.3 Customization and Adaptation

Tableau dashboards provide a highly customizable and adaptable framework, allowing us to tailor the solution to the specific needs and preferences of Black urban farmers. Through customizable features and interactive elements, users can personalize their dashboard experience, optimizing functionality and relevance to their individual farming operations.

3.2.2.4 Data Visualization and Insights

One of the key strengths of Tableau dashboards lies in their ability to transform complex data into actionable insights through visualizations. By presenting farm management data, logistics information, and community engagement metrics in visually compelling formats, the solution enables users to gain valuable insights and make informed decisions to enhance their farming practices.

3.2.2.5 Database Schema Design

To facilitate effective data visualization and streamline the process of gathering information from farmers for visualization purposes, a comprehensive identification of tables and fields within the database structure was undertaken. This phase, similar to establishing an information architecture, aimed to portray the necessary entities and attributes required to capture and represent relevant data points. The identification process was conducted collaboratively and iteratively. Multiple brainstorming sessions were organized to foster collective insights and perspectives, ensuring a holistic understanding of the data requirements and visualization needs.

During these brainstorming sessions, we engaged in structured discussions

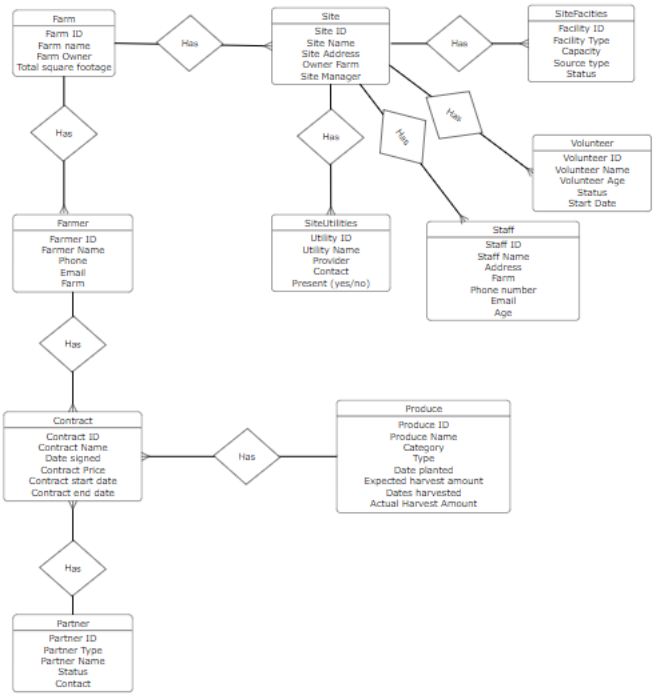


Figure 3.3: ER Diagram

to explore various facets of data collection, storage, and visualization. Key considerations included the types of information to be captured, the granularity of data required, and the relationships between different data elements. Through active collaboration and knowledge sharing, a consensus was reached on the essential tables and fields to be included in the database schema.

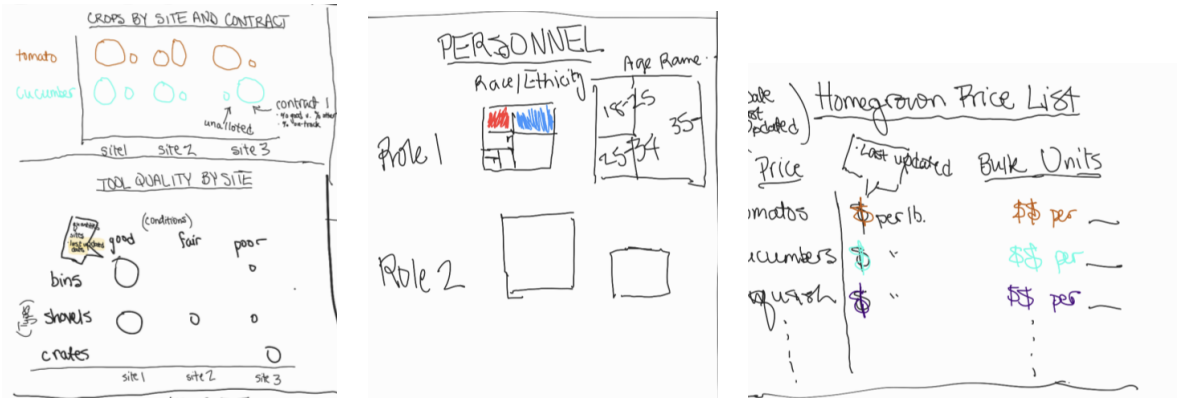
Furthermore, the iterative nature of the identification process allowed for continuous refinement and enhancement of the proposed database structure. The process of identifying tables and fields for the database involved a systematic and collaborative approach, guided by the goal of enabling efficient data visualization and informed decision-making within the context of urban agriculture.

Figure 3.3 shows the Entity-Relationship (ER) Diagram that visually represents the identified database schema and fields.

3.2.3 Low-fidelity Prototypes of the Dashboards

The concept of paper prototyping was introduced as a practical method for conducting usability testing across various digital platforms [43]. It involves creating hand-sketched drafts of interface elements needed to perform specific tasks, simulating user interaction by manipulating these paper prototypes. This method enables the identification of intuitive interface elements and areas of confusion, facilitating rapid iteration and refinement of the design.

We drew inspiration from the existing literature [44] [45] to incorporate paper prototyping into our study. In the initial stages of our research, we engaged in extensive brainstorming sessions to conceptualize a technology solution tailored to the needs of urban farmers. Recognizing the significance of effective user interface design, we opted to employ paper prototyping as a practical approach to visualize and refine our ideas. The designed paper prototypes serve as a tangible representation of our envisioned technology solution, laying the foundation for further refinement and development. Figure 3.4 illustrates some of the sample low-fidelity prototypes sketches drawn during the design process.



a) Sketch 1 b) Sketch 2 c) Sketch 3

Figure 3.4: Sample Low-Fidelity Prototype Sketches

3.2.3.1 Farm Data (Dashboards 1-3)

The first three dashboards in our paper prototypes center around farm information, farm site management, and crops by contracts. These dashboards provide farmers with essential tools for managing their operations, including tracking tools, contract details, and harvest expectations. By integrating features such as quality assessment, surplus and shortage monitoring, and comparisons of planted versus expected crops, our aim is to empower farmers with actionable insights to enhance productivity and decision-making.

3.2.3.2 Regional Farmer (Dashboard 4)

The fourth dashboard of the paper prototyping focuses on regional farm management, offering comprehensive insights into surplus availability, regional farm information, and crop quality. This dashboard serves as a vital tool for urban farmers to efficiently manage resources and operations across multiple farms within the region. By providing real-time data on surplus produce, farmers can optimize harvesting schedules and coordinate pickup arrangements, fostering collaboration and resource-sharing among regional farming communities. Additionally, access to detailed information on regional farm locations and crop quality enables farmers to make informed decisions regarding procurement and distribution, ultimately enhancing overall productivity and sustainability in urban farming endeavors.

3.2.3.3 Distributor (Dashboard 5)

The fifth dashboard of the paper prototypes is dedicated to distributors and plays a pivotal role in facilitating seamless coordination between farmers and distribution partners. With a comprehensive overview of distributor information, crop requests, pick-up and delivery schedules, and procurement details, this dashboard serves as a centralized platform for managing distribution logistics effectively. Distributors can

access real-time data on crop availability and demand, enabling them to plan their procurement strategies and schedule pickups accordingly. Furthermore, the inclusion of procurement information from partnering organizations enhances transparency and collaboration within the distribution network. By providing actionable insights, this dashboard empowers distributors to streamline operations, optimize resource utilization, and ensure timely delivery of fresh produce to end consumers.

3.2.3.4 Redistributor (Dashboard 6)

The sixth dashboard of the paper prototyping caters specifically to redistributors and serves as a comprehensive tool for managing the redistribution process efficiently. Designed to facilitate seamless coordination between redistributors and their network of suppliers and recipients, this dashboard offers a wealth of valuable information at a glance. With detailed insights into delivery destinations, contracts and partnerships, sourcing sites, and additional services and events, redistributors can effectively strategize their distribution operations and maximize the impact of their initiatives. By providing a centralized platform for tracking and managing various aspects of the redistribution process, this dashboard empowers redistributors to enhance transparency, optimize resource allocation, and foster collaboration among stakeholders. With its intuitive interface and robust functionality, this dashboard plays a crucial role in facilitating the seamless flow of goods and services across the redistribution network, ultimately contributing to the broader goals of sustainability and social impact.

3.2.3.5 Shared Data (Dashboard 7)

The seventh and final dashboard serves as a shared access platform accessible to all participants within the LFN. Designed to foster collaboration, transparency, and knowledge sharing across the entire network, this dashboard offers a comprehensive

suite of features and functionalities tailored to meet the diverse needs of its users. From providing insights into common events and initiatives happening across the network to offering access to the Homegrown price list and pickup/delivery tips, this dashboard serves as a valuable resource hub for farmers, distributors, redistributors, and other stakeholders alike. Additionally, users can leverage the dashboard to access Homegrown totals for every farm, track distributor demand and requests, and stay informed about key developments and opportunities within the network. By facilitating open communication and information exchange, this dashboard plays a pivotal role in strengthening community ties, enhancing collaboration, and driving collective action towards shared goals and objectives within the LFN.

3.2.4 High-fidelity Prototypes of the Dashboards

In the realm of user interface design, high fidelity prototypes play a crucial role in visualizing and refining the final product before actual development. A high fidelity prototype represents a near-complete version of the user interface, incorporating detailed design elements, interactions, and functionalities. Unlike low fidelity prototypes that focus on basic structure and layout, high fidelity prototypes provide a more accurate representation of the final product's appearance and behavior, allowing stakeholders to evaluate its usability and aesthetics comprehensively.

Several methodologies and tools are available for creating high fidelity prototypes, each offering unique features and benefits. According to Nielsen Norman Group, a leading authority in user experience research and design, high fidelity prototyping tools support dynamic interactions, realistic visual design, easy sharing and collaboration [46]. There are several tools that are widely used for their robust capabilities in designing high fidelity prototypes. These tools offer a range of features such as responsive design, component libraries, and prototyping modes, enabling designers to create sophisticated and interactive prototypes that closely resemble the final product.

3.2.4.1 Tableau Software for Dashboard Design

In the context of our research, Tableau Software emerged as a powerful tool for designing high fidelity prototypes of the dashboards intended for Black urban farmers. Tableau is a renowned data visualization platform that empowers users to create interactive and visually appealing dashboards, reports, and data visualizations. With its intuitive interface and extensive functionality, Tableau enables users to connect to various data sources, transform raw data into insightful visuals, and customize the appearance and behavior of dashboards to suit specific requirements.

Utilizing Tableau for dashboard design offered several advantages, including:

- **Rich Visualization Capabilities:** Tableau provides a wide range of visualization options, including charts, graphs, maps, and tables, allowing for comprehensive data representation.
- **Interactivity and Drill-Down:** Users can interact with Tableau dashboards by filtering, sorting, and drilling down into data subsets, enhancing data exploration and analysis.
- **Scalability and Performance:** Tableau's robust architecture ensures scalability and high performance, enabling the handling of large datasets and real-time data updates.
- **Ease of Use:** With its drag-and-drop interface and intuitive design tools, Tableau simplifies the process of dashboard creation, making it accessible to both novice and experienced users.

By using Tableau's capabilities, we were able to develop high fidelity prototypes of the dashboards tailored to the specific needs and preferences of Black urban farmers. These prototypes served as valuable visualizations of the proposed technol-

ogy solution, facilitating feedback and refinement before the final implementation stage.

After some brainstorming sessions, we decided to create two sets of dashboards: farm-specific and shared ones. The farm-specific dashboards are designed to cater to the unique needs of individual farms of the LFN, while the shared dashboards are for facilitating collaboration and information sharing among them. In total, there are seven (7) dashboards, comprising three (3) farm-specific dashboards, two (2) shared dashboards, one (1) for distributors, and one (1) for redistributors. The Dashboards 1,2, and 3 are farm-specific dashboards, Dashboard 4 is for distributor, Dashboard 5 is for redistributor, and Dashboards 6 and 7 are the shared dashboards. For the purposes of this study, we are focusing solely on the farm-specific and shared dashboards, excluding the distributor and redistributor dashboards at this stage of development.

3.2.4.2 Crops Data Dashboard

Before introducing the first dashboard, it is essential to understand its purpose and components. This farm-specific dashboard serves as a comprehensive tool for visualizing and managing data pertinent to each farm within the LFN. This dashboard is designed to provide farmers with insights into their crop cultivation activities, site management, and expected harvest quantities. By organizing data into intuitive visualizations, farmers can gain a deeper understanding of their farming operations, identify trends, and make informed decisions to optimize crop production and resource allocation. The dashboard comprises various components, including data visualization of crops categorized by cohorts of the homegrown contract, farm site management metrics detailing the number of plots for each crop, and anticipated harvest amounts for every crop across all sites within each farm. Through the utilization of this dashboard, farmers can streamline their farming processes, enhance productivity, and contribute to the overall success of the LFN. Figure 3.5 represents

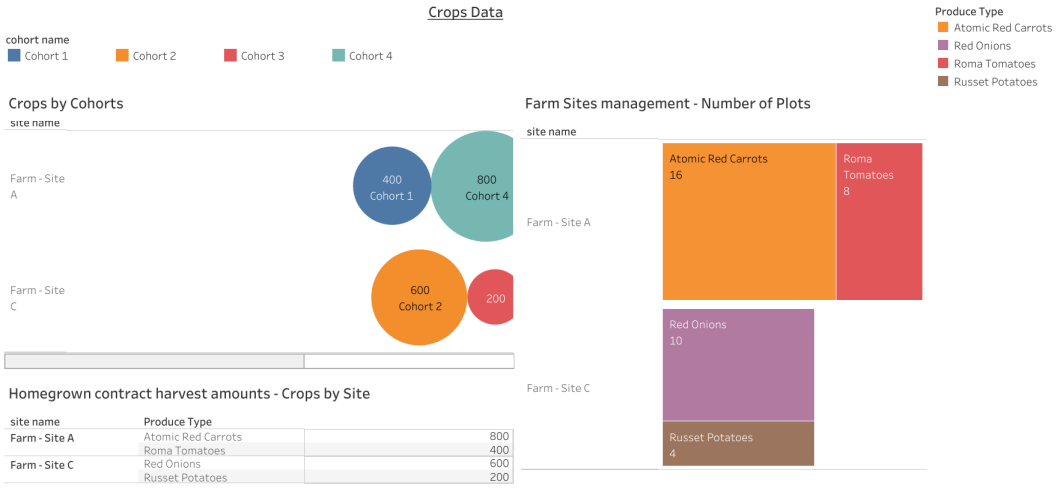


Figure 3.5: Crops Data Dashboard

the first farm-specific dashboard.

3.2.4.3 Harvest Measures Dashboard

The second dashboard, illustrated in Figure 3.6 helps to monitor crop inventory and contract details specific to each farm participating in the Homegrown contract. Through this dashboard, farmers can gain insights into the availability of crops, identify shortages or surpluses, and track essential contract information. Additionally,

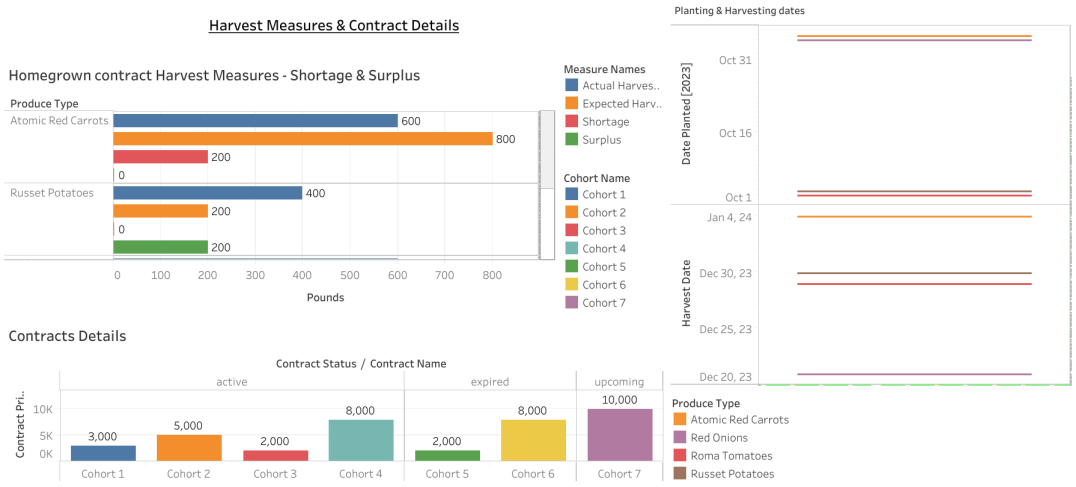


Figure 3.6: Harvest Measures Dashboard

the dashboard displays crucial dates related to crop cultivation, including planting and harvest dates, enabling farmers to effectively manage their agricultural activities

and optimize production workflows. By visualizing this data in a clear and intuitive manner, the second dashboard empowers farmers to make informed decisions and enhance the efficiency of their farming operations.

3.2.4.4 Shortage - Surplus Dashboard

The third dashboard of the farm-specific dashboards provides the critical insights into the actual versus contracted harvest amounts of each crop, as well as identifying shortages and surpluses at the end of every pickup week within the Homegrown contract. This dashboard serves as a pivotal tool for Black urban farmers to moni-

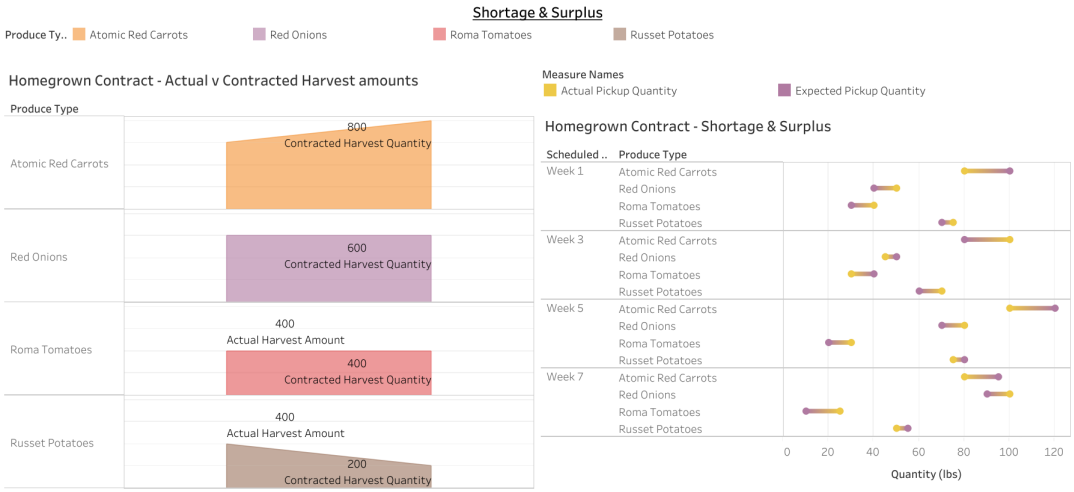


Figure 3.7: Shortage - Surplus Dashboard

tor and manage their crop production effectively, ensuring alignment with contractual obligations and optimizing resource utilization. By visualizing data on harvest quantities and discrepancies between actual and contracted amounts, farmers can proactively address supply chain challenges, adjust planting schedules, and coordinate with stakeholders to mitigate potential shortages or surpluses. Additionally, the dashboard facilitates data-driven decision-making, empowering farmers to optimize harvest planning, distribution strategies, and overall farm productivity. With its comprehensive visualization capabilities, the third dashboard plays a crucial role in enhancing operational efficiency and supporting the sustainable growth of urban

farming initiatives. Figure 3.7 demonstrates the third dashboard designed for the farmers.

3.2.4.5 Distributor Dashboard

The fourth dashboard for distributors, as depicted in Figure 3.8, serves to visualize key aspects related to distribution activities within the urban farming network. Specifically, the dashboard aims to facilitate the management of produce requests, procurement processes with partner organizations, and the demographic composition of the workforce across the age ranges.

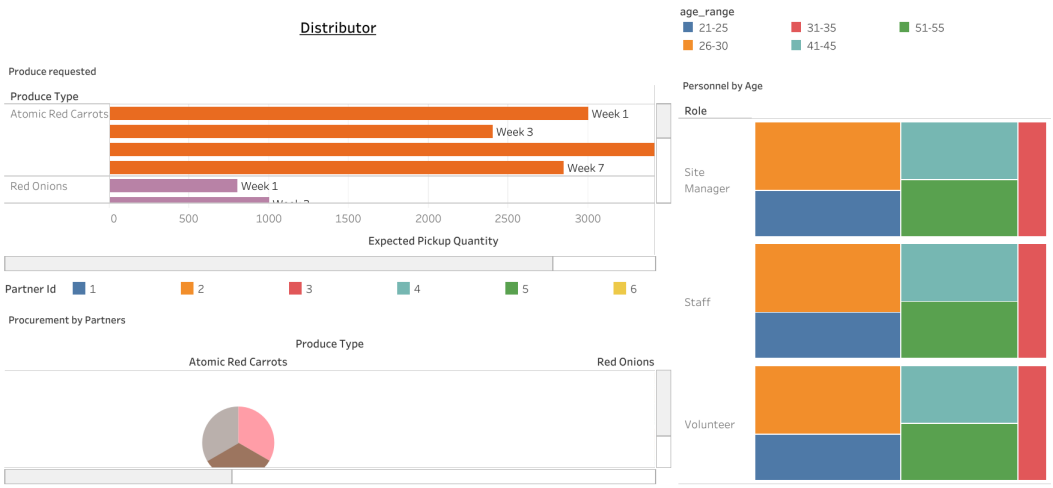


Figure 3.8: Distributor Dashboard

3.2.4.6 Redistributor Dashboard

The fifth dashboard designed for redistributors, illustrated in Figure 3.9, is essential to understand the pivotal role of effective redistribution in optimizing the supply chain and ensuring equitable access to fresh produce within the community. As highlighted by the interviews with Black urban farmers, the redistribution process plays a crucial role in addressing food insecurity and promoting sustainable food systems. The fifth dashboard is specifically tailored to meet the needs of redistributors, offering comprehensive insights into the quantity served weekly across various

locations, the sites sourcing from, and the places being delivered.

Figure 3.9: Redistributor Dashboard

3.2.4.7 Shared Dashboard

The sixth dashboard underscores the significance in facilitating collaboration and information sharing across the LFN. This shared dashboard serves as a centralized platform for visualizing critical data and insights that are pertinent to all participating farms within the network. By consolidating information on crops cultivated under the homegrown contract, inventory status of tools across various farms, and regional farm surplus available for pickup, the dashboard fosters transparency, coordination, and strategic decision-making among network participants. Through intuitive visualizations and interactive features, stakeholders can gain valuable insights into crop distribution, resource availability, and surplus management, thereby enabling more efficient resource allocation and distribution within the network. Figure 3.10 depicts the design of the sixth dashboard, offering a glimpse into its role in enhancing collaboration and efficiency across the LFN.

Figure 3.10: Shared Dashboard

3.2.4.8 Events Calendar Dashboard

The seventh dashboard, shown in Figure 3.11, features a comprehensive calendar that enables farmers to manage and track various events across their farms, including homegrown pickup dates and other significant milestones. By centralizing

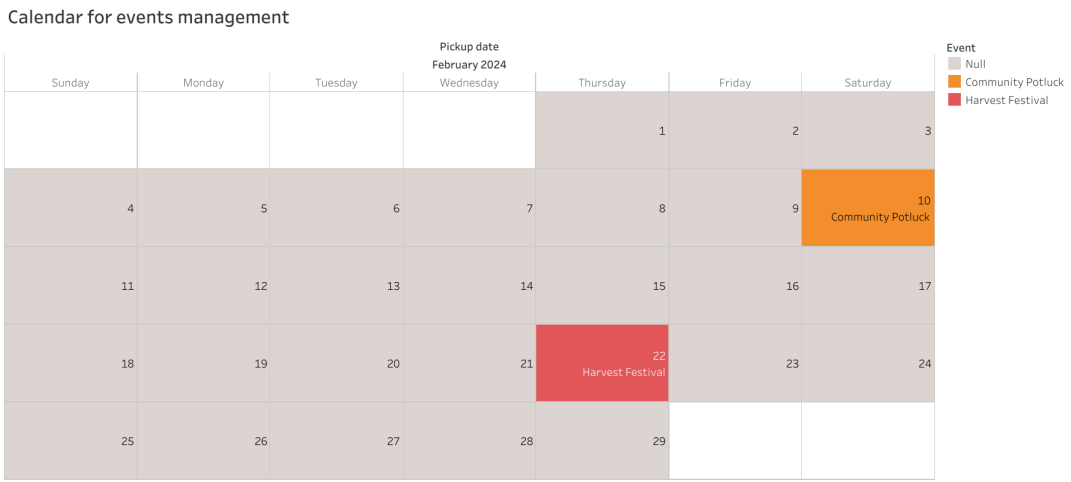


Figure 3.11: Events Calendar

event management and scheduling, the dashboard enhances efficiency and organization within the farming community, ensuring that essential tasks and activities are executed in a timely manner. Additionally, the calendar fosters collaboration and

collective planning, enabling farmers to align their schedules and coordinate efforts effectively.

3.2.5 Initial Feedback

Following the development of the initial Tableau dashboards based on the low fidelity prototypes, the research team conducted several iterations on the developed dashboards focusing on the primary requirements identified during the needs assessment phase before involving the farmers in the design process. These iterations aimed to refine the initial concepts and lay the groundwork for further development.

3.2.5.1 Iterative Design Process

Our research team engaged in an iterative design process, where we brainstormed, prototyped, and refined the dashboards based on the identified needs and design criteria. These iterations focused on exploring different design approaches, layout structures, and data visualization techniques to address the farmers' requirements effectively.

3.2.5.2 Decision to Build a Website

After incorporating and synthesizing the initial feedback, we made the strategic decision to develop a website to host all the dashboards. This decision was driven by the desire to improve accessibility and user experience for Black urban farmers, providing a centralized platform where they could easily access and interact with the farm management tools and logistics information.

3.2.5.3 Rationale for Website Development

The website platform offered several advantages over alternative solutions, including scalability, flexibility, and compatibility with a wide range of devices and operating systems. By hosting the dashboards on a website, the research team aimed to enhance usability, promote collaboration, and streamline access to critical farm management resources for the target user community.

3.3 Homegrown Website

Building upon the iterative design process and initial feedback, the research team embarked on the development of the Homegrown website—a tailored online platform aimed at addressing the specific needs identified during the initial feedback phase. The Homegrown website serves as a central hub for accessing essential information, resources, especially the dashboards tailored to the needs of Black urban farmers of the LFN. Designed with a focus on accessibility and user-friendliness, the website provides a comprehensive platform where users can seamlessly navigate between different sections and access pertinent information with ease. This section outlines the key concepts involved in the creation of the Homegrown website. Figure 3.12 represents the sitemap of the Homegrown website.

3.3.1 Home Page Overview

The home page serves as the entry point for users and provides a succinct overview of the Homegrown study. It outlines the study's mission, objectives, and key features, setting the context for users interested in learning more about the study.

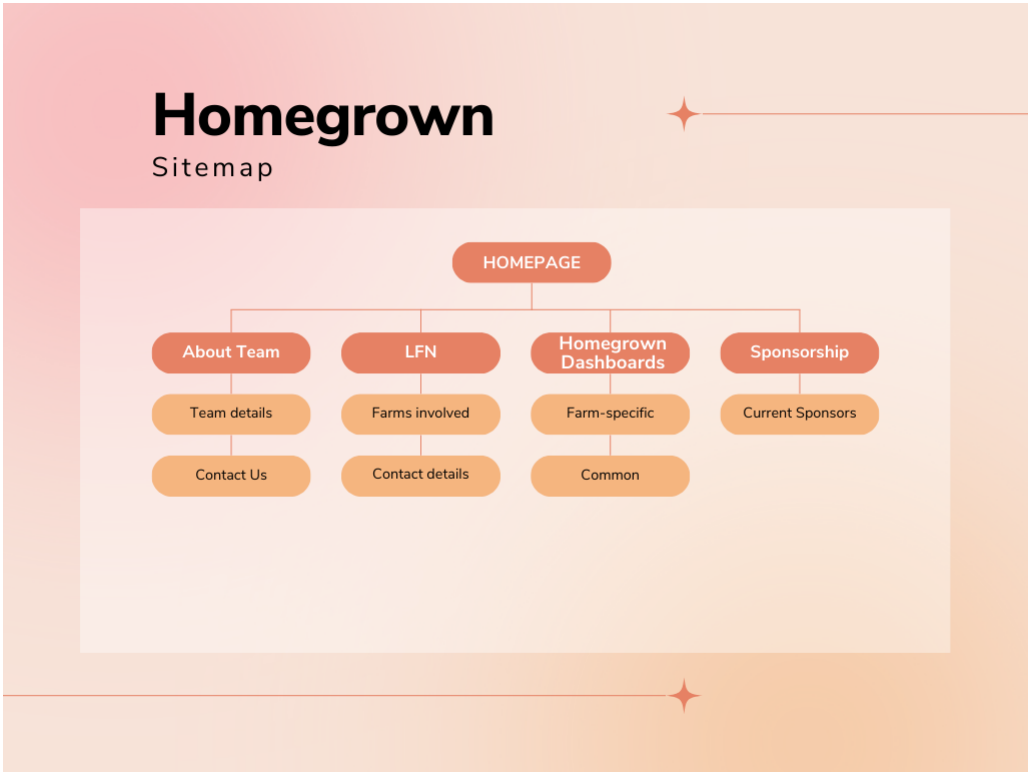


Figure 3.12: Homegrown Sitemap

3.3.2 About Our Research Team

This section offers insights into the research team behind the Homegrown study, including their expertise, background, and roles within the study. It aims to establish credibility and transparency, fostering trust and confidence among website users and potential collaborators.

3.3.3 Black Urban Farms

Dedicated sections are allocated to profile the Black urban farms and farmers involved in the LFN of the Homegrown study. Each farm's details highlights its agricultural practices, and community impact, providing users with valuable insights into the diverse array of farming initiatives supported by the them.

3.3.4 Farm-Specific Dashboards

The website hosts specialized dashboards tailored to meet the unique needs and requirements of individual farms within the network. These dashboards provide information on crops data, harvest details, shortage/surplus, and contracts signed, empowering farmers with actionable insights and decision-making support.

3.3.5 Common Dashboards

In addition to farm-specific dashboards, the website includes common dashboards accessible to all farms of the LFN. These dashboards visualize shared data relevant to the entire network, such as tools inventory, surplus inventory, and events calendar. They serve as collaborative platforms for sharing resources and important information.

3.3.6 Sponsorship

The Sponsorship section showcases the organizations supporting the Homegrown study through sponsorship and partnerships. It acknowledges their contributions to the study's success and highlights opportunities for collaboration, funding, and resource sharing. Users can learn about current sponsors involved in supporting Black urban farming initiatives and Homegrown study.

3.4 Preparation for Farmer Engagement

With a website initially built in place, the research team prepared to engage the farmers in the design and development process. This involvement would ensure that the final solution aligns closely with the needs, preferences, and workflows of Black

urban farmers, ultimately leading to a more effective and user-centric technology solution.

3.5 User feedback

A feedback session was conducted with the Black urban farmers of the LFN to get some valuable feedback regarding the initial draft of the technology. During the interview session, the participants focused more on the logistic issues than the usability of the technology solution developed. They expressed several concerns and considerations primarily related to logistical challenges. Key points highlighted included the long-term viability of the dashboards, concerns about surplus item management and equitable distribution within the network, transportation logistics for crop pickup, and the need for efficient volunteer management systems. Additionally, farmers emphasized the importance of managing storage for harvested crops and the necessity of a streamlined system for event management and volunteer coordination. These insights provide valuable guidance for refining and enhancing the technology solution to better address the practical needs and challenges faced by the farmers within their operational context.

3.6 Usability Test of Improved Website

Based on the feedback gathered from the recent usability test session of the developed technology solution with one of the farmers from the LFN, several valuable insights have emerged to enhance the usability and functionality of the dashboards and website developed for Black urban farmers. The tasks used for usability test session of this study is mentioned in the Appendix A1.

Firstly, the need for improved visibility of surplus and shortage of crops

across farms was highlighted, emphasizing the importance of displaying this information prominently on the common dashboard. Additionally, the farmer suggested visualizing the total amount of crops grown versus the total amount allocated in contracts to effectively manage surplus and unallocated crops.

Furthermore, in the Farm Sites Management dashboard, the farmer expressed the necessity for a more efficient utilization of plot areas within farm sites. Drawing inspiration from the Southern Seed Exposure app, which displays the utilization status of plots including occupied and unutilized areas, the farmer recommended incorporating similar features to optimize land usage and improve overall efficiency.

Lastly, to foster community engagement and knowledge-sharing among farmers, the addition of a Blog or Community tab on the website was proposed. This feature would enable farmers to seek advice, share insights, and address farming-related queries, thereby enhancing collaboration and peer support within the farming community.

Incorporating these suggestions into the design and functionality of the dashboards and website holds the potential to significantly enhance usability and utility for Black urban farmers, ultimately contributing to the success and sustainability of urban farming initiatives. This usability test session is yet to be conducted with the other two farmers soon to collect feedback from them.

3.7 System Usability Scale (SUS)

System Usability Scale is a widely used ten-item questionnaire for subjective assessments of usability [47, 48]. We administered the SUS to the participants to assess the perceived usability of the dashboards and the website. At present, only one farmer who participated in the recent usability test session has responded to the

SUS. The other two are yet to respond once they complete the usability test session. The SUS questionnaire consists of 10 items, with participants rating each item on a likert-scale from 1 (strongly disagree) to 5 (strongly agree). Once all the participants submit their SUS responses, they will be analyzed to evaluate the usability of the technology solution and identify areas for improvement. The SUS questionnaire used for this study is mentioned in the Appendix A1.

Chapter 4

Results

This chapter presents the results of the study, highlighting the answers to the research questions (RQ) posed. First, we will discuss the local farmers' current needs and pain points (RQ1) regarding inventory management. Then the chapter explores the incorporation of technology solution (RQ2) into farm management practices, examining how the designed solution address the identified needs. Following this, the usability and user experience considerations of the developed technology solution are discussed (RQ3), drawing from feedback sessions with farmers. Finally, the chapter concludes with reflections on lessons learned throughout the research process (RQ4), offering valuable insights for future research in sustainable urban agriculture and community empowerment.

4.1 Needs and Pain Points Identified (RQ1)

The findings from the needs assessment phase of the research provide valuable insights into the current challenges and requirements of local farmers for inventory management. Through semi-structured interviews with three Black urban farmers, several key themes emerged, shedding light on the complexities and nuances of their

experiences within the LFN.

The findings revealed a significant lack of collaboration and coordination within the network. This fragmented approach poses barriers to collective action and shared decision-making, highlighting the need for enhanced collaboration and communication channels among farmers. Additionally, the interviews underscored a notable competition for funding and resources among nonprofits, emphasizing the necessity for resource sharing and a unified strategy to pursue shared objectives effectively.

Furthermore, the heavy dependence on community volunteers for farm operations highlighted the importance of streamlining processes and enhancing operational efficiency within the farming initiatives. Issues regarding land utilization emerged as another pressing challenge, underscoring the need for viable solutions to utilize the available land efficiently and facilitate sustainable farming operations.

Moreover, the interviews revealed the critical importance of unifying shared goals and fostering partnerships within the community to maximize the effectiveness and impact of urban farming initiatives. Logistical and technical challenges were also identified, highlighting the need for streamlined processes, efficient communication channels, and user-friendly technology solution that accommodate varying levels of technological proficiency.

These findings provide a comprehensive understanding of the current needs and pain points of local farmers for inventory management, informing the development of technology solution aimed at supporting and empowering Black urban farmers within the LFN.

4.2 Incorporation of Technology (RQ2)

The incorporation of technology offers a promising avenue to address the identified needs and pain points of the farmers within the LFN. As outlined in the methodology chapter, a comprehensive analysis was conducted to understand the specific challenges faced by the farmers and explore potential technological solutions to enhance inventory management. Table 3.2 presents a summary of the identified pain points and corresponding technology design considerations aimed at resolving these challenges.

For instance, one of the primary pain points identified was the lack of collaboration and coordination within the network. To address this issue, the proposed technology solution focuses on facilitating collaboration through the implementation of collaborative tools and communication platforms. By providing farmers with access to shared dashboards, and collaborative workspace, the technology aims to foster greater cooperation and coordination among network participants.

Similarly, the technology design considerations also aim to address other key pain points such as competition for funding and resources, heavy dependence on community volunteers, issues with land utilization, individual goals requiring integration, need for community partnerships, logistical challenges, and technical limitations. Each of these pain points is accompanied by specific technology design considerations aimed at streamlining processes, improving operational efficiency, enhancing support and engagement, and overcoming technical limitations.

Overall, the integration of technology holds significant potential to enhance inventory management for farmers within the LFN by addressing their specific needs and pain points. By leveraging technology-driven solution tailored to the unique requirements of the farming community, it is possible to streamline operations, improve collaboration, and ultimately support the sustainable growth and success of local farming initiatives.

4.3 Usability and User Experience Considerations (RQ3)

Based on the feedback obtained from the user during the initial user feedback session, several key insights and considerations emerged.

Firstly, during the feedback sessions, the participants primarily focused on logistical challenges rather than the usability of the technology solution. This indicates that while the usability of the technology is important, addressing practical needs and operational challenges is paramount for the farmers. Concerns were raised regarding the long-term viability of the dashboards, suggesting a need for sustainability and durability in the technology solution.

Additionally, issues related to surplus item management and equitable distribution within the network were highlighted. This underscores the importance of ensuring that the technology solution facilitates fair and efficient allocation of resources and inventory management practices.

Transportation logistics for crop pickup emerged as another area of concern, indicating the need for integration with logistics management systems to streamline transportation processes and enhance efficiency in crop delivery.

Furthermore, the feedback emphasized the importance of efficient volunteer management systems, storage management for harvested crops, and streamlined event management and volunteer coordination processes. These considerations highlight the multifaceted nature of farm and inventory management, necessitating a comprehensive and user-centric approach in designing the technology solution.

While we uncovered multiple pain points during the initial needs assessment interviews, the feedback session on the designed solution was a catalyst in uncovering additional pain points highlighting the importance of sustained user en-

gagement in novel technology design with under-served user populations.

The insights from the user engagements underscore the significance of addressing logistical challenges and practical needs in addition to usability considerations when developing a technology solution for farm and inventory management. By incorporating these insights into the refinement and enhancement of the technology solution, we can better meet the needs and requirements of the farmers within their operational context, ultimately improving usability and user experience.

4.4 Lessons Learned (RQ4)

Reflecting on the journey of this research study, several key lessons have emerged that could be valuable for future researchers in the realm of technology solutions for urban agriculture and community empowerment.

Throughout the iterative process of user-centered design, we learned the importance of continuous engagement with end-users, particularly Black urban farmers, to understand their needs, preferences, and operational challenges. This iterative approach allowed us to refine our technology solution in response to user feedback.

One of the most significant lessons learned pertains to the importance of contextual understanding in shaping technology solution. By communicating with the Black urban farmers, we gained insights into the nuanced challenges they face, from inefficient collaboration to logistical hurdles in farm management. This contextual understanding served as a guiding principle in designing tailored solution that resonate with the unique context of urban agriculture.

Flexibility and adaptability were also key lessons learned throughout the research process. As we encountered unforeseen challenges and constraints, such as limited availability of farmers and small sample sizes, we learned to pivot and adjust our approach accordingly. This flexibility allowed us to remain responsive

to the evolving needs and dynamics of the LFN, ultimately enriching the research outcome and enhancing the relevance of the technology solution developed.

Collaborating across disciplines proved to be instrumental in advancing the research agenda and maximizing its impact. By engaging with farmers, we leveraged the perspectives to address complex issues at the intersection of agriculture, technology, and wellness. The research team consisted of individuals from varied disciplines. This interdisciplinary collaboration fostered innovation, creativity, and collective problem-solving, laying the groundwork for more inclusive and sustainable approaches to urban agriculture.

Finally, through this research we understood the transformative potential of technology in empowering marginalized communities and advancing social justice goals. By designing technology solution that amplifies the voice of Black urban farmers, we showcased technology as a driver for community resilience, economic empowerment, and collective action. This realization underscores the need for continued investment in technology-driven initiatives that prioritize equity, inclusivity, and social impact in urban agricultural contexts.

Chapter 5

Discussion

5.1 Strengths and Limitations

This study has several strengths. The involvement of multiple farmers ensured a diverse range of perspectives, offering a rich understanding of the nuances within the local farming community. By conducting semi-structured interviews with Black urban farmers, we gained valuable insights into their challenges, requirements, and aspirations. Additionally, the use of paper prototyping and iterative feedback sessions allowed for the development of tailored technology solutions that directly addressed the specific needs identified during the needs assessment phase. Implementing high-fidelity prototypes of the dashboards and the Homegrown website demonstrated a practical application of the research findings, providing tangible solutions to enhance farm management and collaboration among farmers.

However, there are limitations to report. Given the limited number of Black urban farmers (due to historical issues that we mentioned in chapter 2), we could not recruit more participants for the study. As a result, the study focused on a small sample size of Black urban farmers from a specific geographic region, limiting the generalizability of the findings to other contexts. The limited availability of

farmers to engage with the research activities due to their hectic schedules hindered completion of some of the usability studies and collection of comprehensive feedback. Biases or limitations in the data collection process, such as respondent bias or interviewer influence, could have affected the validity of the findings. Additionally, while the technology solution developed in this study offer promising solutions, they may not fully address all the complexities and challenges faced by Black urban farmers, necessitating further refinement based on ongoing feedback and evaluation.

5.2 Future Work

Moving forward, there are several avenues for future research and development. Firstly, exploring the scalability and long-term viability of the technology solutions developed in this study is crucial, including their potential adoption by a broader range of urban farmers and agricultural stakeholders. Continued collaboration and partnership with local communities, organizations, and policymakers are essential to address systemic barriers to funding, and resource allocation for Black urban farmers. Further investigation into the intersection of technology and agriculture, particularly in the context of urban farming, could uncover additional opportunities for innovation and improvement in farm management practices. Additionally, research focusing on the social, economic, and environmental impacts of technology-enabled interventions in urban agriculture could provide valuable insights into the broader implications of such initiatives.

The extension of this work will also involve designing forms to gather real-time data from farmers, developing an efficient database to store this data, and integrating the database with Tableau for visualization of real data. While this study focused on evaluating the usability of the technology solution, the continuation of this work will concentrate on assessing the effectiveness of the developed technology solution in addressing the needs and challenges of Black urban farmers.

5.3 Conclusion

In conclusion, this study sheds light on the unique needs and challenges faced by Black urban farmers and underscores the importance of tailored technology solutions to support their endeavors. Through a comprehensive needs assessment approach, we gained valuable insights into the critical issues surrounding land maintenance, collaboration, technical challenges, and community partnerships within the urban farming context. The development of the Homegrown Dashboards and website represents a significant step towards addressing these challenges, offering practical tools for farm management, collaboration, and data visualization.

While this study has provided valuable insights and tangible solutions, it is just the beginning of a broader conversation and action towards supporting and empowering Black urban farmers in meeting the nutritional needs of black pregnant people and thus contributing towards healthier community. Collaboration, community engagement, and ongoing feedback will be essential in iteratively refining the technology solution developed in this study to ensure their relevance, usability, and effectiveness in real-world settings.

This research contributes to the growing body of literature on technology-enabled interventions in urban agriculture and underscores the potential for technology to drive positive social, economic, and environmental change within urban farming communities. By centering the voices and experiences of Black urban farmers, this study highlights the importance of equity, inclusivity, and empowerment in shaping the future of urban agriculture. Their contributions play a vital role in cultivating healthy community, specifically by addressing the nutritional needs of pregnant urban Black individuals. By ongoing collaboration, and innovation, we can work towards establishing more resilient, sustainable, and equitable food systems for all.

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Appendix A

A list of questions:

A.1 Usability Test Session Tasks

1. Open the website from the link provided.
2. Navigate to the “Farm-specific dashboards” tab.
3. Locate the “Crops Data” dashboard.
4. According to this dashboard, how many plots have “Roma Tomatoes” in ”Farm Sites Management” section.
5. In which site of the farm are the red onions are planted?
6. Locate the “Contract Details” dashboard.
7. How many contracts are active?
8. Locate the “Shortage - Surplus” dashboard.
9. In “week 1 of Red onions”, which quantity is greater? Actual pickup quantity or Expected Pickup quantity?
10. Navigate to the “Common Dashboards” tab.

11. Locate the “Shared Data” dashboard.

12. How many “Harvester” tools are in “Under Repair” status in the ”Tools Inventory” section?

A.2 System Usability Scale Questions

1. I found the dashboards easy to use to identify the visualized data.

    - Strongly Disagree
    - Disagree
    - Neutral
    - Agree
    - Strongly Agree

2. I found it easy to understand how to use the dashboards.

    - Strongly Disagree
    - Disagree
    - Neutral
    - Agree
    - Strongly Agree

3. I found the website easy to use to identify the dashboards.

    - Strongly Disagree
    - Disagree
    - Neutral
    - Agree
    - Strongly Agree

4. I found it easy to locate different dashboards on the website.
    - Strongly Disagree
    - Disagree
    - Neutral
    - Agree
    - Strongly Agree
5. I found it easy to navigate through different tabs of the website.
    - Strongly Disagree
    - Disagree
    - Neutral
    - Agree
    - Strongly Agree
6. I find it useful to be able to visualize the farm and contract information instead of using a written format.
    - Strongly Disagree
    - Disagree
    - Neutral
    - Agree
    - Strongly Agree
7. I found the layout and organization of information on the dashboards to be user-friendly.
    - Strongly Disagree
    - Disagree
    - Neutral

- Agree
- Strongly Agree

8. I feel confident in my ability to perform tasks using the dashboards.
   - Strongly Disagree
   - Disagree
   - Neutral
   - Agree
   - Strongly Agree
9. I feel the dashboards effectively meet my needs for managing farm information.
   - Strongly Disagree
   - Disagree
   - Neutral
   - Agree
   - Strongly Agree
10. I feel using the dashboards and website will improve my efficiency in managing farm-related tasks.
    - Strongly Disagree
    - Disagree
    - Neutral
    - Agree
    - Strongly Agree
11. Please provide any specific features or aspects of the dashboards that can be improved or added.
12. Please provide any other thoughts or comments about the experience with the dashboards and the website.