FieldSmARt

A MODERN GARDENING SOLUTION

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INTRODUCTION

This report presents an innovative augmented reality (AR) application called FieldSmart which is focused on revolutionizing the gardening and agricultural activities carried out by an individual. Within the last decade, there has been an increased use of interconnected technologies in everyday life. Many people, especially young adults are disproportionately being affected by technology-related stress. Since the Covid-19 pandemic, gardening has been an increasingly popular choice of hobby to help these users de-stress. Due to the meticulous nature of the tasks and several factors that affect the plantation, most of the people lack the experience and knowledge to properly plan and maintain a garden. FieldSmart aims to address these challenges and help these users better plan and maintain a garden area by making an augmented reality (AR) application that integrates itself with the user's environment, using data provided by the user and their location to better plan their area, find what flora can cohabitate with local wildlife, and manage their resources to maximize the health and longevity of the space. The agriculture activities are a more commercialized version of gardening and applicable at a large scale, it is also feasible to use this technology for agriculture activities as well. FieldSmart focuses on three core differentiators: hyperlocal personalization, simplified user experience, and seamless AR integration. This is all achieved through a simple, straightforward interface so that users can have less anxiety in using the application. Finally, FieldSmart neatly integrates the world of technology with the natural world, providing a comprehensive answer to the users who want to improve their gardening and farming experience. It also talks about using the application that combines technology of Augmented Reality and design centered Approach, so any individual that has a small balcony or good farm would be able to perform one of the most satisfying hobbies in a simple, pleasant and hassle-free manner. This report considers the difficulties, approaches, and promises of FieldSmart, designating it as an impact making device in the context of modern gardening and farming.

USING TECHNOLOGY TO ALLEVIATE TECH STRESS (WHY WE NEED THE PRODUCT?)

Information communication technologies (ICT) is an industry that has been growing rapidly and cementing itself in modern work culture, especially for those in technology-related industries. For as much as the technological developments have led to increase in productivity, however, the user has been struggling to physically and psychologically keep up. Recent studies show that this increased interconnectedness leads to a constant demand from the workers to be more accessible to the workplace and an increased expectation of worker productivity (Srivastava et al., 2015).

This tetheredness is leading to increased rates of what is called technostress, a psychosocial response to directly or indirectly interacting with computer technology, showing typically as discomposure, tenseness, fear, and anxiety (Berg-Beckhoff et al., 2017). Within this idea, researchers further have broken it down into five categories:

- Techno-overload: Users are required to work faster and longer (Berg-Beckhoff et al., 2017).
- Tecno-invasion: Users are feeling like technology is invading their life and the increased situations of them being reached anytime, leading to employees feeling as if they need to be constantly connected (Berg-Beckhoff et al., 2017).
- Techno-complexity: Users feel inadequate when their skills do not match the increased complexity of required ICT devices, leading to them spending more time learning how to use it and similar technologies (Berg-Beckhoff et al., 2017).
- Techno-Insecurity: Users feel like their jobs are at risk of being replaced with ICT or workers better trained in ICT (Berg-Beckhoff et al., 2017).
- Techno-uncertainty: Users are unsettled by the increasing complexity and changing nature of ICT technologies, leading to an increased need to learn in order to stay on top of the trends (Berg-Beckhoff et al., 2017).

These anxieties not only affect the user in terms of work, but in their personal lives too. The pressure to stay connected and constantly updated can lead to burnout and long-term psychological consequences if left unchecked. These anxieties extend beyond the stereotype of

the middle-aged office worker who is not good with technology. Studies show that these stresses disproportionally affect younger workers and students who even grew up with technology playing a significant role in their life (Bozionelos, 2001). The research showed the anxiety levels to age being nearly inverse of each other. Mind, this was data from 2001. Since then, technologies have become even more pervasive and more of a requirement to function in modern social and work life. Students are now expected to have phones and laptops, communication within teams is taking place all hours of the day and night, and nearly all assignments are completed completely digitally.

As a response to the overwhelming presence of technology in everyday life, many younger adults are deviating towards getting involved in low-tech hobbies to alleviate stress, one such hobby being gardening. Gardening is a hobby a lot of people do to escape and calm themselves; it helps people be centred, stay active, and be outdoors, but the benefits are not just psychosomatic. Research shows that not only is there historical precedent for gardening being a method of maintaining health, but it is estimated that roughly 6000 premature deaths a year are prevented from the increased levels of vitamin D and physical activity that gardening provides (Thompson, 2018). Not only that, but maintaining gardens helps maintain a healthy ecosystem and can assist in urban reforestation efforts.

It has been observed that after the Covid-19 pandemic, when the people were confined to their homes during the lockdown period, they took up new hobbies with remote work and increased free time. Gardening tops this list and is one of the most popular hobbies. According to a survey, 42% of people participating said they used the time to garden more (*2021 National Gardening Survey* 2022). This is not just people who are self-described garden masters and enthusiasts (whose populations reported that about 62% gardened more), but the casual gardener population reported that about 48% of respondents said they wanted to garden more (*2021 National Gardening Survey* 2022).

Why does this matter? In this era of technology. More and more people are sticking to gardening as a fixture in their life, and are likely to continue when they start (San Fratello et al., 2022). But people are not always the most green-thumbed, and people who struggle with starting a new hobby can be more hesitant in maintaining it.

Our team decided to address this challenge and work on a solution that integrates technology in a way that would enable the users to start and maintain their gardens while still preserving the satisfying, low-tech aspects of the hobby. By providing users with the tools and information they need in a seamless, supportive manner, we aim to help them experience the therapeutic benefits of gardening without the added stress of technological overload.

PRODUCT OVERVIEW & FUNCTIONALITY (WHAT IS THE PRODUCT?)

FieldSmart is an AR powered application designed for helping users with gardening and agricultural tasks. It is termed to be the ultimate gardening companion for the users that will help them with all the tasks that are needed to be carried out, whether it be in the backyard of your home or in a vast agriculture field.

The application is powered by an advanced machine learning algorithm combined with the AR technology which will enable it to interact with the real world and provide real time solutions to the problem. The core concept of this app revolves around the capability of providing a tailored solution to the user's problem rather than providing a generic solution which can be left for the user to translate and implement. The model will use deep learning neural networks to analyze and carry out analysis of the environment and use the data gathered from the physical sensors installed in the facility which will be interacting with the application through Internet Of Things (IOT) technology. However, this application is designed to be a standalone product so the dependency on IOT technology has been kept minimal.

Imagine pointing your phone to your backyard or an in-house garden or to an agriculture field, the application will automatically scan the visible area and start giving outputs to the user based on what is visible (see figure 1 in appendix A). This will provide basic information like what is the type of plant that you have, how they are planted with respect to each other, the temperature of the area you are located in, information about the type of soil and other weather conditions like air quality, humidity, etc. which are significant to the plant growth. Beyond this information, it will also automatically suggest to the user the actions that need to be taken or tasks that need to be carried out with respect to the requirements or needs of the user. For example, it will pop up reminders if the crops are ready to harvest when the harvesting season is close by

or it will give out suggestions that the user has planted two different plants which are not compatible to be planted together or the distance between two crops is not appropriate. It will also give custom or user specific recommendations for example if the current week is more dry it will display a watering schedule to the plants which is tailored specific to the type of plants that are planted and the deep learning model of the application will allow it to factor in other weather conditions for the given area to calculate this schedule making it very different for the user who might be using the similar application and has a similar plant, but located in a different geographical area.

The application will incorporate the ability to interact with the user in real time. This will help the user to get a dynamic solution for the problems they are encountering. Consider the following scenario to better understand how this feature is important, let's say the user notices an unusual discoloration on one of the leaves but doesn't know what it is or why it happened. They can simply use their phone and let the application scan it (see figure 2 in appendix A). The application will instantly identify it and give a recommended action and level of urgency. For example, if that discoloration is caused by a fungal infection, it will give out the suggestion to use the specific type of pesticide to treat it (see figure 3 in appendix A). Additionally, the application will also show stores in the vicinity of the user that are selling this particular pesticide and if they are available at that particular time. This feature will be pretty similar to the "nearby me" feature of Google maps except for the fact that it won't require any inputs from the user and will be only displaying the relevant product for solving the problem at hand.

The use of this application extends beyond just plant care; it will also provide support for the tools and equipment that are used for gardening or agriculture purposes. For instance, just by scanning a bag of fertilizer, the application will provide a detailed breakdown of the composition of the fertilizer (see figure 4 in appendix A). Moreover, it will also analyze it in detail to provide information of how and why it is suitable for your specific need, again by factoring in various data acquired from your previous interactions with the application. It will also help you track the maintenance schedules of equipment like tractors (see figure 4 in appendix A). This helps the user to prevent unwanted breakdowns which can lead to reduced efficiency during critical times like harvesting seasons.

COMPETITORS OVERVIEW

Earlier studies done on users of AR solutions in agriculture and gardening show a great deal of optimism on the applicability of AR technology in these areas. However, our survey feedback and user reviews also highlighted critical dissatisfaction with existing solutions. These insights motivated our team to look into the competition in order to get hold of their offerings and evaluate the gaps we could fulfil through our application proposal. There are certain dominant players in the AR farming and gardening market and they always enhance their product with additional features. These include solutions like:

- PlantSnap
- AgriTech AR
- PlantVillage Nuru
- CropX

App Name	Key Features	Primary Focus	User Pain Points
PlantSnap	- Photo-based plant identification - Care advice for tracked species	Plant identification and basic care	- Inconsistent identification accuracy - No integration with local data sources
AgriTech AR	- AR for real-time crop health - Soil and moisture data insights	Precision farming and monitoring	- Expensive implementation - Difficult to learn and adapt for beginners
PlantVillage Nuru	- AI and AR for pest/disease detection	Crop health and advisory	- Limited regional pest data - Struggles with uncommon plant species
CropX	- Soil monitoring with IoT - Irrigation schedule suggestions	Soil health optimization	- High setup cost for IoT devices - Less user-friendly for small-scale farmers

Following table represents the top apps in AR Farming & Gardening Market with Key Features, Primary Focus & User Pain Points

The above table shows that these remain partial solutions as they have helped in plant identification, precision farming, crop health and advisory, soil monitoring, pest detection etc. but never really meets the users' real requirements. They have plenty of issues and user pain points that need to be addressed. Our competitive assessment unveiled the following as the major ones:

- **Hyperlocal personalization is extremely limited:** Most of the current applications know how to identify micronutrient or pest problems but lack the means to overcome such situations in relation to the specific area where the user is located. For instance, in some cases, certain applications will show the fertilizers to apply but do not help the user find out where to buy those or suggest practices that are more suited for the locality's pest issues.
- **Expensive IoT Resources Dependence:** Most of these applications are very advanced, which is great. However, to reap this greatness, they require peripherals like IoT sensors and premium subscriptions, making it non-viable for small scale farmers and hobbyists. On the flip side, such a focus on external hardware means users without huge pre-investments have a barrier to get started.
- **User Interface Biased Complexity Feature:** Existing applications are hard to crack in, especially for the non 'techie' culture. The interfaces and user workflows are designed for professionals in the field rather than ordinary lay persons and hence most of them get annoyed and are not willing to use such tools on a frequent basis, showing a huge gap in terms of technology acceptance.
- **Problems with integration:** While some of the above mentioned competitors do provide fancy options and features like drone support or remotely being able to monitor tasks, but integrating basic stuff like watering schedules or pest monitoring, by crop type seems out of their reach.

USER PAIN POINTS

The pointers above translates into critical headaches for users which can broadly be summarized as follows:

- **Cost Barrier:** Scaling with the complexity of current options excludes the smallholder farmer and the gardening community.
- **Over Generalization:** Applying generic recommendations turned out to be a challenge for users in their localized context.
- **Overly Complicated:** Cluttered interfaces become needless hindrances to access and prolonged use of the product.

These findings highlight a critical need for a more user-friendly, affordable, and locally adaptive solution.

ADDRESSING THE GAPS

Our proposed application seeks to address these challenges by harnessing the advances of AR technology and being usability, accessibility, and hyper localization specifics focused. Some of the key differentiating features of our product from the already existing competition are as follows:

- **Hyper localized Recommendations:** Our app will be enhanced with features that will provide local stores and vendors that have particular products for example fertilizers, seeds, or pest control solutions. This relieves users from a trial-and-error approach because they receive steps that are practical for their environments.
- **Cost-Effective Design:** The app will have a simplistic user interface, with a lot of power in the hands of the user. Just like ChatGPT! Decreasing the unnecessary features would reduce the cost and make it more effective and viable for a wider audience such as small farmers and enthusiasts since it removes the barrier to entry of high purchase price of dietary equipment while also introducing low priced subscription models.

- **Simplified User Experience**: The app will aim to be simple, with a systematic flow of navigation and little configuration efforts. Features will work for pro farmers and for beginners as well to make it universal.
- **Integrated AR Features:** The main AR features will enable users to view the existing or anticipated issues of a plant and the solutions provided for such issues in an interactive manner. It will likewise enable users to quickly move from issue identification to action enhancing the efficiency of farming and gardening.

The market assessment and competitor analysis make it clear that there is a significant scope in the AR market in agriculture and horticulture area; there is however a clear gap in terms of practical application. The gap exists in affordability, usability, and actionable hyperlocal analytics - the space is ready for disruption.

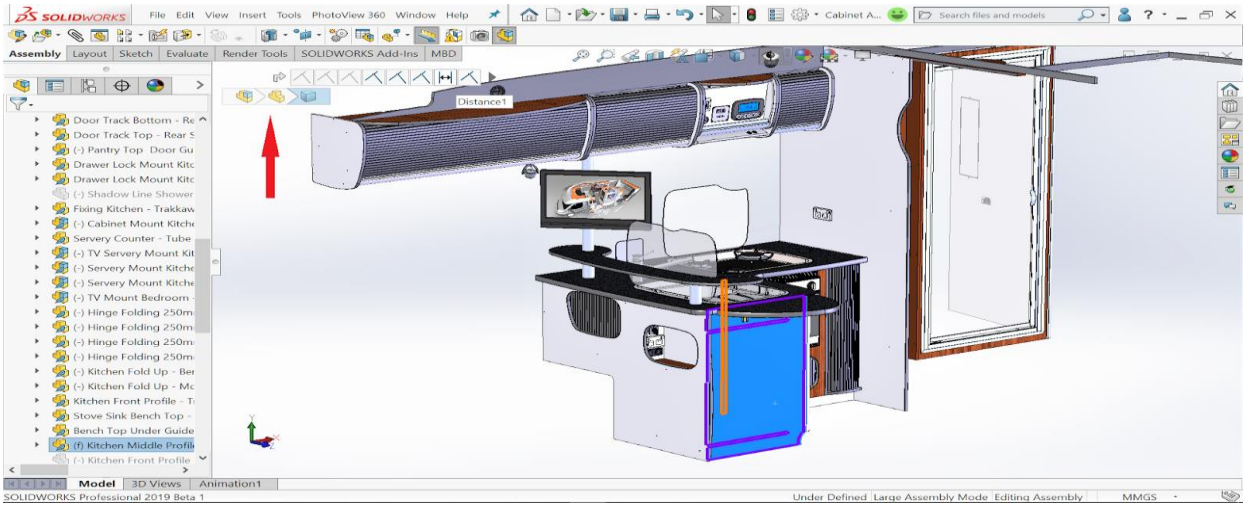
The goal of our application is to be that change agent – a sophisticated yet simple to use tool. We believe by improving technology or by refining the user interface, the most serious challenges users face will be closer to resolution. This will enable hobbyists and professional farmers to be able to confidently perform their practices as well as do so with proficiency.

It is our belief that the advancements in technology should also lead to more real-world applications and impacts instead of being limited to just developing advanced technology. This product defines the direction in which the future should go, minimizing the multifaceted use of AR in agriculture and gardening to easier ones that can promote development.

With this insight about the market and the hurdles in mind, our next step is to concentrate now on the way the product will take shape. Let's look at what we are going to create in this case and how we are going to implement our idea.

IDEATION FOR AN IMMERSIVE & USER-CENTRIC DESIGN

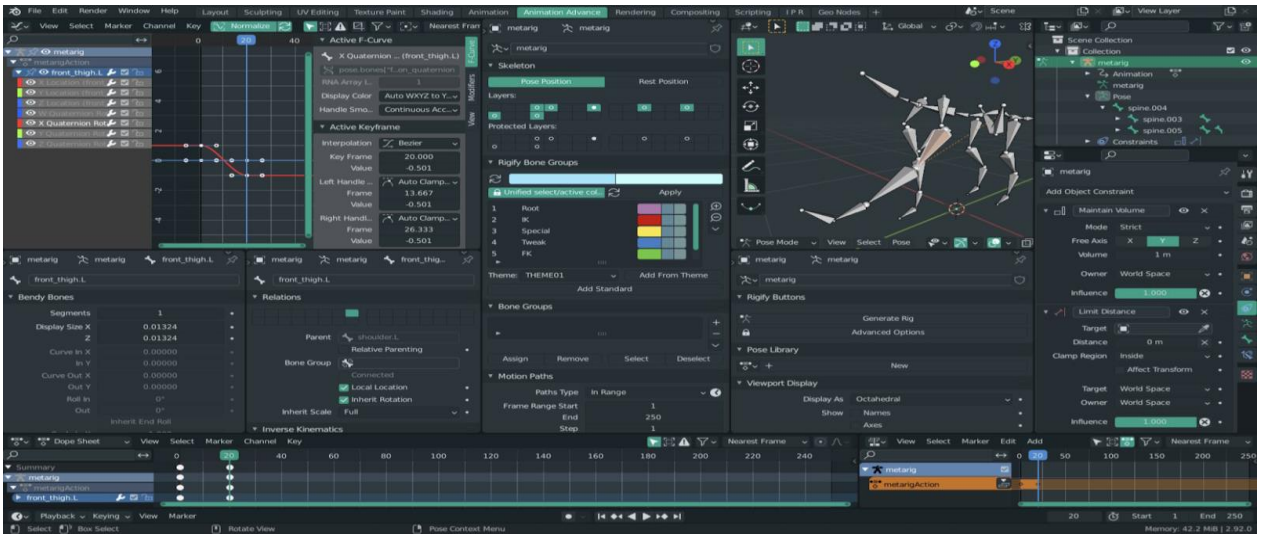
FieldSmart is designed to be an interactive and immersive experience for the user. It continuously interacts with the user at every step to help them navigate through the process or the problem. Hence, interface design was one of the major aspects for this application. Designing an interface for a program as big as this presents an immense challenge. How can we provide a myriad of features spanning across multiple domains without overwhelming the user with large complex interfaces that take time to learn. We kept coming back to one idea presented in class. That was, the idea of an adaptive interface versus and adaptable interface. What does it mean for an interface to be adaptive? What does it mean for an interface to be adaptable?



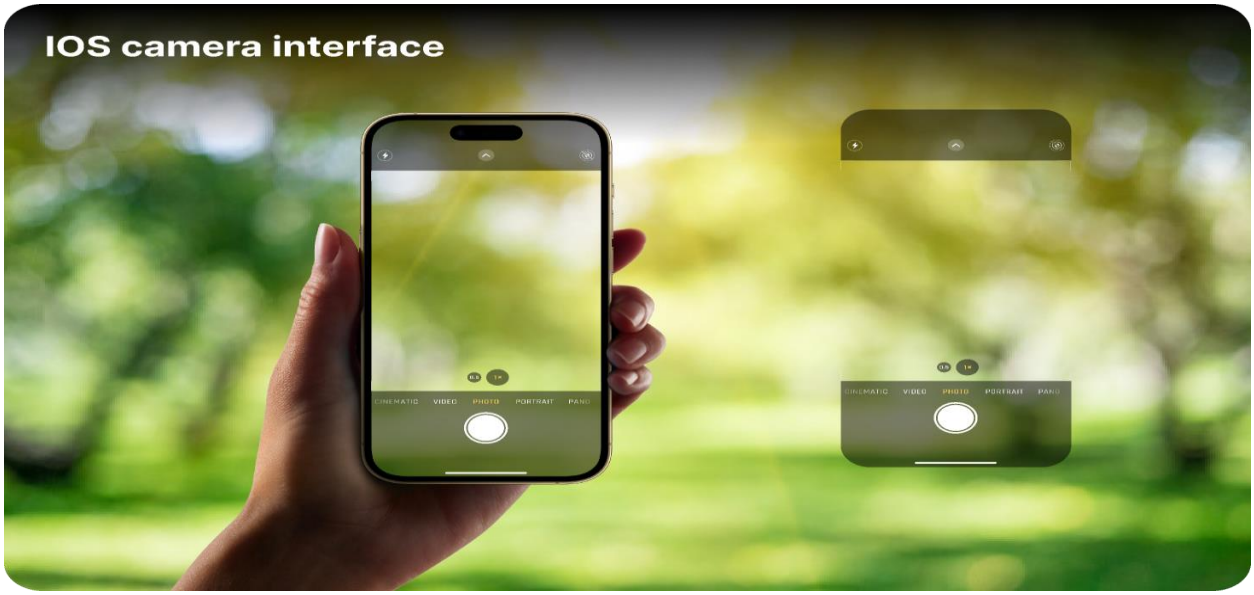
SolidWorks is an example of a software program that has an incredibly adaptable interface. The tasks being asked of the program are both daunting and incredibly varied. Everything from 3D modelling to simulation to surface modelling to architectural renderings. In order to be able to offer the tools to take on these tasks without overloading the user with an unwieldy interface. SolidWorks employs measures such as swappable toolbars and different working environments where different features are available depending on what "mode" you are in. Another example of such a software is Blender. Blender is an open-source software package that enables users to create 3D renderings. Everything from animated movies to realistic visual effects and complex simulations can be created in Blender. Once again, having such a wide set of abilities requires innovative solutions to ensure a usable interface. Blender also employs the idea of having workspaces.

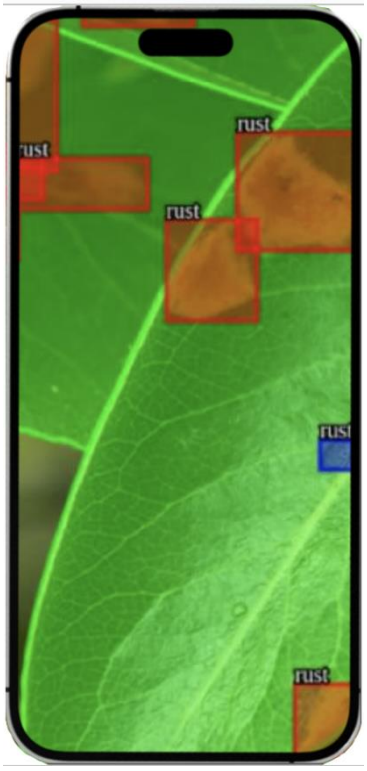
Although these solutions work well for their respective programs. The learning curve for these pieces of software is still considered one of the largest barriers to entry for new users. Often, there are entire certifications that can be awarded to employees to undergo training to be able to use these software packages effectively. Our survey results clearly showed that our prospective users were deeply put off by unwieldy interfaces that required a large time investment in order to learn. They didn't want a tool that ever got in the way of them and the task they wanted to accomplish. They felt that many of these pieces of software did just that.

We wanted to change this. We wanted to create an interface that could contain a quantity and quality of features that are both comparable to software programs like Solidworks but without the learning curve. On the surface, this seems like an inherently flawed pursuit. In order to create an interface that enables a large set of features. You'd need a large number of buttons and widgets. In reality. This interface design problem has been solved before.



Most people don't really think about the camera interface on their phones. For many, it is merely a fact of life. We wanted to build our interface around something that people from all demographics and all walks of life already intuitively know how to use. The smartphone camera interface. Even people who typically find difficulty using new technology and navigating new interfaces often are still able to navigate the camera interface enough to take meaningful photos. In addition to this, the camera interface on all modern smartphones has an example of an adaptive interface element that we wanted to exemplify throughout our entire product. It's a feature that doesn't require pressing a button or navigating to a different interface and yet it's an element that many people use daily. The ability to scan QR codes.





If you're prompted with a QR code. Most phones inherently have the ability to recognize that you're trying to scan a QR code without you ever needing to interact with a button on your phone for this feature. You could be recording your dog one moment, then scan a QR code the next, all without touching any buttons on your phone. Your phone almost "anticipates" what you're trying to do. We wanted our entire application to work this way.

Let's say you were inspecting some potted plants in your garden. You've opened our app and are using the camera interface to inspect the growth progress of each plant. The app has remembered these plants from the previous times you've scanned them and is giving you helpful data and feedback about their progress. Then, you scan a plant and the application recognizes some fungus growing on one of the leaves. Our idea is that, without user intervention, it would highlight the defect it spotted and immediately inform the user with information regarding what it believes the issue is as well as provide a list of possible solutions.

Another example of this would be using the application to provide information regarding farming equipment. Let's imagine that you pointed the camera at a tractor for instance. The program would recognize the machine and provide you with information about its make and

model. It would also provide you with information about resources available for repairs and other maintenance needs that are available nearby based on your location. It could provide information about competing tractors and compare their fuel efficiency for you. However, not everybody owns a tractor. The idea is to only show user what they need at the particular moment. Using this idea, our interface would be built in such a way that if you never pointed the camera at a tractor, you wouldn't ever know that the program is capable of analyzing tractors. This would apply much in the same way as the idea that if you never pointed your phone's camera at a QR code. You might not ever know that it's capable of reading QR codes.

Our philosophy from the outset is that we don't want to ever get in the way of people and their hobbies. We want to enable them to do more. We don't want to ask more of them. The pursuit of this philosophy led us to this interface design. Where vast quantities of high-quality features and incredible ease of use come together to enable users to do more of what they love, and spend less time interacting with technology while they do it.

This approach to a minimalistic interface is something that doesn't exist in any other software currently existing. The majority of currently existing applications for this purpose rely on a large set of menus and numerous buttons and different interfaces that users are expected to be able to navigate.

METHODS

DATA COLLECTION USING SURVEY & USER PERSONA

We started by sending a questionnaire to thirteen young adults who are or want to work in technology to get a feeling for what our users are looking for in a product and to determine our design direction. Questions in the questionnaire asked our users to describe:

- Their current familiarity with Augmented Reality (AR) technology
- What their current and desired gardening habits are
- What would be considered an issue with the technology?
- What would be considered a success with the technology?

69.2% of users admitted they do not currently use technology in their outdoor activities (see figure 1 in appendix B), and 61.6% would be more accepting if it helped them with their goals (see figure 2 in appendix B). The most popular goals stated by our users were relating to making an aesthetically pleasing garden (15.4%), creating a garden that cohabitates with local wildlife (30.8%), and improving the health of their plants (30.8%) (see figure 3 in appendix B). They would like to see technology do this by providing recommendations based on contextual information and helping them visualize and plan out their space and resources better.

In terms of limitations, nearly 40% of our users expressed concerns with data collection and 92.3% were hesitant or refused to use a product they would have to subscribe to (see figure 4 in appendix B). These are the key challenges that we can face for the product and are discussed in detail in the sections ahead. We took this in mind and designed around minimizing user data collection to only what was necessary to provide them with an output that fit their needs and while the design team has little say in the pricing model, in a business area we would suggest minimizing cost where possible. 61.5% of the users expressed that they wanted the information to be accurate, so we want the output of the technology to be relevant and helpful to each individual user's needs, no matter location or climate. Finally, another 61.5% said they wanted the application to be easy to use, so we opted towards a minimalist design with a low learning curve.

With this information in mind, we made a persona as a reference for us to design off of. Our proto-user is a young adult just out of college. They either work in or have an interest in tech, and are eager to start a garden despite not knowing much about how to raise a plant. They are not sure about what types of plants grow well in their area, and want to be mindful of their space, cost, and water usage, as well as the local wildlife. If their use of the current space turns out well, they would like to expand their garden, but making sure what plants they currently have stay alive is the goal right now.

COMPETITIVE ANALYSIS

Investigated the current AR and digital farming apps including CropX, AgriTech AR, PlantVillage Nuru, and PlantSnap. Noted shortcomings in their provision such as the absence of adaptive suggestions, limited scope in terms of external variables (such as local wildlife and soil moisture) at the connections level, cost to the users and steep learning curves. An in depth analysis of the limitations of the existing solutions and what need is being met with our solution can be found under Introduction section.

RESEARCH AND MARKET TREND ANALYSIS

We conducted thorough research on several websites to find out how extensively AR is being incorporated in gardening or agriculture related activities. This gives us an idea about the existing applications that are available to support the users to varying extent (refer the Competitors Overview section). We used platforms like Google Play Store and Apple Store to identify common user grievances from the reviews.

HUMAN FACTOR PRINCIPLES USED IN DESIGN

FieldSmart is designed to be the one stop solution to all the problems that are faced by the people in gardening activities be it in your backyard or in a small pot in your room or in a field spread over acres. The purpose of this application is to make gardening sustainable and more simple such that a person who is new to these activities can do it efficiently without the need to

rely on any other support except this application. The concept and functionality of the application revolves around human-centric design and tries to minimize the cognitive load on the user in every possible action.

The cognitive principles that are incorporated in this application can be understood from how it interacts and helps the user. Below mentioned is a list of principles that the application incorporates:

- **Predictive aiding system:** This is the core functionality of the application which automatically analyzes and distinguishes the elements important/relevant to the user making it easier for the user. For example, it automatically displays the basic important information when the user points their camera without the need of any input.
- **Knowledge in the world:** The system uses knowledge available from the user's database and the extensive internet to give informed recommendations which reduces the cognitive load on the user's memory like remembering the schedule or missing some details which they might have failed to notice at that moment. This will also help capture information that might go unnoticed to the human eye.
- **Affordance and Signifiers:** This principle is concerned with the ability of the application to clearly point out to the user what action needs to be taken and where specifically it needs to be taken. This reduces the confusion which the user might face when the suggestion is generic, not knowing where and to what extent that solution will be effective.
- **Error recovery:** The application automatically suggests the best possible solution, helping the user from making any wrong selections. However, there is a scope to upgrade this information with additional user input and make the machine learning model learn more about a specific problem.
- **Visceral design and Conceptual models:** The application displays all the information in a systematic manner using the icons and symbols that clearly convey the information intended to be, leaving little room for confusion. For example, its interface uses naturalistic visuals, such as icons resembling leaves or soil gauges, to enhance engagement. The conceptual models this application employs, well aligns its explanations with users'

mental expectations, making it intuitive even for those new to agriculture or gardening activities. (see image 4)

- **Reflective design and Task analysis**: As previously mentioned, this application is powerful enough to process a large amount of information on the go but using task analysis principle, it only shows users the most relevant information required at that moment. This kind of reflective design reduces the cognitive load that the user faces and helps them focus on the task at hand without getting overwhelmed by a large amount of information.

PRODUCT DESIGN CHALLENGES

The idea of FieldSmart was to make a highly human-centric and user-friendly application which can be used by people especially the young adults without getting overwhelmed or experiencing the same number of difficulties that they usually experience with the use of conventional applications. This presented us with the following design challenges which we tried to address in the concept design of the FieldSmart.

- We wanted to incorporate highly technical AR features and a rich interface which is very autonomous and requires minimum intervention from the user. This was a big challenge given the nature of the technology and the tasks that it required to do were of complex nature. To overcome this, we chose a minimalist design which can be achieved using the camera of the smartphone. A detailed overview of this can be known for the Ideation section in the report.
- The next challenge was to design this application to be cost effective and sustainable for the user. It should reduce the overall cost involved for the user from using this application to carrying the suggestions that are provided by the application, To overcome this we came with the idea of hyperlocal personalization which aims at providing a personal solution rather than a generic solution and reduce the wastage or error, allowing the user to save money and as well as time.
- The application needs to be adoptable for many people to use it. This needed to be reflected in the design. There are various adoption barriers (refer the Adoption Barriers section of the report) concerning this application however we were trying to resolve it to some extent by keeping a lower learning curve. This needs to be streamlined continuously as the machine learning model trains itself with new user information and adapts to the user's needs.

USER ADOPTION CHALLENGES

FieldSmart is an augmented AR technology that aims at personalizing the gardening or agriculture activity by solving the problems faced by the users during these activities. This technology has some inherent challenges/concerns that needs to be addressed owing to the nature of this product. The following are the major challenges that the product might encounter and reduce its user adaptability:

- **Privacy:** This application is designed to function and address the specific needs of an individual user. This needs a biased learning model for the algorithm that will be running behind this application. To train such a model a large amount of user data will be captured to give relevant information of the user. This can be a problem for people who are concerned with privacy and might feel uncomfortable since a lot of their information like demographics, the property they own like machines and land areas (mostly relevant information linked with the gardening/farming activity) will be captured by the model to train itself.
- **Security:** The idea behind this application is to increase the usability for the user and make it extremely easy to use. This inherent nature of the application limits the use of security features that can be added to the application. For example, the default security settings will allow the application to access data from user's device like camera, location, and microphone to increase the usability with minimum user interference. The application has real time feedback so using a security feature like encrypting the data can severely downgrade the performance and introduce delays.
- **Environmental Factors:** The environmental factors can play a significant role in determining the use and performance of the application. Since the application is designed to be used for outdoor application (open backyards or an agriculture field), it can be exposed to the environmental conditions that are not normal. For example, when the climate is foggy or it is raining heavily, due to the limited visibility the application might not efficiently scan the environment and may provide an incorrect result. We can eliminate this limitation by making users give input to the application but this happens at the cost of reduced usability.

FINDINGS

In testing our generated wireframes with some of our original questionnaire participants, we needed to be deliberate on what we were testing for and used that to influence our methods. Since we don't have user data or geospatial data to test aspects such as data security and information accuracy as thoroughly as if we could if we had a higher-fidelity prototype. To compensate for this, we opted for a form of A/B testing partnered with an interface walkthrough to understand how users perceive how these challenges are being addressed. We provided users with images of the interface and asked them questions on which they felt was better organized, clearer, and felt safer while being open to answering any questions the users may have about the interface. In addition, we wanted to gauge opinions regarding aesthetics and information architecture.

When addressing interface aesthetics and architecture, our users expressed more interest in interfaces that kept the initial screen focusing on the environment and camera rather than information and statistics. For their reasoning, a couple users mentioned how they felt a more minimal interface let them focus more on the garden. A couple more expressed that they felt this interface was safer and expressed displeasure with how they felt the other interfaces were "trying to sell [them] stuff". However, more users expressed the data-focused interfaces felt better organized in their information and how accessible that was to the user.

With this in mind, we proceeded with a hybridized interface, where the user was able to focus on the plants in front of them, but when information is presented, it is in a structured but unobtrusive way. This method maintains a low onboarding time for the user, but also allows them to reap the benefits of the minimalist screen and easy access to necessary information.

CONCLUSION

SOCIETAL IMPACT

FieldSmart is a transformative solution that can change the way people do gardening and agriculture. The application is highly personalized, making it highly associated with the daily lives of the people. Nurturing a plant is an activity which is carried out for a period of time which makes this application a daily use application rather than an occasionally used application.

The societal impact for FieldSmart can be broadly understood with the following:

- **Transforming the interface technology:** The interface design used is a perfect fit for our application. We believe that this approach extends beyond our program. All throughout the technology industry. Companies are constantly creating new products that intend to help people with their hobbies and interests outside of their digital lives. However, oftentimes these companies create a tool that requires more time and work to fully utilize than the time and work it saves the user for accomplishing the task that they initially set out to complete. As previously mentioned in our ideation process for developing this application, we took the example of a complex software like SolidWorks, which is quite famous and is used by companies all over the world, however, when you compare it with ChatGPT, there is a significant difference in the usability. ChatGPT is a recently introduced product that has quickly registered huge user adoption. The opening screen on the ChatGPT webpage shows only one text box which has a single instruction. This interface is very basic yet strong, easy to use, and is quite standard. Similarly, our product would set a benchmark to revolutionize advanced technology and software. This could enable users from all walks of life to be able to pursue any hobby or interest they would like to pursue more easily.
- **Sustainability:** FieldSmart is efficiently designed to provide tailored solution to the user preventing them from getting confused and take a wrong action. However, this also helps to provide a sustainable way of doing these activities compared to a conventional approach. It can be understood from the following two aspects:

- **Economical:** The solution proposed by the application is highly specific to the problem which optimizes the resources needed, allowing the user to cut down the cost associated with wastage and errors. For example, it will tell users which kind of fertilizer or pesticide to use allowing them to save for spending on the wrong type. This can make a significant impact when the application is at large scale for a commercial activity like agriculture.
- **Environmental:** The application provides suggestions for the given problem based on the type of plant, the environmental condition and the intensity of the problem. It also factors in the harm caused by particular chemicals to certain types of plant and can warn users about the same. Environmental sustainability can be better understood with the following example, wherein the application provides a very dynamic watering schedule for the plants, depending on the weather and the type of plant, saving the wastage of water which a regular person would not be able to do by themselves.

- **Mental Health and Well-being:** In the previous sections, we have already discussed how gardening is becoming increasingly popular especially in the post pandemic era. FieldSmart can boost and encourage even more people to engage in gardening as a hobby since it makes the tasks very easy by replacing the cognitively demanding tasks to a mere read and follow type of task. This can improve their mental health and reduce stress levels. The planting of more trees can make the environment greener by reducing the pollution levels which in turn again contributes to the health of the community and the society.

FUTURE SCOPE

The application will use a deep learning neural network model, which with the advent in computing technology, will have a processing power to handle millions of terabytes of data in milliseconds making it possible to have a real time interactivity and continuously learning from the user's specific use or problems. The model will be biased and will be adopted extensively to that user to make a very specific and tailored solution for that user, making this application highly personalized.

In future, this application can be implemented in devices like AR glasses and can also be combined with holographic technology to make it more immersive. The concept of the application can be extended to applications beyond gardening and agriculture, increasing the scope and the usability of this product.

APPENDIX A. FIELDSMART APPLICATION INTERFACE

Fig 1. Interface View When the User is Scanning their Farm [AI-generated image].ChatGPT.

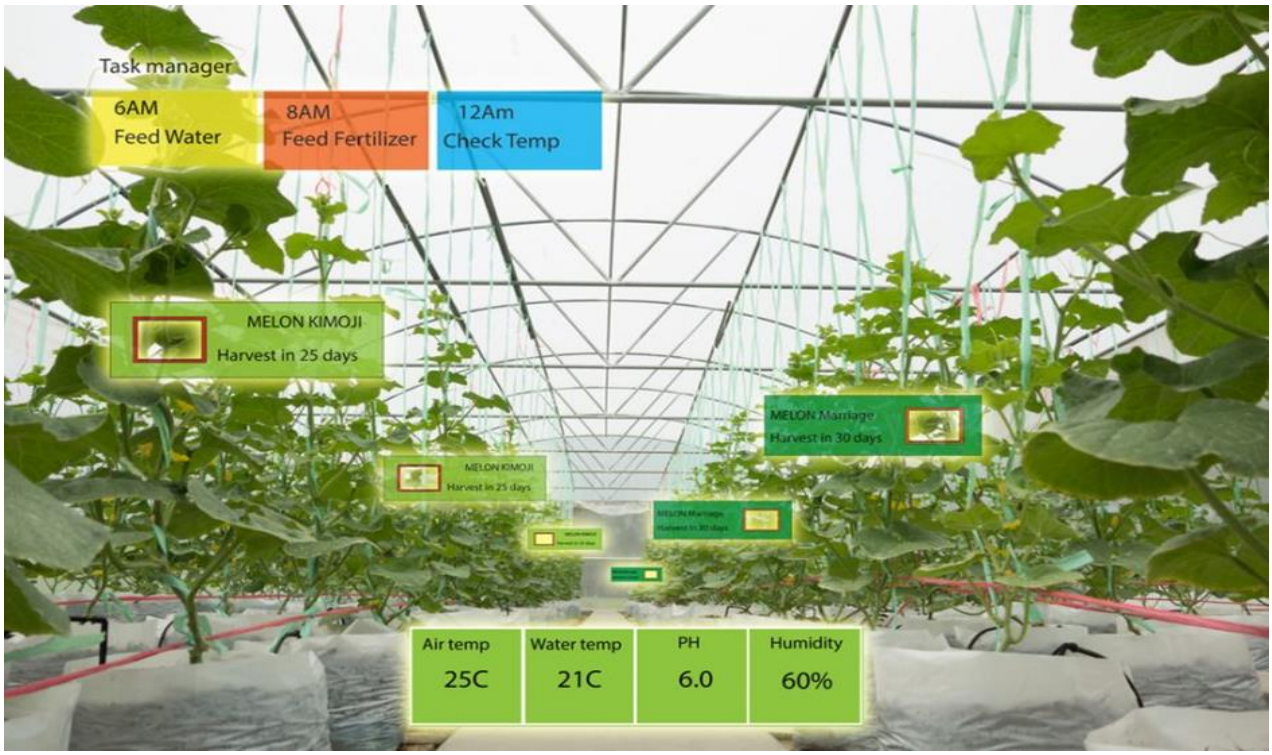


Fig 2. Application is Used to Scan the Abnormality [AI-generated image].ChatGPT.

Fig 3. Proposed Solutions Tailored to User Specific Problem [AI-generated image].ChatGPT.

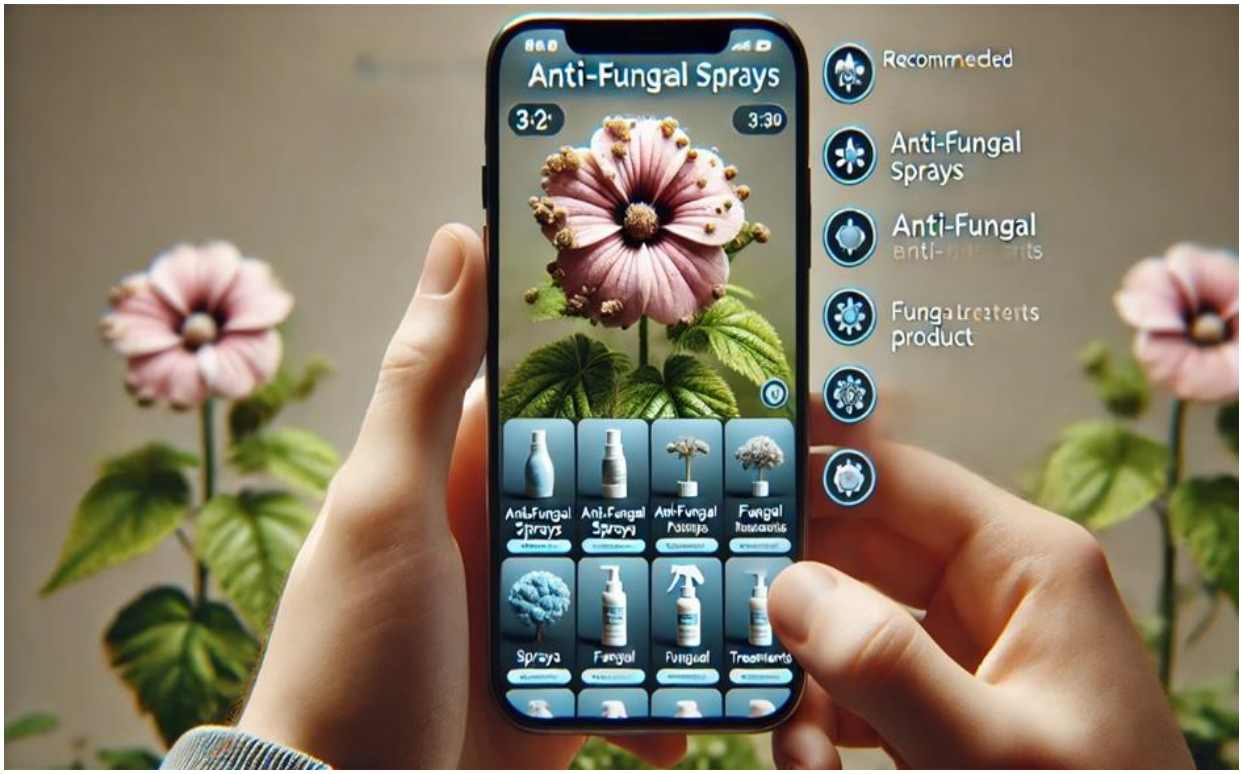


Fig 4. Application Used to Scan a Product/Equipment to Get Detailed Information [AI-generated image].ChatGPT.

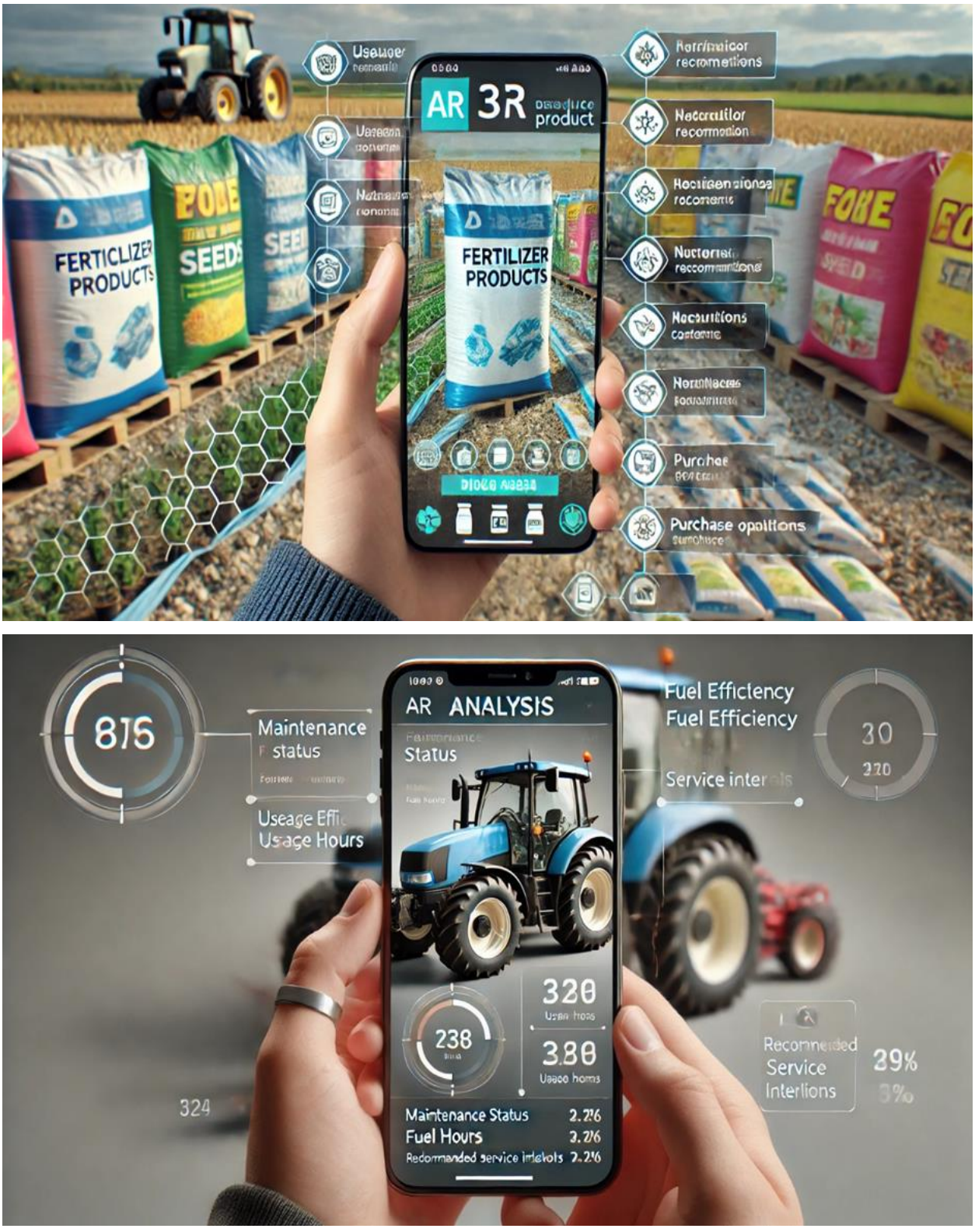


Fig 5. Icons and Displays Made Using Visceral Design and Conceptual Model [AI-generated image].ChatGPT.

APPENDIX B. SURVEY CHARTS

Fig 1. Count of Users Using Tech for Outdoor Activities

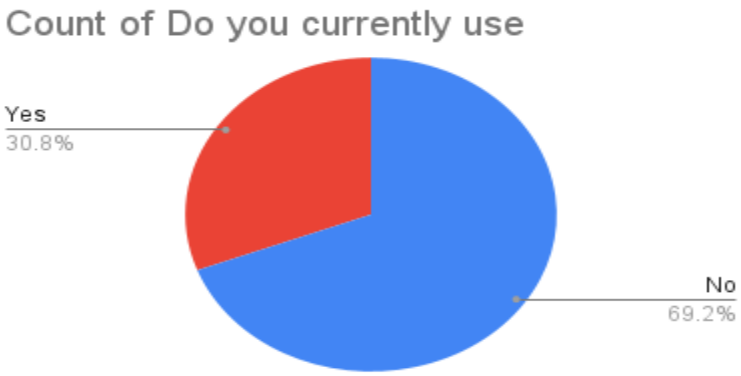


Fig 2. User Acceptance Rates of Tech

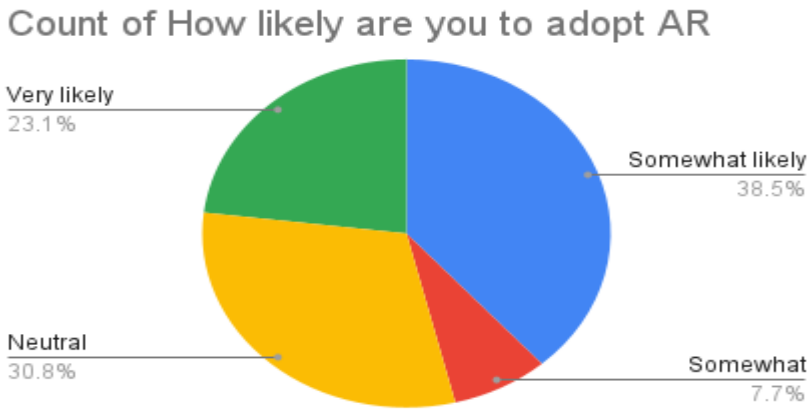


Fig 3. Goals of Gardening Application

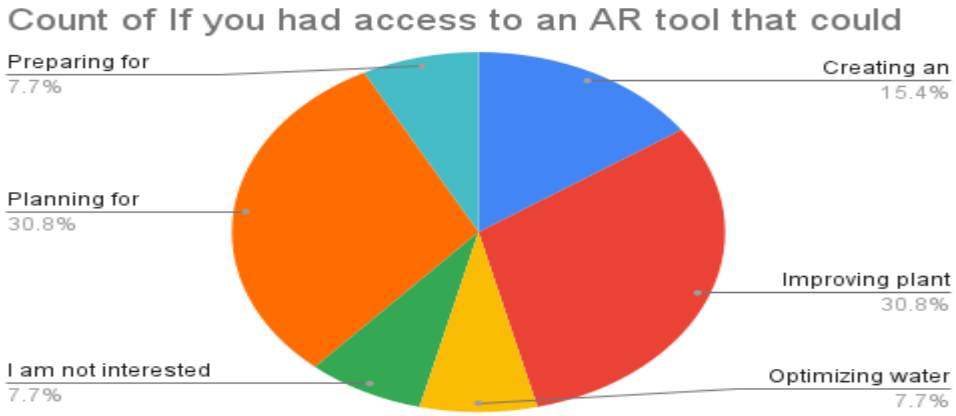


Fig 4. Rate of Acceptance for Subscription Model

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