ABSTRACT

DESIGN IN ADAPTATION TO DROUGHTS AND HEAT WAVES CAUSED BY CLIMATE CHANGE IN RICE FARMS IN LERIDA, TOLIMA, COLOMBIA.

by Andrea D. Mateus Forero

There is a communication gap between farmers in Lerida, Tolima and colombian climate entities which contains information that is vital to better control farming operations. This project addresses this problem by improving the communication platforms between farmers and the technology available to help farmers by using design. The goal of this project was to enhance communication platforms between farmers and climate entities, different design theories and UI/UX tools were implemented to improve this communication. Currently, the design solutions and technologies available to rural farmers are not effective, accurate or user-friendly, these technologies were not designed with rural farmers in mind, they do not have access to the information that they need on a platform that is easy to navigate. This research aims to to enable farmers to get the information they need. It was economically relevant to invest in this problem in the area: Lerida, Tolima. because rice field farms are the first employment opportunity in town (Yanes, 2013). Mitigation adaptations and better communication would be very beneficial to the area (Ramirez-Villegas, n.d.).

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by

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Dedication

My work could not have been done without my grandfather Hernando Forero and my uncles Jorge Enrique Forero and Hernando Javier Forero. All of them inspired me as a person and as a professional, they have taught me to invest in our region and were an example of hard work and entrepreneurship. This work is dedicated also to my mom Maria Isabel Forero and my sister Lina Mateus for always trusting me and supporting me in whichever goal I set for myself.

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DESIGN IN ADAPTATION TO DROUGHTS AND HEAT WAVES

*IN RICE FARMS IN LÉRIDA, TOLIMA, COLOMBIA.

CHAPTER 1: INTRODUCTION

Climates are changing and causing damage in our environments (Ramirez-Villegas, Salazar, Jarvis & Navarro-Racine, 2012). The reasons behind climate change are not the main discussion of this paper. My intent with this topic is to help those who are already affected by one of the many consequences of it: droughts and heat waves. I focused on rice farmers at Lérida, Tolima in Colombia, and how it is important to realize that there is a communication gap between climate entities in Colombia and rural farmers. Vital information for farming is hard to obtain and there is a need for a better platform to enhance this communication process. Farmers are in charge of providing food. Because the new climate conditions have affected the way that they farm, all of the area is going to be affected very soon financially, given that it economically relies on Rice production (Yanes, 2013).

These arguments led to my **research question: Which adaptation design outcomes can designers create that are valued and seamless for everyday life for farmers affected directly by droughts and heat waves?** Even though there are outcomes and digital technology in the market that help farmers with strategies and ways to improve farming, they are often not accurate or user-friendly and do not take into account the technologies that stakeholders have access to. We must ask how well the communication between farmers and the information providers is working. All of these are aspects that the research aimed to cover in order to identify the main current challenges farmers are facing and design an outcome that facilitates this communication.

My goal was to enhance communication between farmers and climate entities to give farmers an opportunity to make more informed decisions over their farming operations. I used design theories, Design Research and UX/UI tools to improve communication between farmers, agricultural engineers and climate information suppliers. I also created a conceptual framework that encompasses one theory and two models to better-frame my research: The Diffusion of innovation theory (Orr, 2003), which explains how a specific population adopts a new idea, behavior or product; the Technology acceptance model (TAM) (Chuttur, 2009) which proposes a guide of how users come to accept and use a technology and the Concerns-Based Adoption Model (CBAM) (Hord, Ruthenford, Hall, 1987) which was created to assure a new innovation program is being adapted properly by individuals (Hord et al., 1987).

CHAPTER 2:
LITERATURE REVIEW

Even though climate change is not the main topic of my research, different evidence of it has been produced in different fields, from agriculture to animal habitats which influences people on realizing the danger of climate change consequences (Washington & Cook, 2011.). The intention with this topic is to help those who are already affected by two specific consequences of climate change: droughts and heat waves. I will focus on rice farmers at Lérida, Tolima in Colombia (Burack, 2009).

The Municipality of Lérida is located geographically north of the Department of Tolima, 73 kilometers from the capital of Ibagué, it is located between the following coordinates: 4º 52 '58 " of Latitude North and 74º 55' of Longitude to the West of the Meridian of Greenwich and average height of 366 Meters above sea level, its population is around 20,153. Agriculture is the activity that generate most employment in the Municipality of Lérida, Crops of Rice and Sorghum are the most important crops. (City Hall of Lérida Tolima, 2003)

There is no universal definition of Heat Waves but it is associated with particularly hot sustained temperatures, these have even knows to impact notably on human mortality, regional economies and ecosystems (Meehl & Tebaldi, 2004). On the other hand, a drought is view in general as a sustained and regionally extensive occurrence of below average natural availability, this can include precipitation, river runoff or groundwater (Beran, Rodier, 1985).

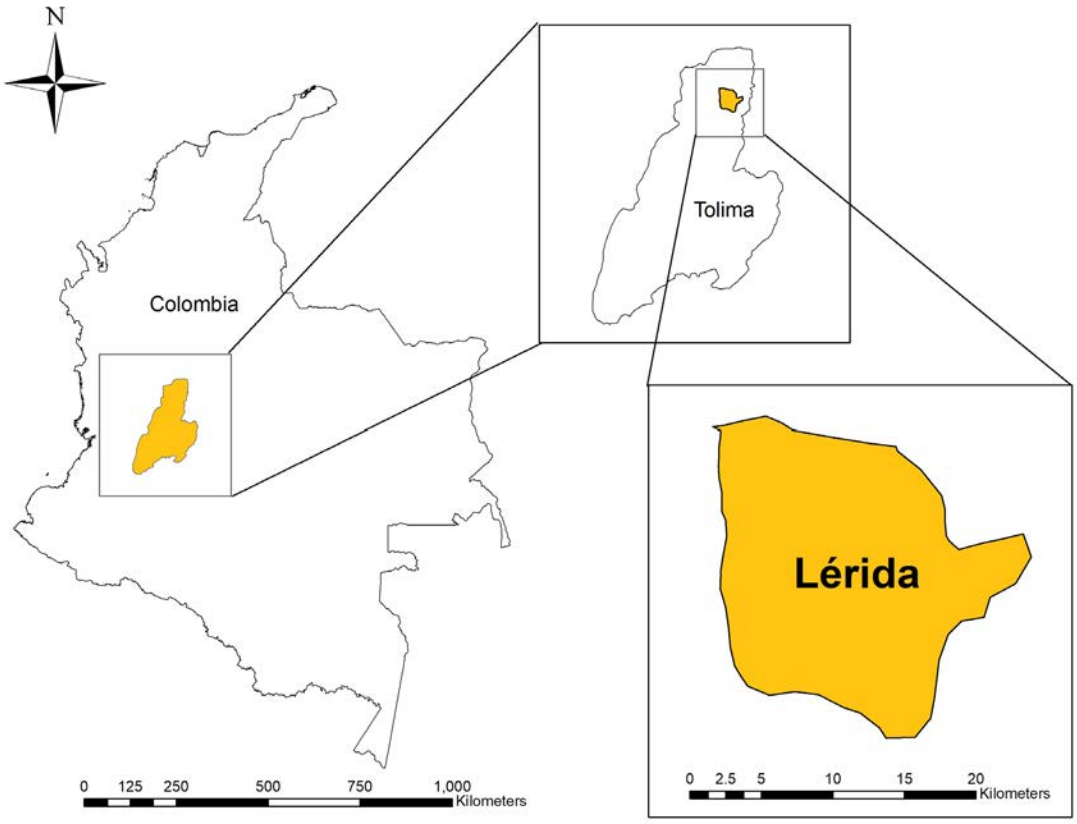


Figure 1. *Map of Lérida, Tolima*

Heat waves and droughts affect different parts of a community, especially if it is in a developing country where agriculture is an important component of the economy (Ramirez-Villegas et al., 2012). This is the case in Colombia, more specifically the city of Lérida in the Tolima department. Constantly affected by droughts and heat waves (Peña Quiñones, Arce Barboza, Ayarza Moreno & Lascano Aguilar, 2010).

As mentioned before, a big percentage of Lérida rice farmers rely on rice cropping for financial reasons, these farmers are currently looking to improve farming techniques. Rice production consists in a three phases process: Pre-planting, Growth and Postproduction. Pre-planting consists in choosing the right rice variety, check the seed quality, developing a cropping calendar, and preparing the rice field for planting. Growth is when Important management factors come into action during the growth

of the rice crop. These include planting method, water, fertilizer, weeds, and pests and diseases ("Step-by-step production," n.d).

Droughts and heat waves can affect theses stages: worldwide, water for agriculture is becoming increasingly scarce. Due to its semi-aquatic ancestry, rice is extremely sensitive to water shortage ("Step-by-step production," n.d). There are many adaptation resources to droughts and heat waves when farming, however the intent of the project is to be able to provide a user friendly solution to farmers who have not had access to these resources so far in the study area (Hawken, 2017).

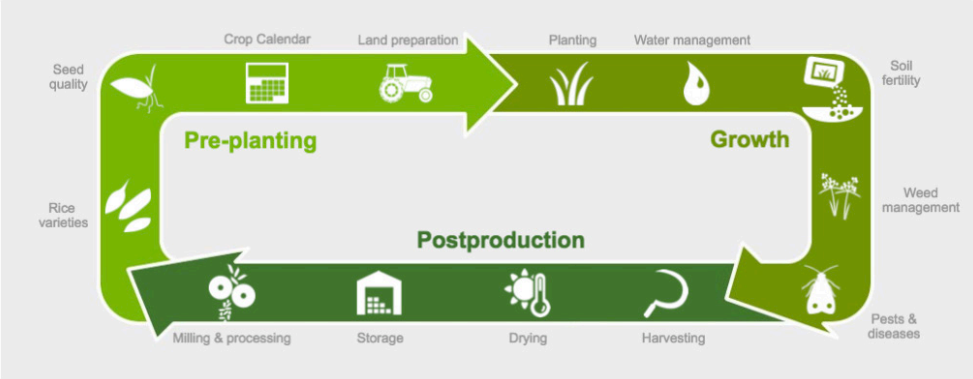


Figure 2. *Rice production process ("Step-by-step production" n.d.)*

Even though my research aims to bridge the gap between available information and the rural farmers needs, there are many stakeholders affected by the droughts and heat waves in Lérida, Tolima (Yanes, 2013). Farmers might seem like the primary stakeholders, however, the entire community is affected by the lack of rice which is key in their diet and economy (Yanes, 2013), this has economical consequence, as it increases the price of rice in the market. With the help of an accurate climate communication system, farmers may be able to increase their crop yields which is good for the whole community (Ramirez-Villegas et al., 2012).

Economically, rice cultivation is the first employment resource in Lérida and currently the rice industry in Lérida is threatened by The U.S.-Colombia Free Trade Agreement (Villareal, 2012) and climate change

(Yanes, 2013). There is an opportunity to implement an adaptation design outcome to these vulnerable town areas.

In order to understand what resources are available, this project covers certain studies that have been published in both natural and social sciences. Natural sciences are the disciplines that deal only with natural events (i.e. independent and dependent variables in nature) using scientific methods, whereas social sciences are viewed as those that deal with "human society, societal groups, individuals in their relationships with others or institutions of societies and material goods as expression of human cohabitation" (Boutellier, Boutellier & Raeder, 2011). It is important to categorize these studies in a global, regional and local scale: Global, because climate change is a phenomena which factors and consequences apply globally; regional because in Colombia the agricultural sector has traditionally been of key importance to the economy, given its contribution to GDP, employment and exports (OECD, 2015); and local because rice field are the first employment resource in town (Yanes, 2013). Each of these scales brings up important points and each scale has different points of view to help better frame how to help rural farmers in the rice fields.

2.1 NATURAL SCIENCES

On a global scale, Climate change can be defined as a significant variation in the weather conditions or its variability in a certain amount of time, generally in periods of ten years or more (Ramirez-Villegas et al., 2012). Temperatures have increased overall: Even if the concentrations of greenhouse gases in the atmosphere had been stabilized in the year 2000, we are already committed to further global warming of about another half a degree by the end of the 21st century (Boutellier, et al., 2011) which affect temperatures and, consequently, affects farming by altering farming techniques, schedules and systems (Backlund, Janetos, & Schimel, 2008).

Colombia, a tropical country, is being highly affected, specifically in rice field areas the temperature has increased. It is estimated that by 2050,

65% of the current rice fields in Lérida, Tolima will likely increases in temperatures between 2° and 2.5°C (some 61% of the areas could feature 3% greater precipitation) (Ramirez-Villegas et al., 2012). Because of this, adaptation measures need to be addressed. Recent work of CIAT, International Center for Tropical Agriculture, has shown that adaptation strategies, such as building irrigation systems and establishing a rice genetic improvement and research center, are completely offset by the increases in agricultural yields and income by the 2030s (Ramirez-Villegas et al., 2012). This means it is worth investing in these adaptation strategies over a long term period. For example, changes in crop phenology and impact on product flows to markets and supply chains for rice could be impacted by changes in harvest and sowing dates. Infrastructural changes, such as irrigation or drainage, could be used for perennial crops (Ramirez-Villegas et al., 2012).

Locally, there is a study in Espinal, a city located near by Lérida, Tolima (refer to figure 3). Both cities share climate conditions and similar population and culture. The study analysis suggests that temperatures are going to increase more than 0.6 °C by 2020 (Peña Quiñones et al., 2010). If the weather keeps this tendency by 2019 is possible that the pastures of the surrounding areas of Espinal require a higher water consumption per unit area (approximately 400 m3 /ha) (Peña Quiñones et al., 2010).

Between 2011 and 2040, there is an estimate of vulnerability in the agriculture sector in specific areas in Colombia in which Tolima (Region where Lérida is located) is included (Ocampoa, 2013). Considering the scope of reported climate change effects in Tolima as a region, it is easy to understand why adaptation methods are necessary in Lérida.

2.2 SOCIAL SCIENCES

Climate change affects not only farmers, but the community as well. There are social, physical and economic consequences of climate change (Burack, 2009). These implications need to be addressed and the best way is to better adapt to this climate change.

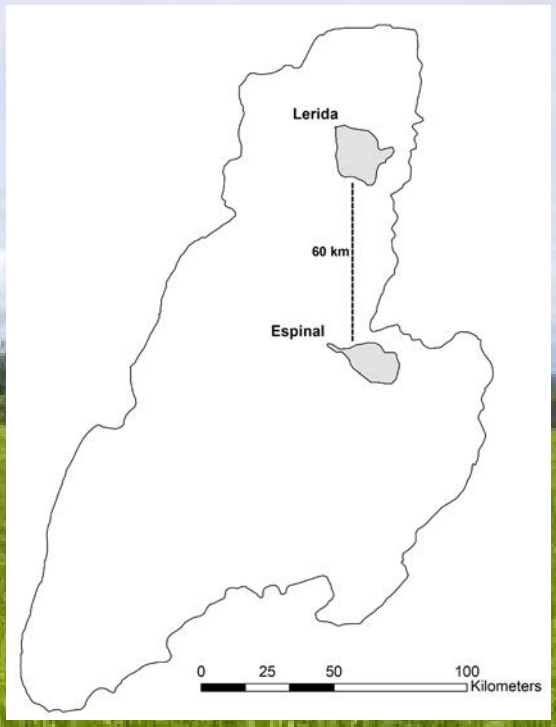


Figure 3. *Map illustrating the distance between Espinal and Lérida*

AGRICULTURE ENGINEER IN A RICE FIELD IN LÉRIDA

The New Hampshire Climate Action Plan does an excellent job of addressing all of the different aspects of climate change that a community needs to adapt to (Burack, 2009). In terms of agriculture, some of the consequences of climate changes include changes in growing season and crop productivity, summer heat stress, increased rainfall and drought, and greater growth in weeds and insect pests(Burack, 2009) Some of the adaptation methods are: alter crop mix and forest species to better match the changing climatic conditions; breed new plant species that are more tolerant of changing climate conditions; and alter the timing of planting dates in response to changing growing conditions (Burack, 2009). It is important to understand climate change consequences on a global scale, as well as to understand where it would affect a community and how to adapt to these consequences.

Because of Lérida's local weather, droughts and heat waves have a large impact on cultivation and harvest, making them a focal point of this project. It is important to understand that in developing countries, agriculture is key in the economic system, especially in Colombia (OECD, 2015). Agriculture has traditionally been a significant component of the Colombian economy, contributing with about 10% to 14% (not specified if includes agroindustry or not) of the National Gross Domestic Product (GDP) and the jobs and livelihoods of at least 3.7 million people (DANE, 2011). Agriculture is a mainstay for food and nutritional security and is a part of the national industrial sector. Much of agricultural GDP comes from trade, comprising 40% of total Colombian exports (DANE 2011) (Peña Quiñones et al., 2010).

Psychological impacts of climate change are important to consider as well Studies suggest that there is a link between human aggression and higher temperatures (Hsiang, Burke, & Miguel, 2013). This does not suggest entirely that it is the case in Lérida, Tolima, but it might affect the attitude of workers on farms where drought and heat waves are longer and more intense every year.

Workers in the area are mostly men and are usually not very familiar with technology, which raises the question: Even if they have access to climate change adaptation resources, would they be able to use it? In a world where

interactive marketing will more than triple over the next five years (Goodwill & Fischer, n.d.), farmers that do not have access to digital platforms are lacking information to help them educate themselves with new resources. A market category of Annual Per Capita Income of less than $1,500 is of about 4,000 million in the United States only. As technologists, it is the early market that we should be looking at, farmers at Lérida might fall into this category. (Prahalad & Hart, 2002)

Throughout my field research I learned that low level workers in the area are working in the fields because they do not have an educated background and this is a way to support themselves (and their families) economically. In third world countries, educated human resources are an important factor in economic growth and development, yet growing unemployment among graduates in many developing countries has slowed the expansion of education which might suggest the reason why low level employees in fields are not familiar with technology or educational resources (Mashayekhi,1977).

Findings from my interviews highlighted how important it is to acknowledge a significant portion of low level workers on rice fields are elderly population who have been working on these fields their entire lives. This is the population that has had to adapt to significant big climate changes in the past years, most of their knowledge has been passed over generations which does not apply to the current climate. Results from the "Factors affecting the adoption and use of mobile devices and services by elderly people" study indicate that elderly people are interested in using mobile phones and services as long as these services deliver them real value (Mallenius & Tuunainen, 2007). Users must be capable to handle the physical device as well as to understand and remember how the device and the services work. If this is not the case then a mobile phone for example, can be replaced by a simpler security phone.

Technology design for an elderly audience is gerontechnology, which refers to the design of technology for elderly that aims to improve their life functioning on a daily basis (Bouma, 1992), a good example of simple technology design for elderly or non technology familiar community is Fitbit, a device that focused on tracking healthy habits through products and online services that harness the power of new technologies (Toriola, 2017).

2.3 CURRENT DESIGN WORK

There are design outcomes that are currently helping farmers to adapt to climate change all around the world, although none of them seem to fit elderly or non familiar with technology communities, the UX/UI experience is a good starting point to address farmers. These are two examples:

First is Weenat (www.weenat.com/en), an application that along with a physical device who must be placed in the soil where the harvest is going to be, will provide information to farmers when taking care of harvest scheduling and maintenance. Right now it is a French product, however countries nearby France are using it as well. Reviews and reports have been made and customers are very satisfied with it. Their interface looks appropriate and user friendly for their target audience, it has a lot of options from weather warnings to farming advices/tips.

Second is Smart Akis (www.smart-akis.com), a platform which provides all the new technologies available to help agriculture. It is not a single product service, it serves more like a Blog which farmers in need can go to when they have very specific needs and find what will fit best their interests. It is a good service because it encapsulates all the technology available and does a great job categorizing each of them.

Besides design outcomes, there are new approaches to how rice farming can be more effective, for example: Because rice cultivation is responsible for at least 10% of agricultural greenhouse gas emissions and higher ambient temperatures where rice is cultivated increase emissions, a new method for rice cultivation was created: System of Rice Intensification (SRI), a system that lowers the input required for rice production (seeds, water, and fertilizer) while dramatically increasing crop yield (Hawken, 2017).

This approach is more of a scientific approach which can be taken into account for this project, however a design related outcome is what the project aim to contribute with for a solution.

2.4 CONCEPTUAL FRAMEWORK

The project included a conceptual framework that encompassed one theory and two models to better frame the research: The Diffusion of innovation theory (Orr, 2003), the Technology acceptance model (TAM) (Chuttur,2009) and the Concerns-Based Adoption Model (CBAM) model which created to assure a new model is being adopted properly by individuals (Hord et al., 1987).

Because the projects aimed to incorporate a new solution to provide farmers with resources to better adapt to heat waves and droughts, The Diffusion of innovation theory was a resource to know how farmers perceived a new idea, behavior or product. When it came to know how farmers and agricultural engineers were accepting this new idea, behavior or product, the Technology Acceptance Model highlighted two major factors:

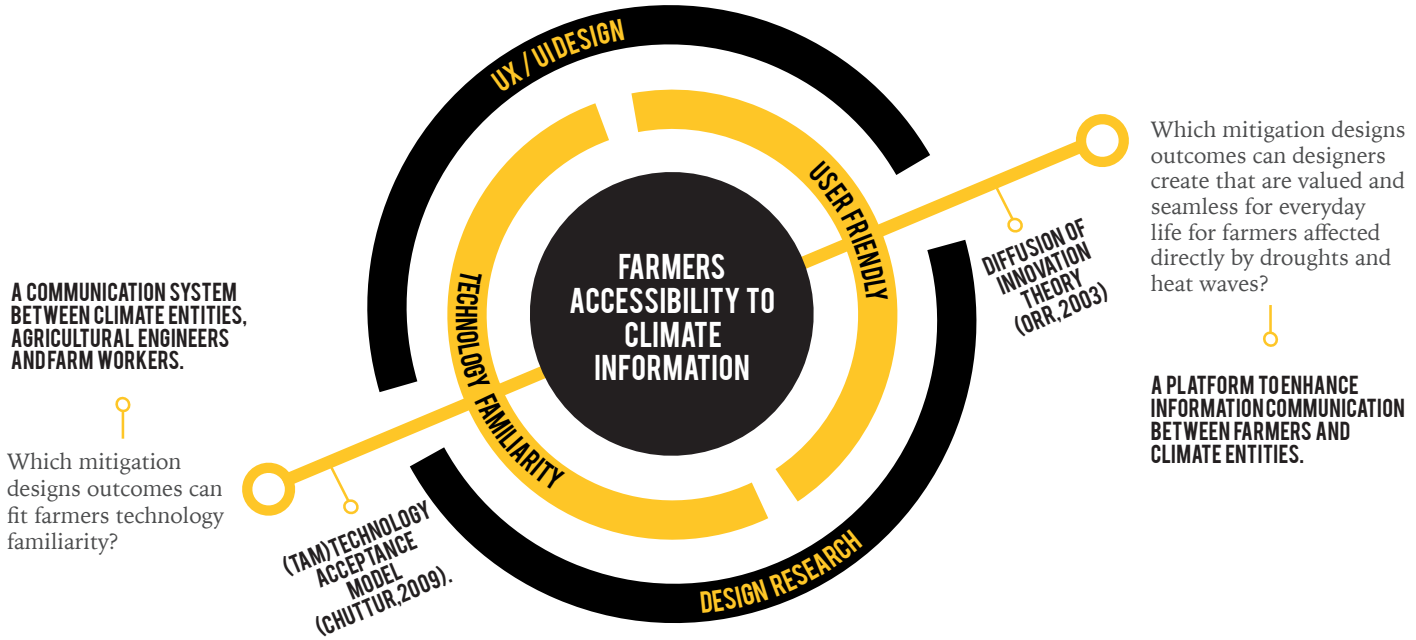


Figure 4. Conceptual Framework

Perceived usefulness (PU) – This is the degree to which the user thinks the new idea or product will enhance their job performance. For this project, it was about questioning if the design enhanced the farming process in the rice fields in Lérida affected by heat waves and droughts?

Perceived ease-of-use (PEOU) – This is the degree to which the user believes that using a particular system would be free from effort. For this project, this was a key factor given that farmers and agricultural engineers familiarity with technology was not high and the design required to be easy to use for them.

The Concerns-Based Adoption Model (CBAM) was used to assure the new design was being adapted properly by the users testing it. CBAM has three components: Innovation Configurations, Stages of Concern, and Levels of Use. Only Open-ended statements were applied as part of the Stage of concern, which helped the project to identify farmers and agricultural engineers attitudes and beliefs toward the new design. With this information, the target audience necessities that were not approach, could be identified.

Regardless of which design outcome this research lead to, it was subjected to the Climate-Smart Cycle. This cycle served as a guide to make the right decision when thinking of adaptations for the right target, the right needs in the right scenario (Stein, Glick, Edelson & Staudt,2014). It is a great tool to theoretically test my choices when designing an outcome to adaptation to climate change.

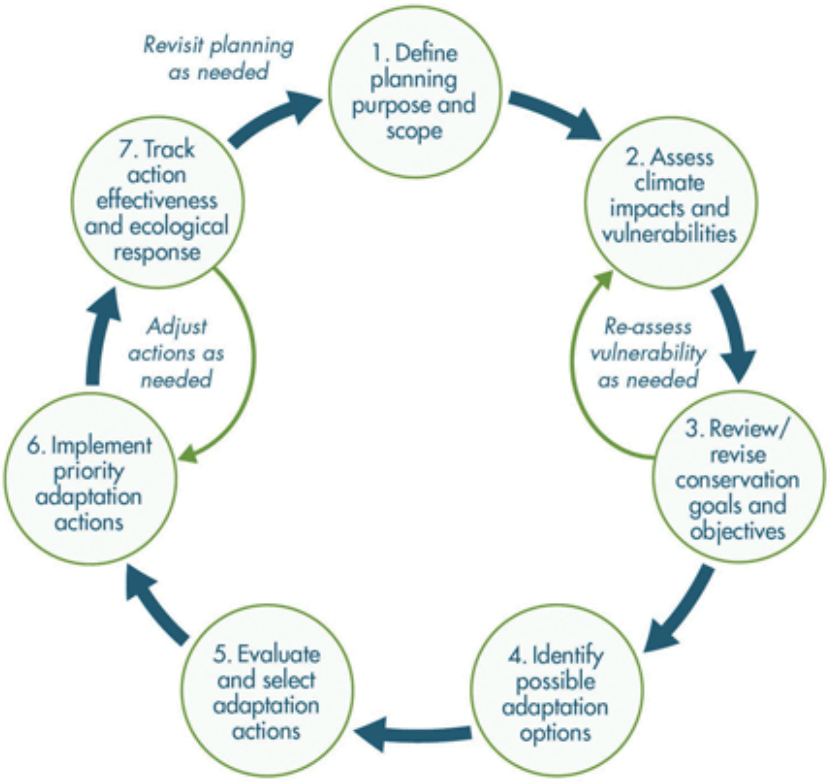


Figure 5. *Climate Smart Cycle, graphic taken from (Stein et al. 2014)*

There is a problem and a need. A problem with communication between farmers and climate entities in Lérida and a need to adapt to the new conditions when farming. Because this affects highly both farmers and agricultural engineers as well as Lérida's economy, It is worth the time and resources spent in this research. As mentioned before, revenues in investing in agriculture mitigation adaptation will overlap costs when adapting to climate change if it is done right (Ramirez-Villegas et al., 2012).

In order to design, the project followed a Life-based design approach (Saariluoma, 2010). There must be an understanding that the user interface is only one piece of the whole design challenge in the interaction design outcome, this means that when thinking of the design outcomes biological, psychological and social restrictions and possibilities of the target group must be taken into consideration. In this case, such issues

can refer to self-efficacy and sense of coherence of uneducated and/or elderly low level workers at farms. In solving design problems we need social and anthropological information.

After reviewing literature, I can address the research question: Which adaptation designs outcomes can designers create that are valued and seamless for everyday life for rice farmers affected directly by droughts and heat waves in Lérida, Tolima? From a global stand, there is not a lot of information specifically about the study area Lérida, Tolima but there is plenty of literature in climate change and adaptations that can be used and test in the area. There are also many interfaces that have excellent UI/UX tools that can be use in my design outcome. I added field research so that I could gather the last information needed in order to answer my research question, how can this literature apply in Lérida, Tolima?

CHAPTER 3: METHODOLOGY

When I first addressed my research question, I understood I needed to connect at an emotional and physical level with my target audience, rural farmers. This narrowed my methodology to Semi-structured interviews and Observation research.

3.1 OBSERVATIONAL RESEARCH

Observational Research was a priority in my research because it provided me with ways to check for nonverbal expression of feelings, determine how subjects interact with each other, how they communicate with each other, and document for how much time is spent on various activities (Kawulich, 2005).

Because my thesis is specifically in an area in Lérida, Tolima, I traveled to the area in order to conduct a field research that would help me better understand who, when and with what farmer workers are trying to lower the damages caused by drought and heat waves. By being in the area of study I could better immerse in the thoughts and feelings of those subjects working under high temperatures. This is a complete list of the observations conducted during this phase of the project:

3.1.1 MORNING OBSERVATION

Day: August 22

Time: 6:30am to 8:00am

Location: Lérida, Tolima, Farm “El vergel”

Subjects: Workers in the morning schedule.

Activity Observed: Workers getting ready to work and being assigned to different activities to complete during that day.

3.1.2 AFTERNOON OBSERVATION

Day: August 22

Time: 3:30pm to 5:00pm

Location: Lérida, Tolima, Farm “El vergel”

Subjects: Water disposal worker in the early stage rice field and Agriculture engineer managing.

Activity Observed: The agriculture engineer checked on the workers to make sure they were doing the work assigned to them. The water disposal worker was one of them, he walked us through the field in order to understand how he was setting up trails to manage the water.

3.1.3 AGRICULTURE ENGINEERS NETWORKING

Day: August 23

Time: 8:30am to 9:30am

Location: Lérida, Tolima, downtown in Lérida, Tolima.

Subjects: 2 Agricultural engineers

Activity Observed: The Agricultural engineers were talking about rice updates on the fields and news in the field.

3.2 SEMI-STRUCTURED INTERVIEWS

Semi-structured interviews offer topics and questions to the interviewee, but are designed so that the interviewee's ideas and opinion can be obtained instead of pushing the interviewee toward preconceived choices (Zorn, 2010), which made it a perfect method for me to identify rural farmers true feelings and thoughts.

Given that my concern is the current relationship between the technology available (smartphones, cellphones, text message, wifi and phone calls)and the workers at farms, I conducted interviews (refer to appendix C and D) in order to obtain more in detail information about the level of familiarity of the workers with technology so that I could set a standard of which technology will better fit their necessities in a user friendly way. In order to provide more in detail data, I segmented my target group to the following:

Male workers from age 30 to 70, who work at the rice farms located in the area at least once a week and who have been working in the field for enough time to have dealt with droughts and heat waves.

After each candidate gave written and oral consent (refer to appendix A and B), they were interviewed and recorded. For this interview, candidates listened to a brief yet detailed explanation of what the study was about followed by 11 questions that they agreed to respond to these interviews took an average of eight minutes per candidate. This is the specific information for the six interviews:

3.2.1 FARM WORKERS INTERVIEWS

Day: August 22

Time: 8:30am to 9:30am

Location: Lérida, Tolima, Farm "El vergel"

Subjects: Workers that are familiar with rice fields and heat waves and droughts.

Day: August 22
Time: 1:30 pm to 2:30pm
Location: Lérida, Tolima, Farm “El vergel”
Subjects: Water disposal worker
Number of interviews: 1

3.2.2 AGRICULTURE ENGINEERS INTERVIEWS

Day: August 23
Time: 11:30 pm to 2:30pm
Location: Lérida, Tolima downtown
Subjects: Agricultural engineers
Number of interviews: 2

Once I arrived in Lérida I met with farmer owners who gave me a schedule for two days in which I would visit the rice fields, learn about the general harvesting process. Once I did the tour, I met the candidates and did the interviews. Each candidate was interviewed in the workplace. I interviewed five candidates from the same small area. By the time I was interviewing the last candidate I noticed that the answers were repetitive and that I have found the core of the issue. Talking to each candidate while being in their environment gave me a clear idea of what was missing and why they could not adapt better to droughts and heat waves.

CHAPTER 4: RESULTS

The main goal of this research was to find data to better understand the environment and worker and farmers relationship with technology that would help to decrease the consequences on rice farms fields caused by heat waves and droughts. Result for this study were mixed, along the way results concerning the worker's physical and emotional state when working on this conditions were outstanding and gained a more important part in the study.

After interviewing six workers in the work environment, the following themes were recognized:

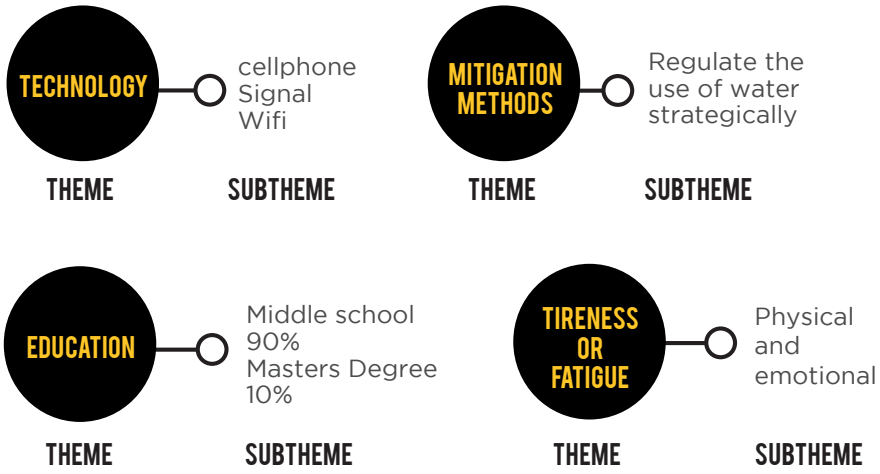


Figure 6. *Themes and subthemes found in the research*

Workers talked the most about how they felt physically and mentally while working in high temperatures. They also mentioned that cellphones are the most useful technology while working despite the fact that phone signal and Internet are not reliable.

Most of the workers are not technology savvy and only use cell phones at work to communicate with each other and the farm managers. Generally, the agricultural engineer is the person in charge of scheduling the harvest and makes the executive decisions when it comes to care of the rice sowing, harvesting, etc. Then he communicates to the workers what to do in order to achieve better results. The agricultural engineer is highly educated and uses technology on a daily basis with easy access to computers and Internet.

4.1 EDUCATION LEVEL

The majority of the subjects were not highly educated and those who work at the rice farms gained knowledge in an empirical way rather than by studying, meaning most of the workers learned their skills from other farmers, mos of the time family members, and got better at these chores with time. Most of them are not technology savvy and only use cell phones at work to communicate with each other and the agricultural engineers. The agricultural engineers on the other hand, are highly educated and have access to Internet and smart phones.

4.2 WORK FLOW

Workers get hired based on the season, sowing or harvesting, and for specific jobs such as creating water routes through the farm. There are only a few workers that are hired full time, the rest are only available via contracts that last only a few weeks or even days. Because of the high temperatures subjects have to take at least a 30 minute break every three hours at work and do not work a regular of eight 8 hours per day. Shifts start very early in the morning before the heat increases.

Generally, the agricultural engineer is the person in charge of scheduling the harvest and making executive decisions when it comes to taking care of the rice sowing, harvesting etc. Then he communicates to the workers what to do

in order to achieve better results. The agricultural engineer has easy access to computers and Internet which allows him/her to check climate updates and do research prior to the next day and inform the farm workers what to do and when in the rice fields the next day.

4.3 RESOURCES

Because of their location, the closest meteorological centers of the INAT, National Institute for Land Adaptation in Colombia, are located far from Lérida in places with a different weather and even geography, which makes it incredibly difficult to collect current, customized information for the farmers in Lérida, Tolima, unless they have access to Internet.

Because of this, farmers collect information in national climate entities websites that have the data they need for the day. Even though the information might be collected it is hard to translate to the farm workers given that most of them do not even have easy access to computers, nor, will they voluntarily learn about it and do not have access, or even know how to use, smart phones.

4.4 CONCEPTUAL FRAMEWORK APPLIED

In this research I referred to "The diffusion of innovation theory" (Orr, 2003) because it is important to understand what is currently being use in Lérida, Tolima to decrease the consequences of heat waves and droughts so that whichever is the new idea or product that is the design will be taken as an innovation and therefore be spread easily. Otherwise it would be just another method that would not be relevant for agricultural engineers and workers.

I used The technology acceptance model (TAM) (Chuttur,2009) in order to test my findings in the interview and my digital platform prototypes. The "Perceived usefulness" helped me frame how farmer workers agreed that a better understanding of the climate predictions would enhance their job performance and have more control of their farming in the interviews. The "Perceived ease-of-use" help me understand the agricultural engineers attitudes, they were very positive and believed that the new digital platforms will make the information collection easier. It will save them time and help them take more informative decision when planning their farming techniques. The Climate smart cycle was applied as well:

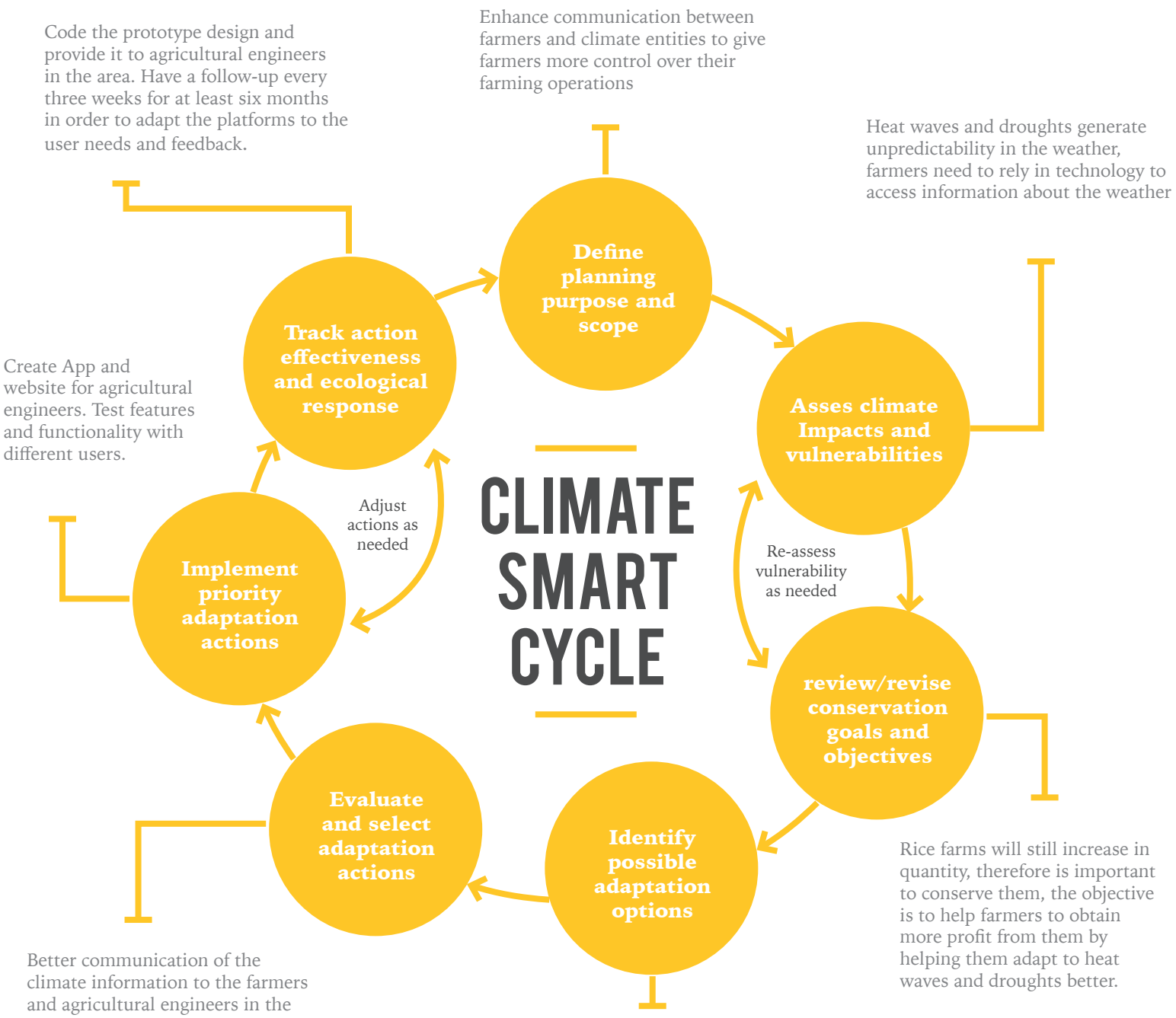


Figure 7. *Climate smart cycle applied*

CHAPTER 5:
RESULTS DESIGN RESEARCH

I found walking on the rice fields at very high temperatures while talking with the workers gave me a personal perspective of what they have to cope with while working. I consider it the most meaningful experience of my field research, to be able to connect with the subjects at such a level. To be able to use my knowledge and capacity to help them and the community by extension gave sense to what I do everyday as a student and a professional experience designer purpose.

After reviewing findings and taking into account the immersion experienced when doing field research, a literature review and semi-structured interviews, the research results suggested that the climate information that farmers need such as weather, chance of rain and even news and updates about the rice Colombian groups finding is available in the Fedearroz (http://www.fedearroz.com.co/new/index.php) and the Ideam (http://www.ideam.gov.co) websites. However to be able find this information requires at least several clicks and a few minutes. If it is the users first time in these websites, it could last much longer. These platforms have a weak UX/UI experience. Because the information already exists, the broken communication comes from a weak UX/UI experience and Design Research from the climate entities communication team.

5.1 IDEAM

Figure 8. *Ideam homepage*

Ideam is a Colombian climate entity whose vision is to in the near future generate and provide hydrological, meteorological and environmental information for the definition of public policies and decision-making related to sustainable development and the prevention of the effects of climate change ("Acerca de la entidad", n.d). Ideam allows agricultural engineers to access information about monthly, biweekly, daily climate. However to access this information, users have to click multiple times and the information is not read clear because of the size of the text and the window that it is shown on.

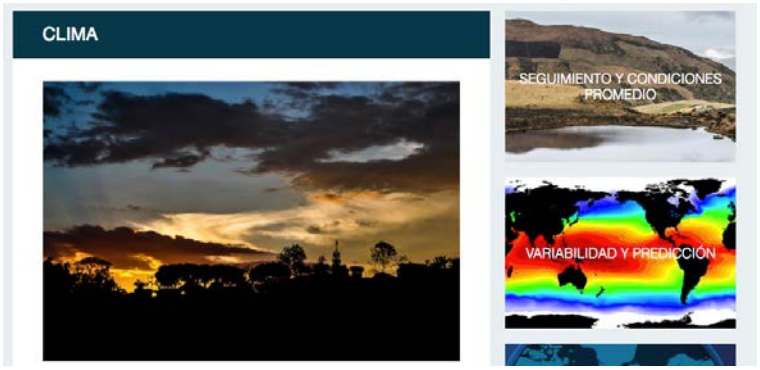


Figure 9. *Ideam clima page*

Figure 10. *Ideam Boletín mensual de predicción climática 2010 page*

5.2 FEDEARROZ

Figure 11. *Fedearroz specific location climate landing page*

Fedearroz is the rice national entity in Colombia. It provides news, updates and climate information to rice farmers. For this project, the climate information is the relevant feature, in order to access it, new users can easily spend several minutes because it is located at the bottom of the website (refer to figure XII). it offers however, valuable information and interaction by allowing users to select location on a map of Colombia (refer to figure XIII). Once you access the window with the location's weather, the information displayed could be better display, for example there is no chance of rain displayed, just the information use to calculate it.

Figure 12. *Fedearroz homepage footer*

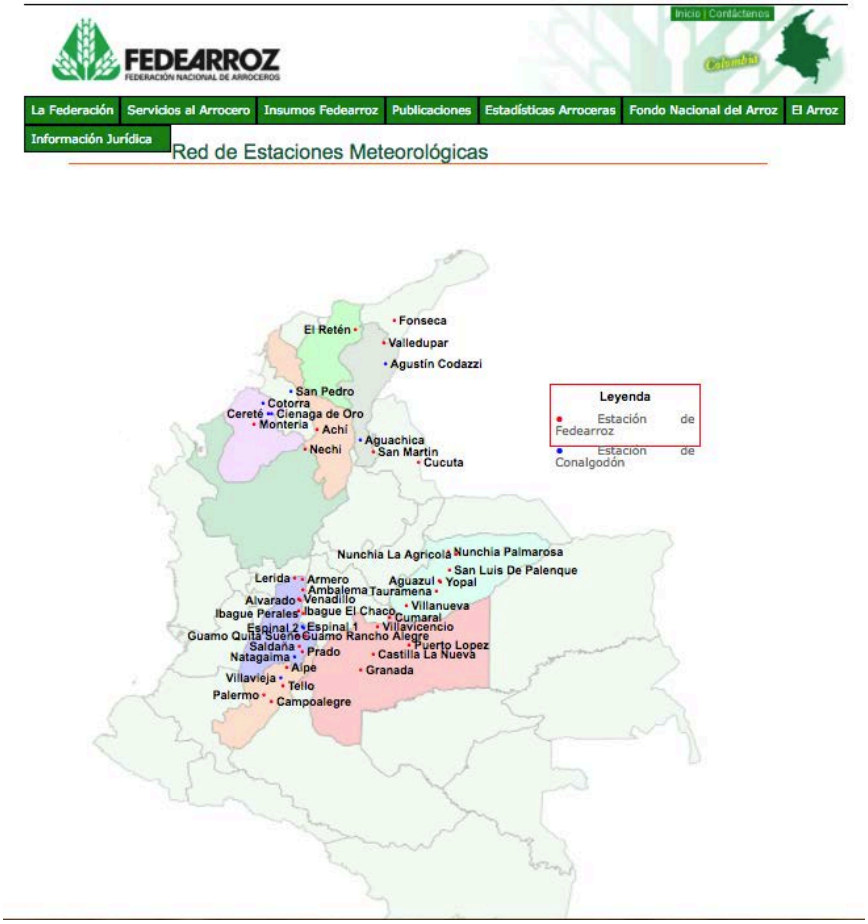


Figure 13. *Fedearroz map of locations page*

5.3 CHALLENGES IDENTIFIED

- Lack of communication between the local entities in charge of weather and agricultural engineers.
- Lack of technology use in the field.
- Poor technological skills from workers.
- Need for a (could be text based) design solution to enhance communication between agricultural engineers and workers.

According to this information, there was an opportunity for the user experience to take one step further and that I could incorporate a third party in the communication system: Farm workers. Keeping this in mind, I addressed each of these main points and how I could fix it through UX/UI Design for the agricultural engineers, colombian climate entities and farm workers.

Lack of communication between the local entities in charge of weather and agricultural engineers. Because of the location of Lérida, is hard to obtain a physical climate center. Also, because of the need of updates almost daily and the work environment, a print based solution will not be cost efficient or practical. Therefore a digital design would be the best platform to address the communication gap.

Lack of technology use in the field. Keeping in mind the work flow of the rice farms currently, a digital platform will make sense given that the agriculture engineer is the person in charge of delegating and planning the crops and process of the rice fields. Because engineers have access and the knowledge of digital devices such as computers, iPads and smart phones, it would be very helpful for them to be able to gather information about climate through one of these devices.

Poor technological skills from workers. In order to communicate this information to the farm workers, a system that links smart phones and computers with cell phone text message or a call system is required.

Need for a (could be text based) design solution to enhance communication between agricultural engineers and workers. Both agricultural engineers and workers will have a common communication system, as of now this communication exists and work but in order to make agricultural engineers work flow

more user friendly and practical, a platform must allow them to gather information from climate entities and share it with farm workers without having to switch platforms.

If I could revise this research I would extend my field research to be able to talk to those in charge of the meteorological centers of the INAT around the area in order to be able to focused even more the design prototype and most importantly be one step ahead so that it could actually be implemented in the area.

5.4 LIMITATIONS OF THE RESEARCH

Given that most of the workers contracts are only for short periods of time it was hard to find many working while I was in the research area. Also, because rice fields are seasonal (ricepedia, n.d) , agricultural engineers schedule the farms fields so that there is at least one harvest about to be cropped which means that not many workers were assigned during my field research because not all the farm fields were active at the moment. Because of this there was a small number of participants.

At the time of my trip to the area, there were multiple rain episodes that made me postpone my interviews and field work until temperatures rose to be considered, or close to heat waves.

5.5 THIS RESEARCH IN FUTURE WORK

This research can be used for future government or private organizations in order to better design solutions for farmers to be able to decrease the damage caused by heat waves and droughts in areas with similar geography and harvest. The intent of this research is to facilitate the use of technology for the right user, hopefully the data gathered will guide and help designers and engineers to design appropriately.

CHAPTER 6:
DESIGN INTERVENTION

As a solution for these challenges, both an app and a website were created as platforms to better communicate the climate information to specific areas, in this case Lérida, Colombia. Both platforms were focused on sharing existing information about climate in a user friendly way to agricultural engineers and a push notification system in which text message will be sent to farm workers. Services within these platforms include search location, sending information via text message and scheduling workers hours. Cli-mate, as the name suggests, is a partner for agricultural engineers when it comes to climate information.

CLIMATE

Figure 14. *Climate Logo*

6.1 DESIGN THINKING

After gathering all the data and having a clear idea of the services the digital platforms were going to include, I started the design process.

6.1.1 INTERFACE

I used open Android material as a reference, it is simple, clean and cost efficient. Using this material helps the building of the App to be less complicated. It is also one of the most popular interfaces which makes almost intuitive to the user.

6.1.2 COLOR

For the app I wanted to add images so that the audience that was not really familiar with reading and writing could still use the App. For my color palette I chose contrasting colors:

Figure 15. *App Color palette*

6.1.3 INFORMATION ARCHITECTURE

Before any sketches or wire frames, it was vital to create an information architecture to have a clear idea of what the design required and the app flow.

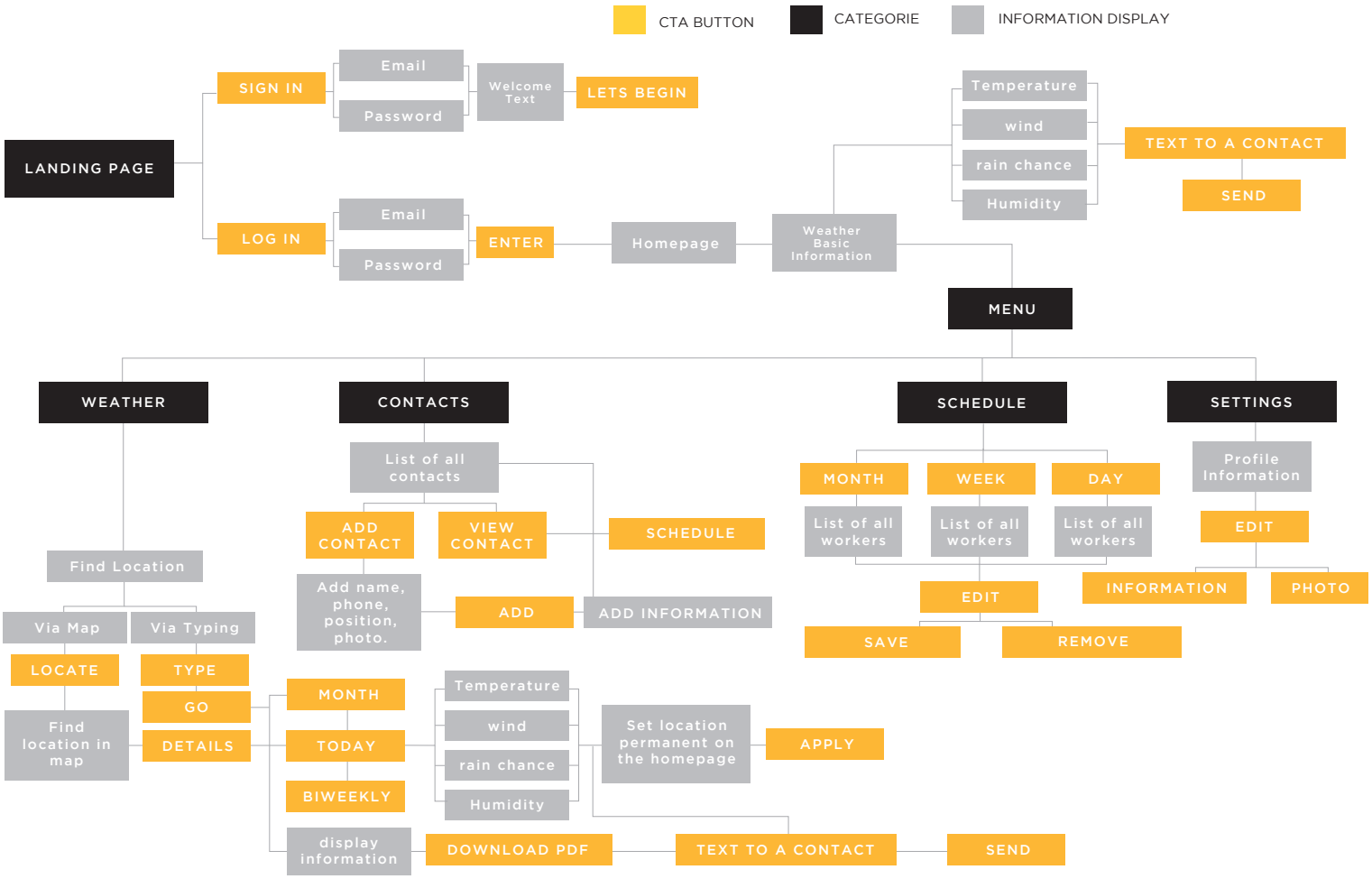


Figure 16. App Information Architecture

6.2 CLIMATE APP

This will be a tool for engineers to prepare their next workday and manage employees based on the climate information they gather.

6.2.1 AUDIENCE

The App is designed to target the agricultural engineers.

6.2.2 SYSTEM

Because all of my participants use Android phones, I designed it specifically for Android users.

6.2.3 SERVICES

The App is designed to enhance the communication between agricultural engineers, Colombia climate entities and farmer workers. Therefore the following services are offered:

- Location climate information: This includes weather, chances of rain, precipitation, baromettic pressure.

- Monthly, Biweekly and daily climate information.

- Ability to send text messages with the climate information to the user contacts, which are the farmer workers, with just one tap.

- A contact list which includes all, recent and favorite options.

- Search for a location via the map or typing.

- Schedule, this is a very important tool because engineers would be able to schedule workers for a week, day or a month.

- Because they have access to climate information in the same platform it would be easier for them to cancel or add workers to the schedule depending on the weather. It would be beneficial for the farm workers because their schedule can be organized depending on the weather throughout the day so that they don't have to deal

with high temperatures and take breaks in that time to be more productive during low temperature hours.

-Settings include profile updates and able/disable text message options, is not common in Colombia to have unlimited text messages services.

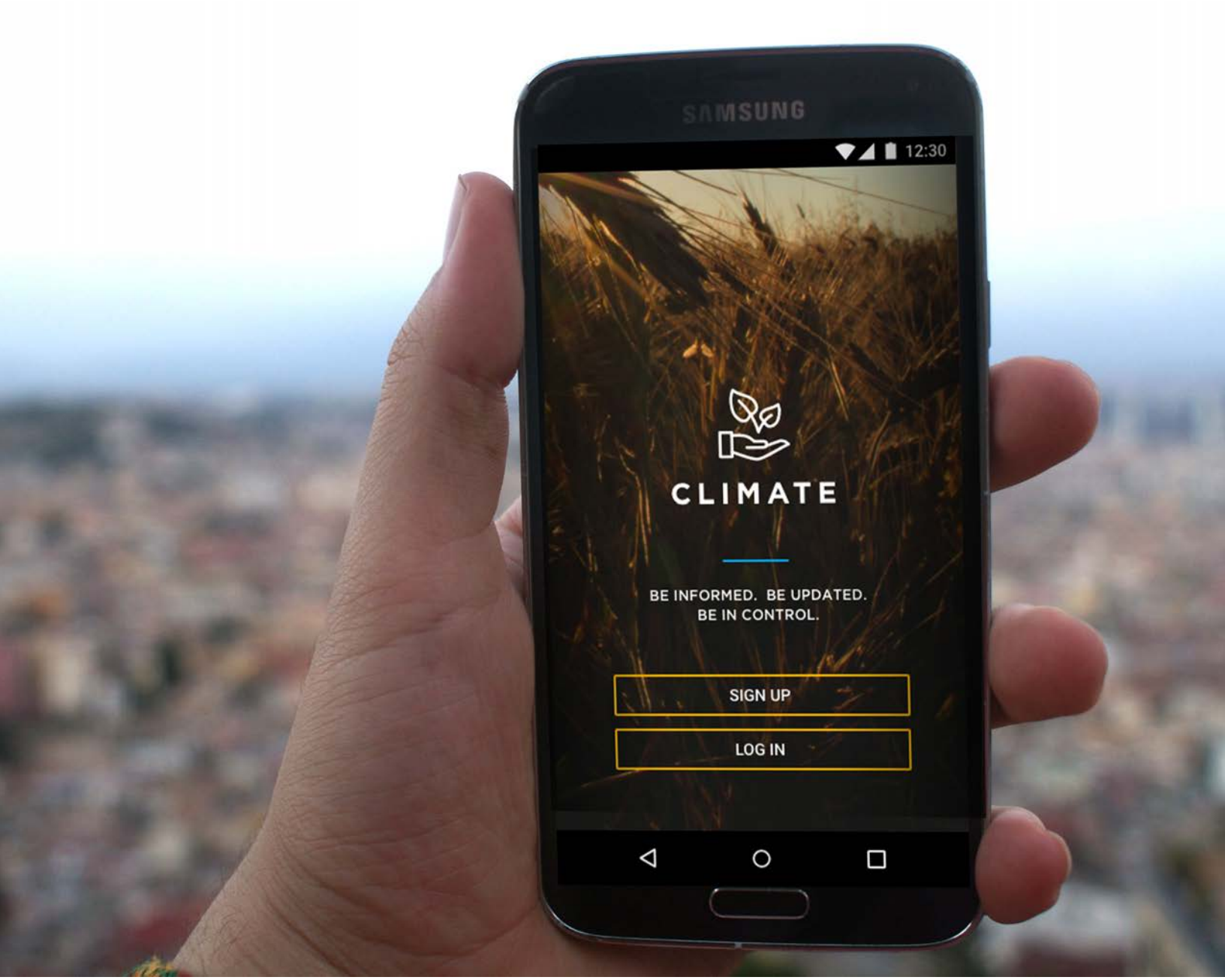


Figure 17. *Climate app mockup*

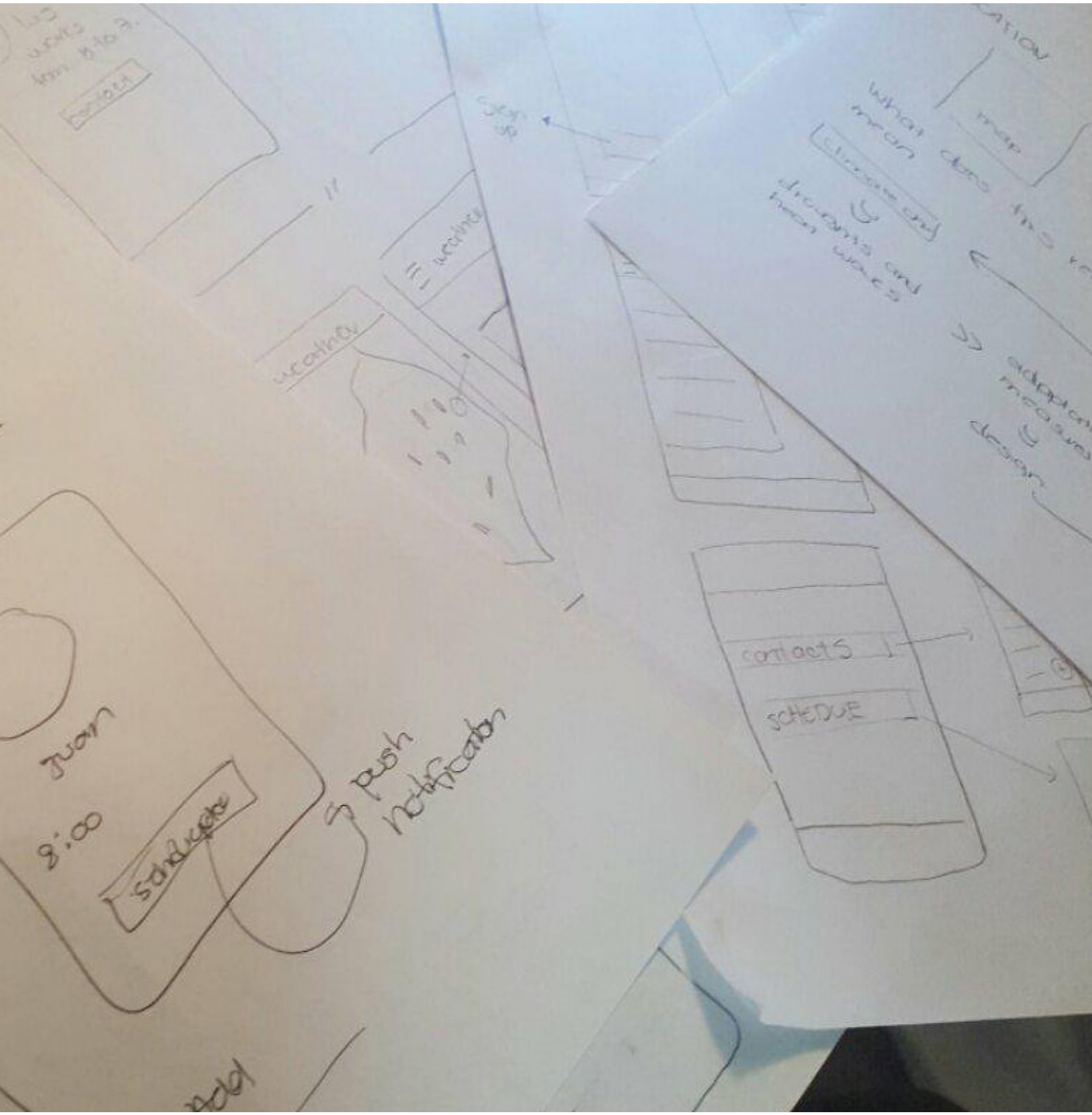
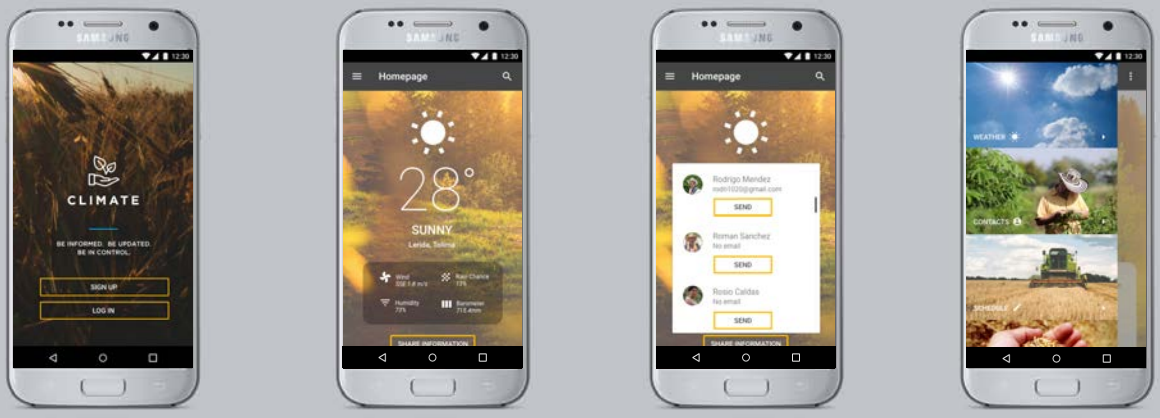
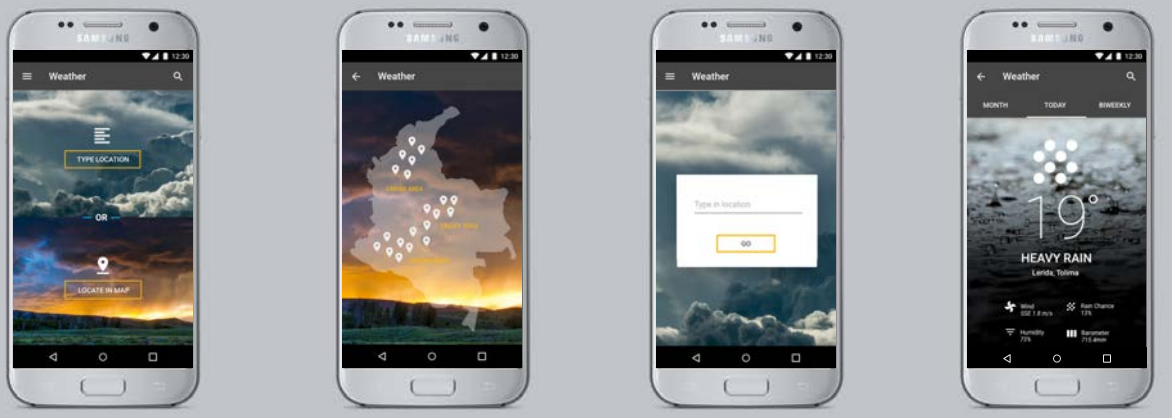


Figure 18. *Climate digital platforms sketches*



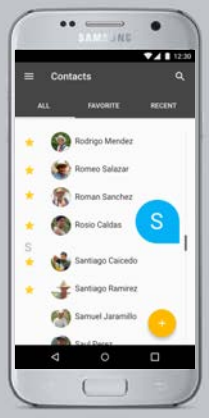
Landing page. *Homepage.* *Share information feature.* *Menu.*



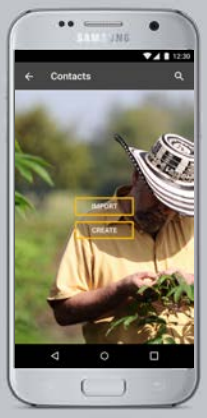
Type or locate in map a location. *Locate in map a location.* *Type in location.* *Location found information.*

Figure 19. *Climate app services mockup* *(Samsung smartphone mockup image by Daniel Bolyhos, App design by Andrea Mateus)*

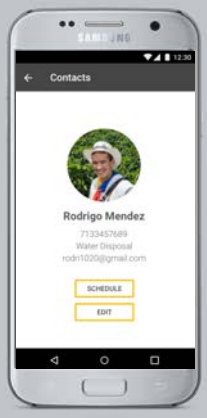
Monthly, Current and Biweekly weather report.



Contacts tab.

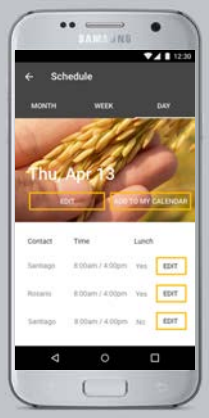


Import contacts from your phone or create a new one.

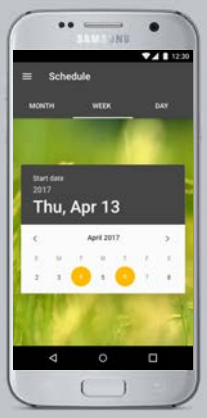


Schedule or edit your contacts.

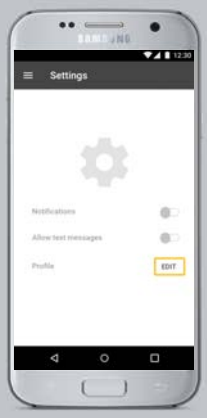
Review your schedule for the month, week and day.



Schedule workers.



Week schedule view.



Edit your profile, disable/able text messafes and notifications.

Figure 20. *Climate app services mockup continued* *(Samsung smartphone mockup image by Daniel Bolyhos, App design by Andrea Mateus)*

6.3 CLIMATE WEBSITE

The website is designed to enhance the communication between agricultural engineers, Colombia climate entities and the rice field community. This will be a more in depth tool for them to learn about the rice fields climate and the community in general. The website is currently being designed.

6.3.1 AUDIENCE

The website is designed to target the agricultural engineers when they are looking for more in depth information and connect with the rice field community.

6.3.2 SYSTEM

Because all of my participants are more familiar with Windows than with Apple, I based my design with the Windows interface.

6.3.3 SERVICES

The website is designed for users to spend more time on it, to educate and connect the rice field community it will offer these services:

- Location Climate information: This includes weather, chances of rain, precipitation, barometric pressure.

- Very detailed reports of the climate, precipitation etc.

- A blog with information, innovations and news in the rice field in Colombia and the world.

- An interactive platform to connect different rice authorities and services in Colombia.

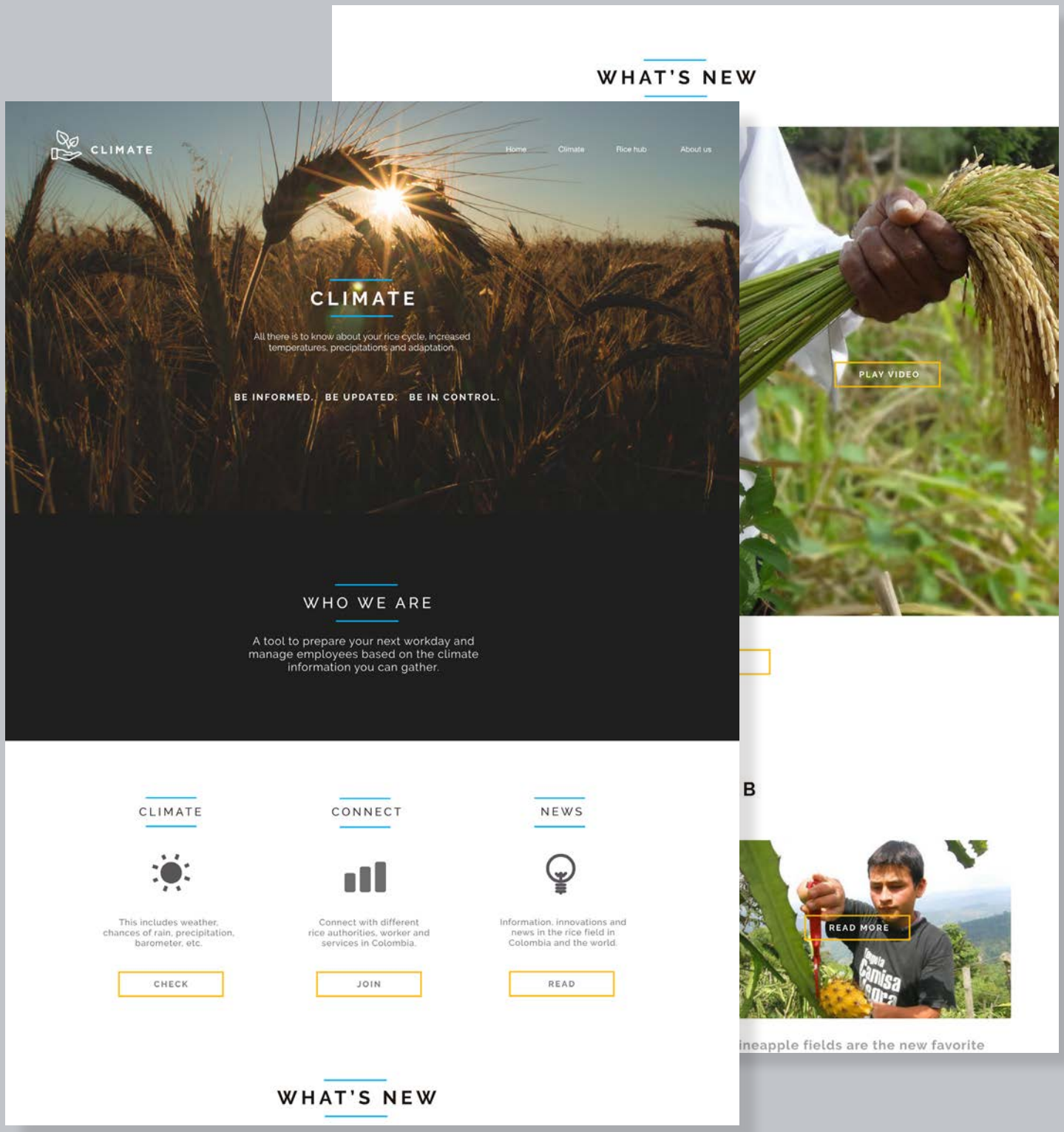


Figure 21. Climate website homepage mockup

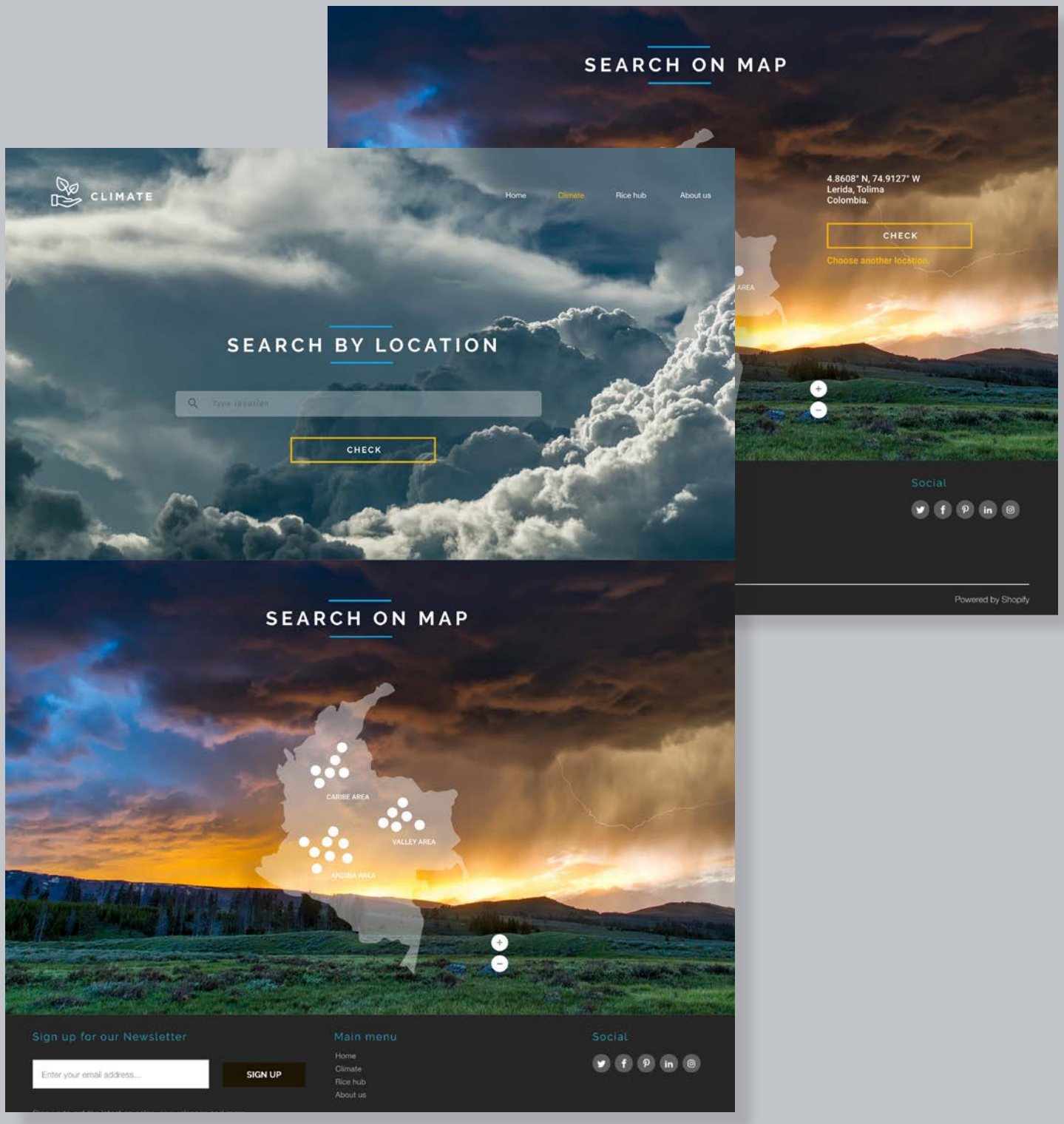


Figure 22. Climate website weather page mockup

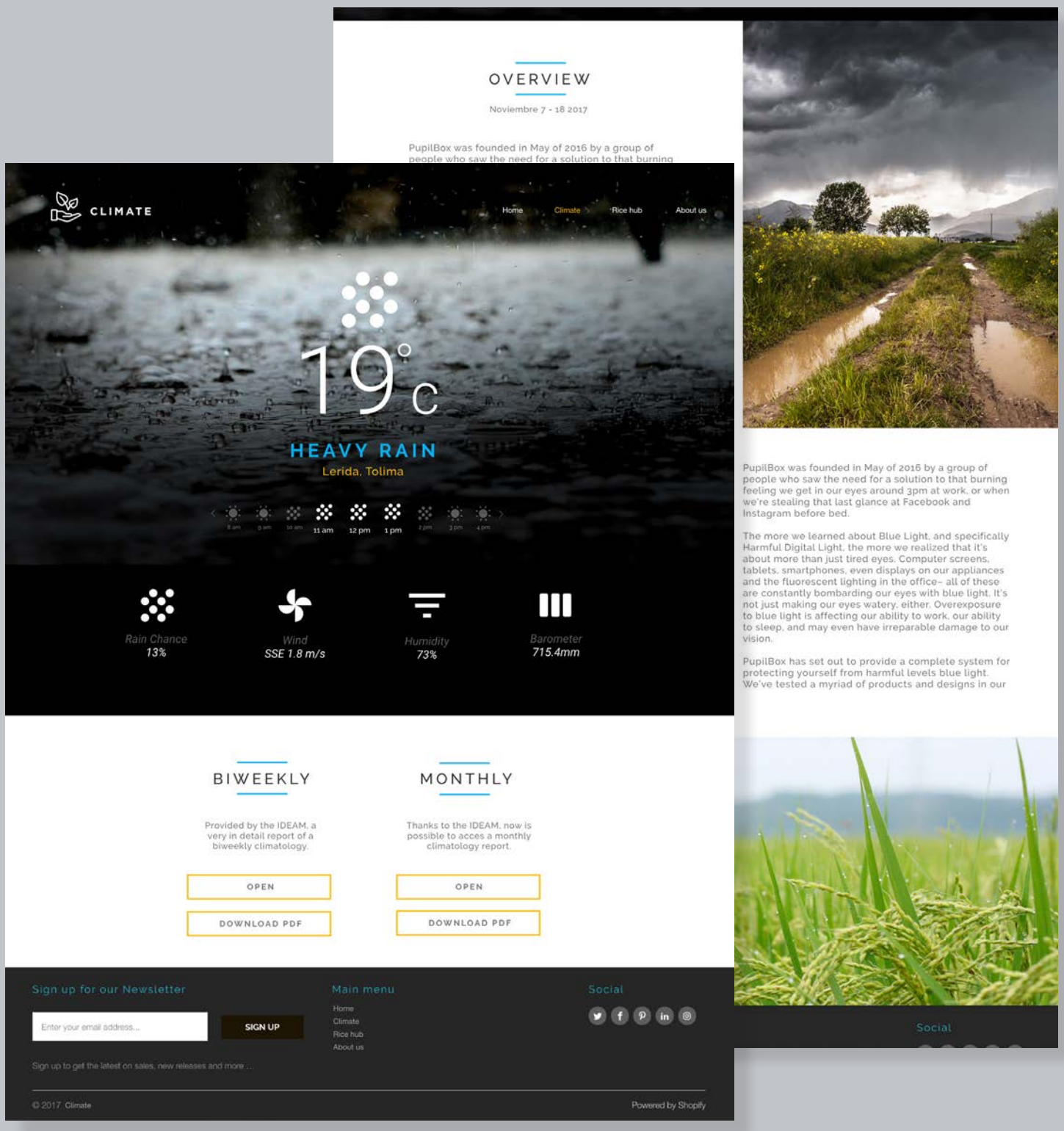


Figure 23. Climate website weather page mockup continued

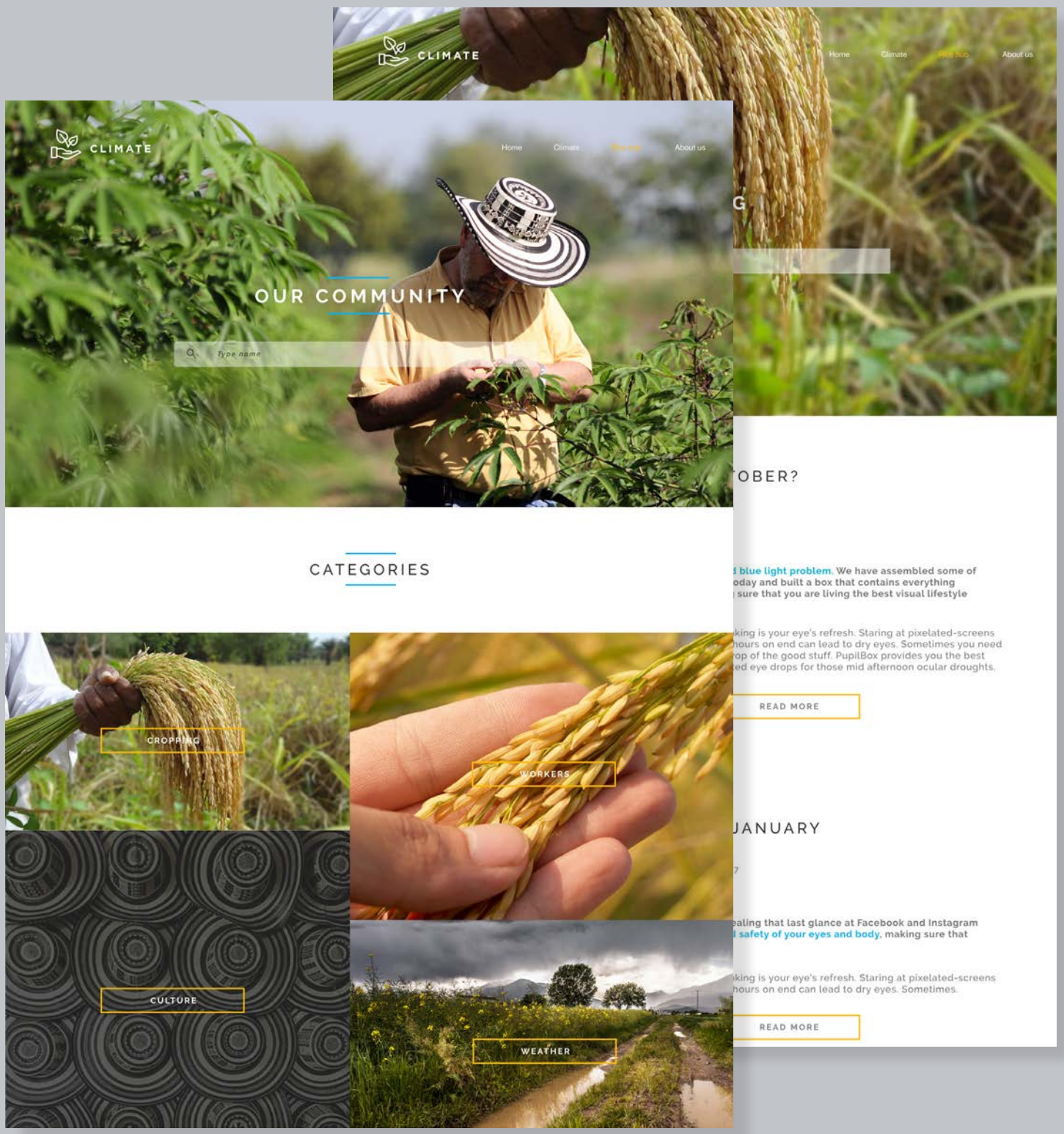


Figure 24. Climate website rice hub page mockup

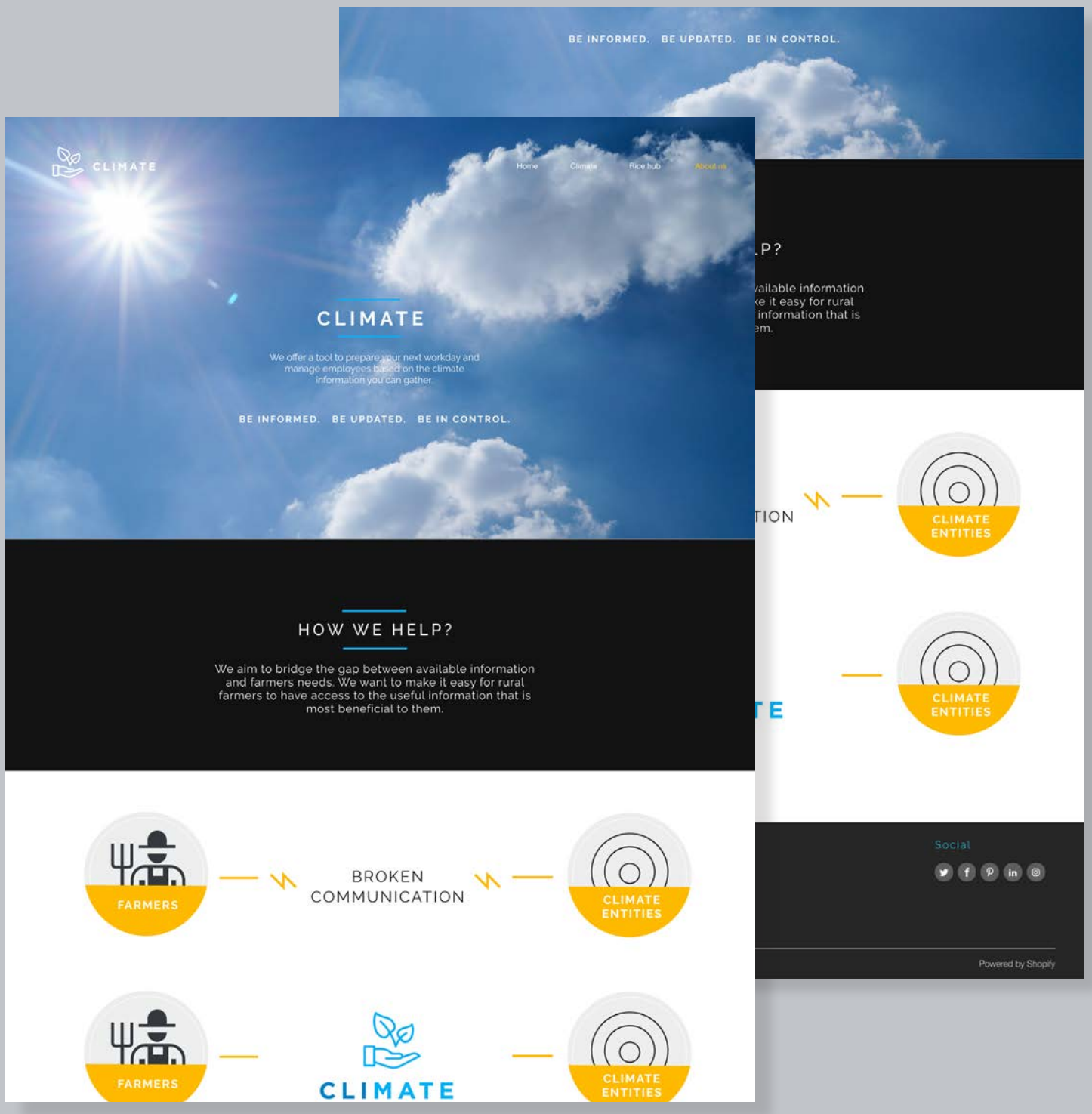


Figure 25. Climate website about us page mockup continued

6.4 PROTOTYPING

In order to give a more in depth and real feeling to the App and website, I used Adobe XD to create both prototypes. This UI program allows me to create interactive designs that are easy to share.

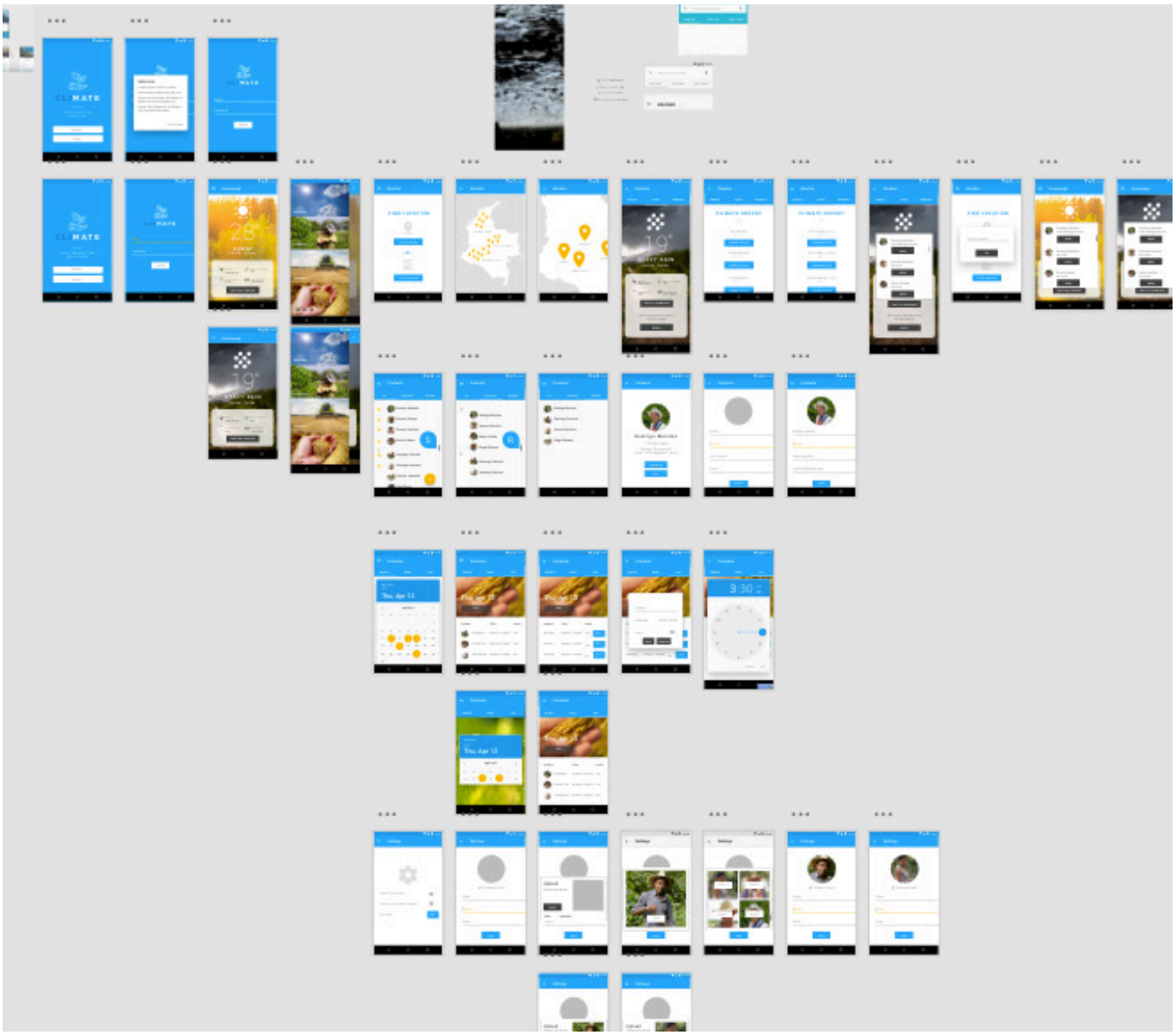


Figure 26. *Climate app prototype design in XD screenshot*

6.5 TESTING

Each user testing the digital platforms were given the following links via email, whatsapp or text message:

- App: *https://xd.adobe.com/view/ac1c8c4a-b8b4-4cbc-8b58-3a2aaf0e0d4d/*

- Website: *https://xd.adobe.com/view/ae813ef8-bd4a-410b-ad6b-97806ca9f00e/*

You can use these links currently to test these platforms as well, just type in the links in your phone or computer browser.

These links included an interactive prototype for each digital platform. Users could tap on buttons and choose options (refer to Figure XXVII). Each user was asked for feedback about how friendly and easy to use was the platform and if they could obtain climate information easily. Users were sent two round of links, the first one was a beta version of the platforms and the second one was the final product with image, colors and new features included.

Users were one agricultural engineers and four users not familiar with the area or rice field in order to test pure user interface and user experience tools. Only the App was tested, currently the website is going through the first testing phase. These were some of the feedback comments gathered:

> *"I have tested the application and I loved the design. It is very clean and modern. The only thing that is not working right are the circle and square buttons (bottom of the application). Also, I will work on the functionality of the schedule because I was not able to go back when i selected a date."*
>
> *-User 1*

"Testing this application was fairly straight-forward. The navigation was easily recognizable, and the use of photos and pictograms made the interface accessible to those who aren't necessarily fluent in cellular technology. The application obviously depends on a cellular connection for use, but the intended audience would most likely have access to such a network. I believe this prototype has a solid structure, and could be used as the template for a successful product."

-User 2

"The App is aesthetically pleasing. I see the basic function of this app upfront of sending the information to the farmers. It is easy and I think that will help farmers a lot. The rest of the app regarding adding the contact information and downloading the data follows the standard procedure. So that is helpful. It will easy for the users to pick-up the functionality. Hamburger menu is little big for my liking but nothing wrong with that. I really liked the functionality of the app where a manager can manage his contacts. Its one of the most complex task, but the design of the app makes it look easier. The only issue I see, which is not about the design, but about the farmers using their phones and checking their message. (Also hopefully they are literate) But I can see how this app can be useful in this scenario."

-User 3

"I think the app is effective. It seems simple and easy to use. The video shows the perspective of a manager scheduling his contacts, who receive text messages regarding when they should/can work. This is based off the weather that is being supplied to the manager from the app. It is an interface that allows the user to make informed decisions and contact multiple workers all from one platform. The only assumptions being made are that 1) the weather reports are accurate 2) the cell phone service is reliable 3) the workers have a cell phone and know how to use it."

-User 4

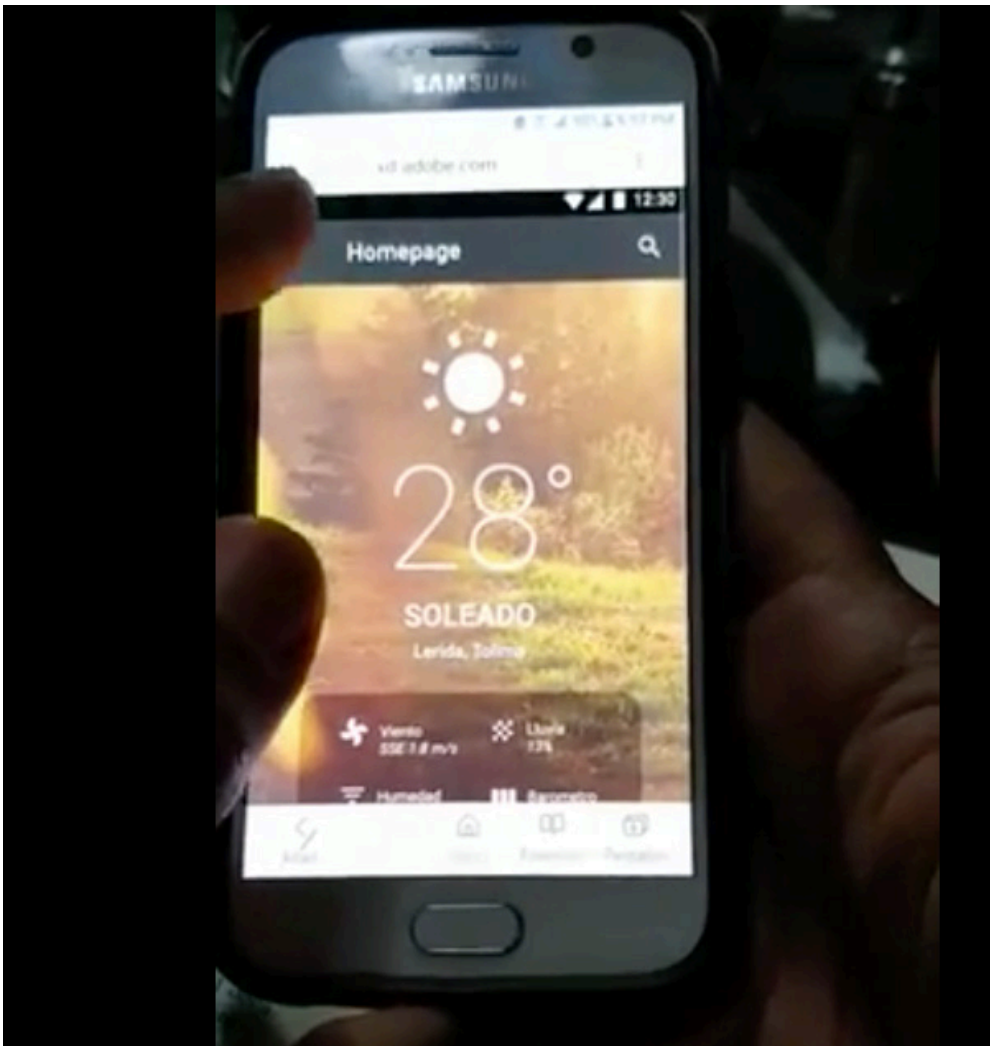


Figure 27. *Climate app prototype being tested by agriculture engineer*

6.6 CONCLUSION

The platform design was accurate in terms of UX/UI for the target audience. The research involved and the theories Applied gave the App and the website an outstanding level of accuracy.

I am confident that with these tools the App can serve as a bridge in the gap of the communication between Colombian climate entities, agricultural engineers and rural farmers. The push notification system are messages that pop up on a mobile devices, those can be sent at any time; users do not have to be in the App or using their devices to receive them. These text messages build a communication system between agricultural engineers and rural farm workers. Getting users to install an app is only half the battle. Getting them to use it regularly is the other half (Hathibelagal, 2016) push notification systems can also by used to remind agricultural engineers of the app's existence and benefits.

The scheduling and weather sections of the App serve as an information bridge between the Colombian climate entities and the agriculture farmers. The climate information is already available through the climate entities websites which do an excellent job in gathering it, but with the App and website created in this project, agricultural engineers would have a better user-friendly experience when collecting it. This would enhance their job performance by saving them time, organizing their schedule and communicating with farmers all in one platform. This way climate entities are available to communicate the information they gather, agricultural engineers can take better informed decision when planning their farming techniques and farmers can be told about their workflow for the next day in their cellphones.

6.7 SUGGESTIONS FOR FUTURE RESEARCH

It was challenging to be able to gather the data at the testing phase given that the users were not in the same location as me. In case of a research that requires designing a digital platform, it is important to keep in mind that the users have accessibility to a computer, camera and audio.

Deep research is key to be able to complete a user friendly, successful design outcome, the researcher must be completely committed to the study and understand that research must be given equal or more time that design in a project like this.

CHAPTER 7:
DESIGN RESEARCH CONCLUSIONS AND DISCUSSION

When I first addressed this topic my goal was to help farmers in Lérida with heat waves and droughts, and as the literature review evolved I could find the right way to do so. Once I set the goal to create a design outcome that served as a bridge for the communication gap between agricultural engineers, Colombian climate entities and farm workers I identified the challenges and used my UX/ID, Design Research and Graphic Design skills to create a digital platform to solve the broken communication that exceeded my expectations.

This research is relevant for many fields and professionals depending on the approach from which it is viewed. For example it could be cite in an agriculture, Graphic Design or UX/UI design study. Agriculture, because of the impact that the design outcome, can have a positive affects to the farming operations, Graphic Design because of the graphics and consistency use in the design outcome. A UX/UI design study could benefit as well because of all the resources, prototyping and research tools used to create the App and website.

Even though the testing phase revealed good feedback and an accuracy in the services and interface of the App, there is a need for further research and design. The design outcome can be elevated to create an actual artifact that would use satellite data to be able to apply precision farming (Beecham research, n.d.), a precision agriculture that optimizes the yield per unit of farming land, which achieves best quality in the product and best financial returns. It would also help farmers and make their farming operations easier. Even though developed countries tend to be the ones using these systems the most because their farms are often large (Tran & Nguyen, 2006), for developing countries agriculture is highly important in their economy, and technology innovation has been well received because the majority of population in less developed countries derives its livelihood from agricultural production. If there is an opportunity to increase productions and incomes with technology then the community is open to it (Feder, Just, Zilberman, 1985). This would mean a considerable economic investment and goverment or private funding should be requested.

In terms of design, the Climate App can be elevated with more services and data, it could also be coded, tested and launched in the market in order to gather data based on the new users responses. And to go even beyond that, a marketing campaign would be beneficial to promote the digital platforms, as it is Apps are now an integral part of people's daily micro-moments, with people spending an average of 30 hours per month in them, according to Nielsen (Tiongson, 2015).

Overall the design outcome was a big advance to achieve the goal of enhance communication between entities and farmers so they can have more control over their farming operations. This, by serving as a translator between the information in the climate entities website and what the agricultural engineers need to prepare next day's work flow, including communicating with the rural farmers in a digital technology that they could use and understand, a cellphone.

REFERENCES

Acerca de la entidad - IDEAM. (n.d.). Retrieved November 26, 2017, from http://www.ideam.gov.co/web/entidad/acerca-entidad

Angeles Villareal, M. (2014). *The U.S.-Colombia Free Trade Agreement: Background and Issues* (Rep.). Congressional Research Service

Backlund, P., Janetos, A., & Schimel, D. (2008). The effects of climate change on agriculture, land resources, water resources, and biodiversity in the United States. CCSP. Synthesis and Assessment Product 4.3 Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. https://www.usda.gov/oce/climate_change/SAP4_3/CCSPFinalReport.pdf

Beran, M., & Rodier, J.A. (1985) Hydrological aspects of drought. *Studies and reports in hydrology, 39,* https://hydrologie.org/BIB/Publ_UNESCO/SR_039_E_1985.pdf

Bouma, H. (1992). Gerontechnology: Making technology relevant for the elderly. *Studies in Health Technology and Informatics, 3,* 1-5. http://doi.org/10.3233/978-1-60750-847-2-1

Boutellier , R. & Gassmann, O. & Raeder, S (2011). *What is the difference between social and natural sciences?* Retrieved from http://www.collier.sts.vt.edu/sciwrite/pdfs/boutellier_2011.pdf

Burack, T. S. (2009). The New Hampshire Climate Action Plan A Plan for New Hampshire's Energy, Environmental and Economic Development Future

Retrieved from http://media.northernpasseis.us/attachments/Att_1833_A13_NH_Climate_Action_Plan.pdf

Chuttur, M. (2009). Overview of the Technology Acceptance Model: Origins, Developments and Future Directions. *Sprouts: Working Papers on Information Systems, 9(37)*. http://sprouts.aisnet.org/9-37

City Hall of Lérida Tolima. (2003). *Esquema de Ordenamiento Territorial Lérida Tolima*. Retrieved from http://cdim.esap.edu.co/BancoMedios/Documentos%20PDF/diagnostico-%20Lérida%20(452%20pag%20-%205846%20kb).pdf Designer. (n.d.). Retrieved April 30, 2017, from https://www.fitbit.com/home.

Tran, D.V. & Nguyen. (2006). *The concept and implementation of precision farming and rice integrated crop management systems for sustainable production in the twenty-first century*. Retrieve from: http://www.fao.org/3/a-a0869t/a0869t04.pdf

Feder G. , Just E. , Zilberman D. (Jan., 1985), "Adoption of Agricultural Innovations in Developing Countries: A Survey," *Economic Development and Cultural Change, 33* (2), 255-98. http://dx.doi.org/10.1086/451461

Goodwill, B., Fischer, K. (n.d.). *NEW MEDIA – NEW AUDIENCES – NEW TECHNOLOGIES Social Media is Changing the PSA Landscape.* Retrieved from http://www.psaresearch.com/PSA-BOOK.pdf

Hathibelagal, Ashraff. (2016, February). *How to Get Started With Push Notifications On Android.* Retrieved from https://code.tutsplus.com/tutorials/how-to-get-started-with-push-notifications-on-android--cms-25870

Hawken, P. (2017). Drawdown: *the most comprehensive plan ever proposed to reverse global warming.* NY, NY: Penguin Books.

Hord, S. M., Rutherford, W. L., L. H., & Hall, G. E. (1987). *Taking Charge of Change*. Austin, TX: Association for Supervision and Curriculum Development

Hsiang, SM., Burke M., & Miguel E. (2013). Quantifying the influence of climate on human conflict. *Science. Vol. 341* (Issue 6151). http://doi: 10.1126/science.1235367.

Kawulich, B. (2005). Participant Observation as a Data Collection Method. *Forum Qualitative Sozialforschung / Forum: Qualitative Social Research, 6* (2). doi:http://dx.doi.org/10.17169/fqs-6.2.466

Mallenius, S., & Tuunainen, V.K. (2007). Factors affecting the adoption and use of mobile devices and services by elderly people – results from a pilot study.

Mashayekhi, A. N. (1977). Economic planning and growth of education in developing countries. *SIMULATION, 29* (6), 189 - 197. https://doi.org/10.1177/003754977702900602

Meehl, G., & Tebaldi, C. (13 Aug 2004). More Intense, More Frequent, and Longer Lasting Heat Waves in the 21st Century. *Science, Vol. 305*, pp. 994-997. doi: 10.1126/science.1098704

Ocampoa O. ,(2013), Climate Change and its Impact on the Agriculture. *Boletín Técnico, Vol.51,* (Issue 3), pp.16-22. file:///Users/andreamateusforero/Downloads/150-1-2564-1-10-20171016.pdf

OECD. (2015). OECD Review of Agricultural Policies: Colombia 2015. *OECD Review of Agricultural Policies*. http://dx.doi.org/10.1787/9789264227644-en

Orr, G. (2003, March 18). [Review of the book *Diffusion of Innovations*, by R. Everett] https://web.stanford.edu/class/symbsys205/Diffusion%20of%20Innovations.htm

Peña Quiñones, A. J., Arce Barboza, B. A., Ayarza Moreno M.A. , Lascano Aguilar C. E., (2010), Simulation under climatic change scenario generated with spectrum singular analysis of water requirements of pastures. *Acta Agronómica, 59*. http://www.scielo.org.co/scielo.php?script=sci_arttext&pid=S0120-28122010000100001

Prahalad, C., & Hart, S. L. (2002, January 10). The Fortune at the Bottom of the Pyramid. *strategy+business,* Issue 26. Retrieved from https://www.strategybusiness.com/article/11518?gko=9a4ba

Ramirez-Villegas J, Salazar M, Jarvis A, Navarro-Racines CE. 2012. A way forward on adaptation to climate change in Colombian agriculture: perspectives towards 2050. *Climatic Change 115(3-4):611-628*.

Saariluoma, P. (2010). Life-Based Design - An Approach to Design for Life. Global journal of management and business research, 10(5). https://www.researchgate.net/publication/45108096_Life-Based_Design_-_An_Approach_to_Design_for_Life

Smart-AKIS. (n.d.). Retrieved April 09, 2017, from http://www.smart-akis.com/.

Stein B.A , Glick P. , Edelson N. & Staudt A. ,(2014), Climate-Smart Conservation: Putting Adaptation Principles into Practice. *Federal Government Series, vii, 262 p*. https://www.nwf.org/~/media/PDFs/Global-Warming/Climate-Smart-Conservation/NWF-Climate-Smart-Conservation_5-08-14.pdf

Step-by-step production. (n.d.). Retrieved November 24, 2017, from http://www.knowledgebank.irri.org/step-by-step-production

Tiongson, J. (2017, October 25). *Mobile App Marketing Insights: How Consumers Really Find and Use Your Apps*. Retrieved from https://www.thinkwithgoogle.com/consumer-insights/mobile-app-marketing-insights/

Toriola, A. (2017, October 17). Best Fitness & Activity Trackers for Seniors (the Elderly). Retrieved November 01, 2017, from http://bestchoicesforseniors.com/best-fitness-activity-trackers-for-seniors-the-elderly/

Beecham research, (n.d.). *Towards smart farming: Agriculture embracing IoT vision*. Retrieve from: https://www.beechamresearch.com/files/BRL%20Smart%20Farming%20Executive%20Summary.pdf

Villarreal, M. A. (2012). he U.S.-Colombia Free Trade Agreement: Background and Issues. *Congressional Research Service Reports*. https://fas.org/sgp/crs/row/RL34470.pdf

Washington, H., & Cook, J. (2011). *Climate Change Denial: Heads in the SandClimate Change Denial: Heads in the Sand*. New York, NY: Earthscan.

Yanes, S. J. (2013). Perfil productivo, municipio Lérida (Rep.). *Perfil productivo* PNUD Colombia. https://issuu.com/pnudcol/docs/perfil_productivo_municipio_l__rida

Zorn, T. (2010). *Designing and Conducting Semi-Structured Interviews for research.* Retrieved from http://home.utah.edu/~u0326119/Comm4170-01/resources/Interviewguidelines.pdf

APPENDICES

APPENDIX A: CONSENT FORM (SPANISH)

Formulario de consentimiento
Para participar en un estudio de entrevistas en profundidad
"Ayudar a los productores de arroz colombianos a adaptarse a las sequías y las olas de calor causadas por el cambio climático a través del diseño"

Usted está invitado a participar en una entrevista que hace parte de un estudio conducido por Andrea Mateus Forero, estudiante de maestría en Bellas Artes en el programa de Diseño Experimental en Miami University en Oxford, Ohio, Estados Unidos.

Andrea Mateus Forero, El investigador principal de este estudio, está interesada en estudiar qué recursos confiables, asequibles y amigables para el usuario pueden ser diseñados para ayudar a los trabajadores de las fincas y los agricultores de arroz a adaptarse a las sequías y las olas de calor. Esta entrevista es completamente confidencial y su participación es totalmente voluntaria. La entrevista tomará alrededor de 30 minutos de su valioso tiempo. Los datos de esta entrevista en profundidad se recopilarán mediante grabaciones de audio y toma de notas. Usted entiende que como compensación se le dara un bono para reclamar en un supermercado local. Se le harán preguntas sobre su experiencia trabajando en fincas de arroz y sus conocimientos que ha adquirida por medio de generaciones anteriores en este tema. La grabación y las notas de todos los participantes serán almacenadas estrictamente en un lugar seguro y solo los

investigadores principales tendrán acceso a él.

No se hará referencia personal en informes orales o escritos, que podrían vincularlo(a) a este estudio. Los datos serán analizados con toda la información adquirida de varias entrevistas y los resultados serán presentados en general, sin especificaciones en ciertos participantes. Aunque no se espera ninguna molestia mientras participa en este estudio, puede retirar su participación en cualquier momento durante la entrevista sin penalidad. Usted puede negarse a contestar cualquier pregunta que usted no se siente cómodo(a) respondiendo. Para poder participar, tiene que tener al menos 18 años de edad.

Si desea obtener más información sobre este estudio, incluyendo el procesamiento de datos, hallazgos, etc., antes o después de este estudio de entrevistas en profundidad, comuníquese con Andrea Mateus Forero mateusad@miamiOH.edu | +1 (713) 907.2595). Para preguntas o inquietudes acerca de los derechos de los sujetos de la investigación o la voluntariedad de este procedimiento de consentimiento por favor comunicarse con la oficina de cumplimiento de investigacion en Miami University: humansubjects@miamioh.edu |+1 (513) 529.3600

Sinceramente,
Andrea Mateus Forero
Investigador Principal
Candidato de maestría | Departamento de Arte | Miami University
124 Art Building
Oxford, OH 45056
513-529-2900
mateusad@miamiOH.edu

Si acepta participar en esta investigación, por favor firme abajo, desprenda la sección de la firma y entrégueselo al investigador. Guarde por favor la

información de arriba para futuras referencias.

_____

_____
Firma del sujeto aceptando participar Fecha
Con mi firma afirmo que tengo por lo menos 18 años de edad y he recibido una copia del Formulario de Consentimiento para guardar.

_____
_____
Firma del investigador principal Fecha

APPENDIX B: CONSENT FORM (ENGLISH)

Consent Form
for participation in an in-depth interview study on
"Helping Colombian rice farmers adapt to droughts and heat waves caused by climate change through design"

You are invited to participate in an in-depth interview study that is designed by Andrea Mateus Forero, Master of Fine Arts in Experience Design graduate student at Miami University in Oxford, Ohio. The purpose of this in-depth interview study is to understand which resources rice farmers and low level workers use to adapt to droughts and heat waves.

Andrea Mateus Forero, the Principal Investigator of this study, is interested in studying which reliable, affordable, and user friendly resources can be

designed to help low level workers and farmers to adapt to droughts and heat waves. This in-depth interview study is completely confidential and your participation is entirely voluntary. The in-depth interview will take around 30 minutes of your valuable time. In-depth interview data will be collected by audio recording and note taking. You understand that as compensation you will be given a bonus to claim at a local supermarket. You will be asked questions regarding your experience working in rice farms and your knowledge from previous generations in this topic. The recording and notes from all participants will be strictly stored in a secured location and only the principal investigators will have access to it.

No personal reference will be made in oral or written reports, which could link you to this study. The data will be analyzed for all subjects and presented in aggregate summary format. Though no discomfort is anticipated while participating in this study, you can withdraw your participation at any time during the in-depth interview study without penalty. You can refuse to answer any question that you are not comfortable with. In order to participate, you have to be at least 18 years old.

If you would like to have additional information regarding this study, including data processing, findings, etc, before or after this in-depth interview study, please contact Andrea Mateus Forero (mateusad@miamiOH.edu | +1 (713) 907.2595). For questions or concerns about the rights of research subjects or the voluntariness of this consent procedure, please contact the Research Compliance Office at Miami: (513) 529-3600 or humansubjects@miamioh.edu.

Sincerely,
Andrea Mateus Forero
Principal Investigators
MFA in Experience Design
Department of Art | College of Creative Arts | Miami University
124 Art Building
Oxford, OH 45056
513-529-2900
mateusad@miamiOH.edu

If you agree to participate in this research, please sign below, detach the signature section and return to us. Please keep the information above for future reference.

_____

_____

Signature of subject agreeing to participate Date

With my signature I affirm that I am at least 18 years of age and have received a copy of the Consent Form to keep.

_____

_____

Signature of the Principal Investigator Date

APPENDIX C: INTERVIEW QUESTIONS (SPANISH)

Entrevistas para el estudio:
"Ayuda a los productores de arroz colombianos a adaptarse a las sequías y las olas de calor causadas por el cambio climático a través del diseño"

¿Cuántas veces por semana trabaja en las fincas de arroz?

¿Está usted familiarizado con la sequía y las olas de calor?

Describa cómo se siente cuando hay largas olas de calor y sequías mientras trabaja.

Cuando usted trabaja en las fincas de arroz, ¿qué métodos se usan para reducir los daños a los cultivos a causa de estas sequías y olas de calor?

¿Por qué utiliza estos métodos?

¿Cuándo utiliza usted aparatos tecnológicos en las fincas de arroz?

¿Qué dispositivo tecnológico, impreso o conversación usted utiliza en el trabajo para distribuir información?

En sus pausas o tiempo personal, ¿qué dispositivo de tecnología utiliza más?

¿Cómo es la señal del teléfono en las fincas de arroz?

¿Consideraría usted que un dispositivo tecnológico es inconveniente para transportar mientras trabaja?

APPENDIX D: INTERVIEW QUESTIONS (ENGLISH)

In-depth interview study on
"Helping Colombian rice farmers adapt to droughts and heat waves caused by climate change through design"

How many days per week do you work at the rice farms?

How often do you deal with drought and heat waves when farming?

Please describe how you feel when there are long heat waves and droughts while working.

When you work at the rice farms, what measures do you take to prepare the farm for drought?

When you work at the rice farms, which methods do you use to help the farm withstand/ reduce the negative effects of the heat wave?

Why do you use these methods?

When do you use electronic technologies at the rice farms?

Which electronic technology, paper, word of mouth, or other communication/ distribution methods
you use at work?

In your breaks or personal time, which technology device you use the most?

How is the phone signal in the rice farms?

Would you consider a technological device inconvenient to carry around while you work?

APPENDIX E: IRB APPROVAL

MIAMI UNIVERSITY

Research Compliance Office
102 Roudebush Hall
Miami University, Oxford, OH 45056

6-Jun-17

To: Andrea D Mateus Forero and Dennis Cheatham (mateusad@miamioh.edu; cheatdm@miamioh.edu)
Art Department

RE: Helping Colombian rice farmers adapt to droughts and heat waves caused by climate change through design
Project reference number is: 02533e
(please refer to this ID number in all correspondence to compliance administration)

The project noted above and as described in your application for registering Human Subjects (HS) research has been screened to determine if it is regulated research or meets the criteria of one of the categories of research that can be exempt from approval of an Institutional Review Board (per 45 CFR 46). The determination for your research is indicated below.

The research described in the application is regulated human subjects research, however, the description meets the criteria of at least one exempt category included in 45 CFR 46 and associated guidance.

The Applicable Exempt Category(ies) is/are: 2

Research may proceed upon receipt of this certification and compliance with any conditions described in the accompanying email message. When research is deemed exempt from IRB review, it is the responsibility of the researcher listed above to ensure that all future persons not listed on the filed application who i) will aid in collecting data or, ii) will have access to data with subject identifying information, meet the training requirements (CITI Online Training).

If you are considering any changes in this research that may alter the level of risk or wish to include a vulnerable population (e.g. subjects <18 years of age) that was not previously specified in the application, you must consult the Research Compliance Office before implementing these changes.
Exemption certification is not transferrable; this certificate only applies to the researcher specified above. All research exempted from IRB review is subject to post-certification monitoring and audit by the compliance office.

Neal H. Sullivan, PhD
Director: Research Ethics and Integrity Program

DESIGN IN ADAPTATION TO DROUGHTS AND HEAT WAVES
*IN RICE FARMS IN LÉRIDA, TOLIMA, COLOMBIA.

Typefaces used are Bebas by Flat-it, Gotham Book by Tobias Frere-Jones, Times New Roman by Stanley Morison, Iowan Old Style, book and bold by John Downer.

4 copies were printed.