EPICS PURDUE

Urban Farming

Team: Farm Design
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Fall 2018

Introduction

Problem Statement

According to the Feeding America Study, Gary, IN currently possesses 14 of the 24 food deserts in Lake County (Reed, 2018). In order to address the lack of access to fresh produce and healthy food, Marty Henderson and Purdue University have partnered to build a rooftop garden for the community. According to the U.S. Census Bureau, as of 2017, Gary has a population of 76,008 and 35.9% of the population is in poverty. The issue of combined poverty, lack of fresh produce, ability to use Supplemental Nutrition Assistance Program (SNAP) across more fresh food markets, and community empowerment and involvement are all factors in addressing the needs of Gary through a sustainable rooftop garden.

Community Partner

Our community partner for EPICS Urban Farming is Marty Henderson. Marty is the owner of the building where the rooftop garden is going to be installed. He is a pastor in Gary who is opening a community center and plans to put a rooftop garden, an aquaponics system and greenhouses on the same property. His goal is to provide more fresh produce to the Gary area, along with educating the youth and helping justice served individuals re-enter the community. Once this rooftop garden is installed, Marty will be selling the produce to a farmers market, local restaurants and grocery stores in Gary.

Stakeholder Analysis

The primary stakeholder for this project is our project partner, Marty Henderson. He owns and runs Peace Garden and Farms in Gary, Indiana. Our primary communication about the project has been with Marty and he is the one that ultimately makes decisions about the project and potential solutions that the EPICS team presents.

Gary, as a community, is also a stakeholder since the goal of the rooftop garden is to provide healthy and fresh food that is easily accessible to them. In order to fulfill the project's duty for the community, the garden must have appealing and nutritional foods that are culturally relevant to Gary, must be sustainable and provide for several seasons, and the food must be distributed so that it is easily accessible for the community members. Marketing and communication about the garden must also reach the community. Gary has a population of 35.9% in poverty, 13.7% of the population under 65 have a disability, and 4.7% of the population live in a household that speaks a language other than English. The effectiveness of the garden is partially dependent upon accessibility and community awareness of the food. Thus, transportation, having

someone possibly deliver food, and advertisements in other languages may be aspects to consider.

In addition to the Gary community, stakeholders will include the individuals that will be working on the garden such as workers and volunteers. Although school-aged groups will also be working on the garden, they will be identified as their own stakeholder entity. The garden must be easily accessible for all ages and able-bodied individuals. Access to the roof must not be too physically straining, tools and garden supplies must be kept on the roof to make the maintenance simple and efficient, and the garden layout must accommodate space large enough to walk, pick weeds, harvest vegetables, and maintain the overall space.

As previously mentioned, the school groups that work with the garden are also stakeholders. They will be working on the garden maintenance during the summer months and it is important that garden supplies and access to the roof are easy, accessible, and efficient. Additionally, the consideration of spatial layout and rooftop structural integrity must be able to accommodate large groups of people.

Finally, another stakeholder is the group of justice served individuals, such as Chris, who work with Marty on community re-entry. It is important to be sensitive to their experiences and offer meaningful leadership and work opportunities for them that will offer skills and experience that can be used in the workforce and community.

Production of the garden may go to grocery stores to be sold. It will be important to develop professional relationships with local grocery stores in order to do this.

Objective and Goals

This semester, the goal of the Farm Design team is to obtain valuable research, resources, and plans for this rooftop garden. Since this is a new project (as of Fall 2018), the team is still gathering all background information and determining the feasibility of the project. Researching and learning about Rooftop gardens and problems associated with them are vital to be able to build a good foundation for the project. Obtaining this information is important in order to help Marty create a better community in the Gary area.

Semester Timeline

By the end of this semester, the Farm Design team hopes to have determined the feasibility of the project, acquired valuable research, and start a conceptual design.

Project Scope

The scope of the project is to construct a rooftop garden at the Peace Garden and Farms facility, located at a former National Guard Armory in Gary, Indiana. Everyone who is a consumer of produce from the garden, including justice-served individuals in the area, are stakeholders of this project. The project strives to understand the needs of the community and of the stakeholders, assess the structure of the building, and design a sustainable

rooftop garden. The main objective of the project is to improve the availability of fresh produce through urban agriculture in a USDA designated food desert.

EPICS Design Phase

Based on the EPICS Design Process diagram, our team's project is in the project identification phase. The team has finished identifying the stakeholders and basic stakeholder requirements. To determine our time constraints, the team created a Gantt chart which helps us keep our research and project on schedule. The team will be wrapping up on the project identification phase soon and will be moving onto the specification development phase.

During the latter half of the first semester, the team transitioned into the specification development phase. In this phase, we are trying to obtain a deeper understanding of what the project calls for and how the users will interact with what we finalize on. We have been comparing our ideas to other rooftop gardens that have been successful in the field. Other rooftop gardens include rooftop gardens such as the gardens built by Omni Ecosystems. We are now looking to create our own prototype rooftop garden at Purdue to evaluate what the needs will be for the garden in Gary. This way we will be able to prevent any issues that could arise in the final product. Building a rooftop garden in Purdue will also teach us the different kinds of maintenance rooftop gardens will require. We will also be able to present our prototype garden to our project partner and receive feedback in regards to what could be improved. After all of our partner's needs are met, the team will be able to transition into the conceptual design phase.

EPICS Design Process

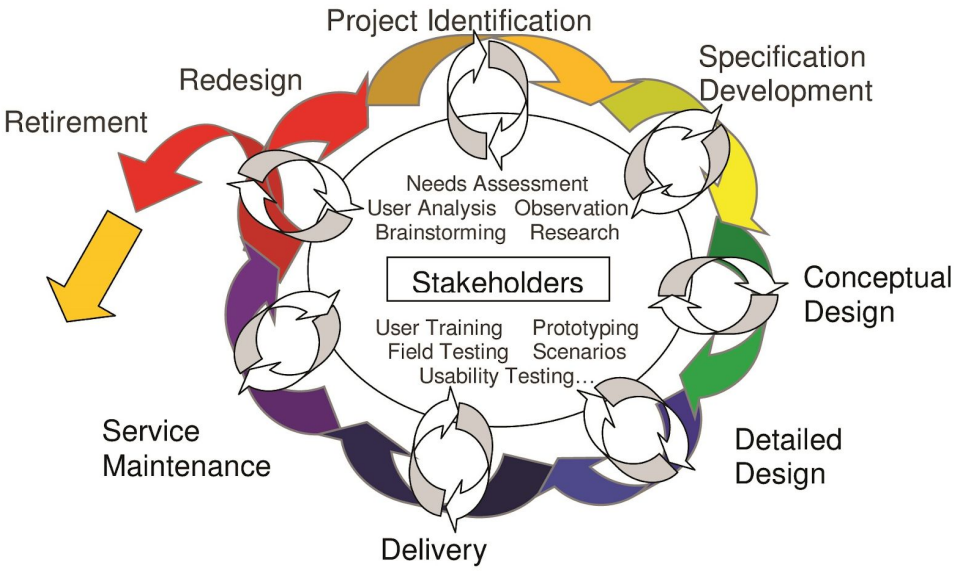


Figure 1. EPICS Design Process.EPICS. (2010, Jan.) *EPICS Design Process*. Retrieved from https://sharepoint.ecn.purdue.edu/epics/teams/public%20documents/epics_design_process.pdf

Background

Site Visit

September 08, 2018

Omni Ecosystems:
Omni Ecosystems facilitates the integration of gardens, flora, and fauna into city life through designing and installing sustainable rooftop gardens. Aside from aesthetics and recreation, their installations can yield crop output, help with stormwater retention, assist in building insulation, prolong rooftop life, and boost general city morale such as reducing outside noise and bringing nature into the city. Sam Irwin, who works on the business side of Omni gave us a tour and also sent documentation to help with our project.

Omni contained unique and compelling aspects of their designs and product. First, they have an incredibly well researched soil formula. Second, they use the “infinity roof” method. Layers of terrain, soil, and plants are put on the roof instead of using the conventional method of boxes. Marty Henderson, primary stakeholder, found Omni’s method most appealing and would ideally like to have an infinity roof. In order to provide security to the roof, Omni had it reinforced with steel beams. Access to the roof was primarily through ladders, which would be difficult for anyone with physical disabilities.

Uncommon Grounds:
Uncommon grounds is considered as the first certified organic rooftop farm in the US. Allison Glovak, the head gardener, showed us around the rooftop garden. Their rooftop garden was drastically different from Omni’s design. First, they built a risen structure on

top of the roof instead of building directly on the roof. This was done because the roof could not directly support the garden and extra reinforcement was required, however, if any issues with the roof occurred it would be very difficult to address. Second, the plants were in boxes. This required soil maintenance in order to maintain nutrients. Some difficulties this presents are avoiding soil and plant diseases since the plants are so contained.

Another difference between Uncommon Grounds and Omni Ecosystems was the difference between garden output. Uncommon Grounds operated differently due to the fact that their garden was to provide produce to be used in their restaurant. This required more attentiveness to their product and gardening methods in order to comply with produce and restaurant standards.

Actual Site:

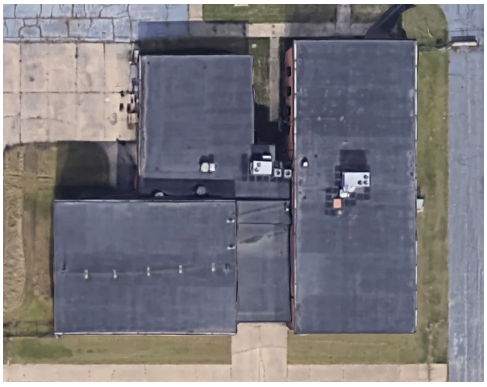
The site visit was one component that contributed to major progress in the project. One, seeing the actual area where the project was to be executed helped us visualize things more clearly. Second, it aided in conceptualizing the current problems and possible ideas for brainstorming solutions.

There are two roofs in total for the gardens, connected by the roof over the vestibule in the middle. The roofs appear to be well supported; however, input from the infrastructure team would be necessary to decide upon the soil that will go over it. Another important decision is whether or not to have borders around the plants, which depends on the type of plants grown and the amount of surplus space available. The current ideal is to grow plants in parallel sets of rows.

Apart from the buildings where the garden is supposed to be, there are others, like the one that would carry the solar panels. Then there is space for the hoophouse and the aquaponics system (which come after the rooftop in priority).

One of the issues that was very blatant was the access to the roof. The roof could only be accessed from inside the building, without a sturdy support. One of things then, that would be resourceful for the people working in the garden would be to have better access to the roof, ideally from the outside. This would come in conjunction with a gate so as to limit access to the roof to its rightful members.

As the work on the project continues, the main areas of focus aided by the visit would be to calculate the amount of crop that has to be grown, keeping in mind that the produce has to feed the whole community. Any surplus produce goes to the grocery store, so choosing those produce with good market value is another factor to consider.



Retrieved from Google Earth

Demographics

In 1906, Ebert Gary founded the city of Gary to establish a prosperous steel industry. By the mid 20th century, thousands of immigrants entered the US to work for the booming industry. These immigrants included workers from Greece, Italy, Poland, Russia, and Mexico. The majority of immigrants were African Americans traveling from the Southern United States. To accommodate the large number of workers entering the US, the Gary Land Company built a multitude of houses. The Europeans were forced to adopt the American culture while Latinos and African Americans were discriminated against. Eventually, the Europeans left Gary, causing the population of Gary to be predominantly African American. This population change is highlighted in Figure 10.

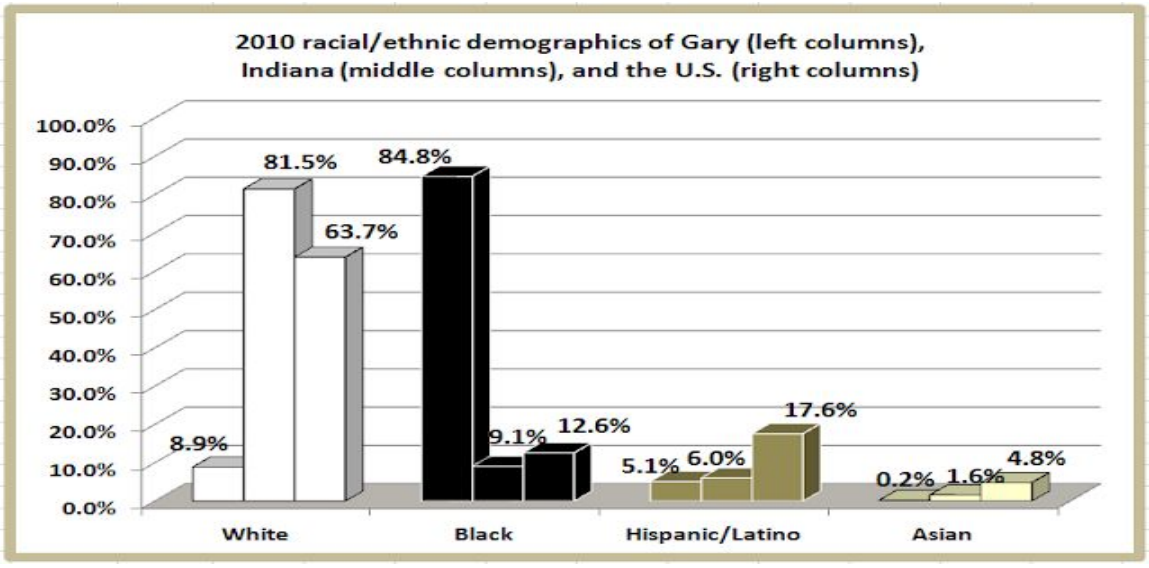


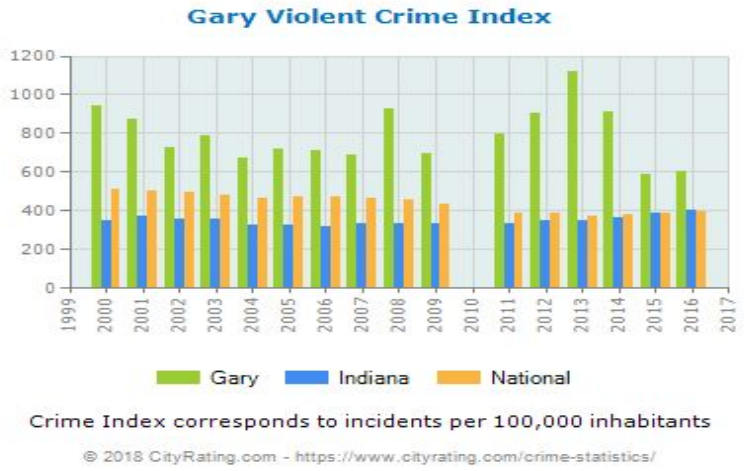
Figure 2. Racial Demographics Gary, IN 2010

In 1969, Gary employed 30% of northwestern Indiana. By 2002, this percentage had dropped to 8% because of overseas competition and less demand for steel in the United

States. In the span of 1960s to 1987, the number of workers decreased from 30,000 to 6,000. Gary has seen much adversity including segregation, industrial pollution, political corruption and increase in crime as shown in Figure 11. All of these factors play a role in Gary not being able to provide social services and fresh produce.

Today, Gary has a population of 76,008. The population is broken down to 81.5% African American, 13.6% white and 5.6% Hispanic or Latino. The mean household income is $28,895 and 35.9% of the population is under the poverty line. There are around 31,205 households and 2.47 people per household. Out of these households, only 4.7% speak a language other than English. Of the population, 18% of people under 65 do not have health insurance.

Figure 3. Violent Crime Index Gary



IN 2017-2018. Gary Crime Rate Report (Indiana). (n.d.). Retrieved from https://www.cityrating.com/crime-statistics/indiana/gary.html

Food Desert

A food desert is usually an urban area where it is difficult to buy affordable or fresh quality produce. Food deserts happen when people have little to no access to places that sell fresh and nutritious food, usually due to lack of transportation. Food deserts exist all over the United States, but they are more prevalent in impoverished areas, often where minorities live. The USDA's website has a food desert locator which is a comprehensive map of the areas where food desert exists all over the nation[USDA]. A large part of Gary, Indiana, is a food desert according to the map.

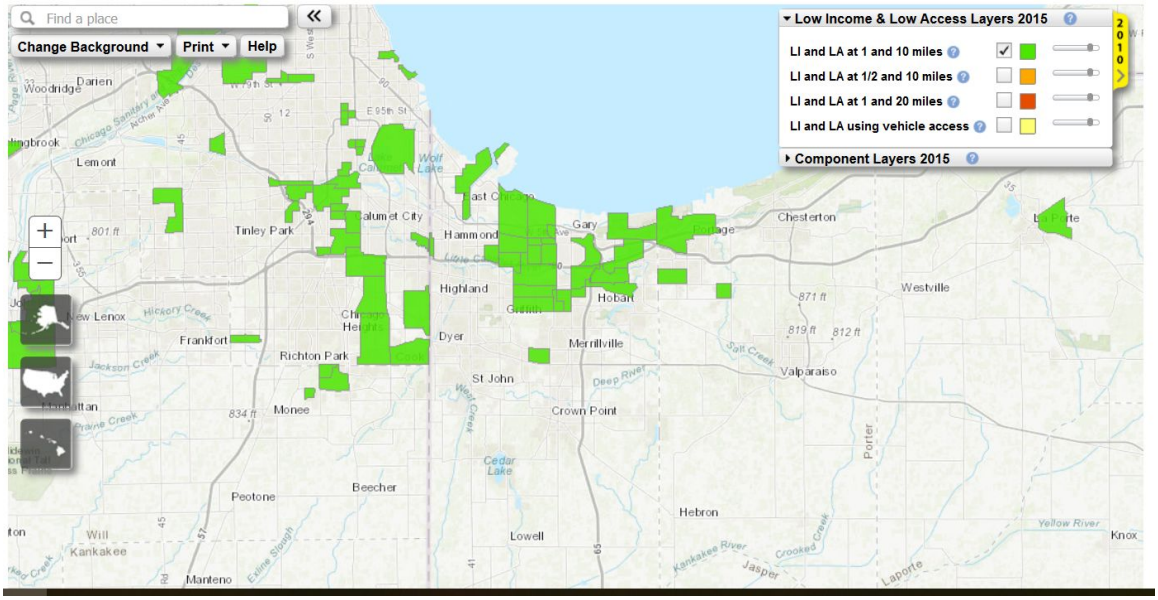


Figure 4. Income Areas of Northwestern Indiana.USDA - ERS. (n.d.). Retrieved September 27, 2018, from https://www.ers.usda.gov/data-products/food-access-research-atlas/go-to-the-atlas

Some facts about food deserts:

- Usually happens in areas with a high poverty rate
- Lack of local groceries and lack of transportation to groceries that sell fresh produce
- About 25-30 Million people in the United States live within a food desert
- Food deserts are more common in the Southern States

Weather Data

Our team evaluated the weather data from the Gary, Indiana area to have a better understanding of what types of plants and soils could be used for the rooftop garden. Temperature, rainfall, snowfall and humidity data were collected from Weather Underground (WU) and Weatherspark.

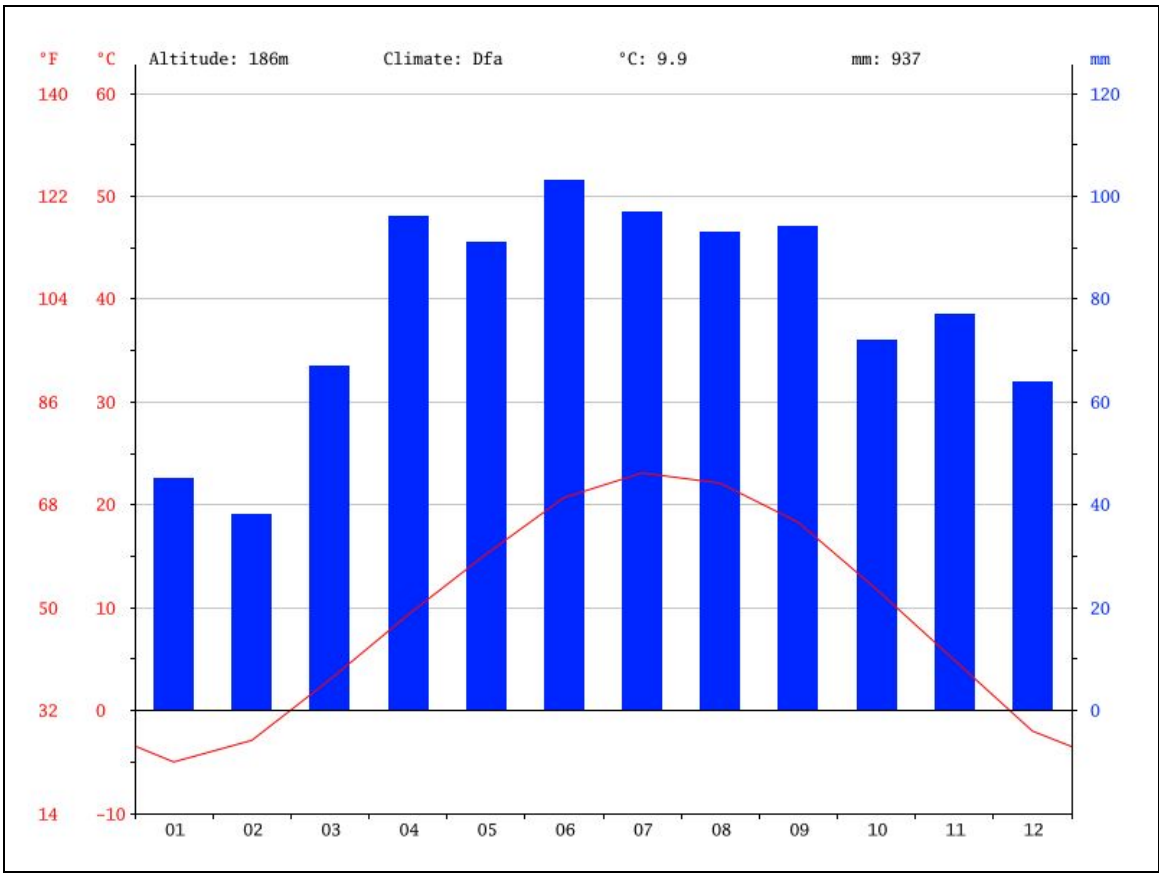


Figure 5. Average Temperature and Rainfall in Gary, IN. Climate-Data.org. (2015, August 09). Retrieved November 29, 2018, from https://en.climate-data.org/north-america/united-states-of-america/indiana/gary-17511/

Temperature data was a necessity to be collected from the area. The measurements collected provided us with information such as points of freezing and burning of water for the plants. Too cold of temperatures would cause the roots of the plants to die, along with the freezing of the water supply to the plants. Too warm of temperatures would cause the water on the plants to scorch the leaves, or the plants could become dehydrated. The temperature on the roof will be warmer than the ground because of the materials being put on the roof. Figure 7 provides the temperatures of the different materials that can be used on the roof. As shown in Figure 3, Gary, IN experiences all four seasons - winter, spring, summer and autumn. Rainfall data determined whether or not installing rainfall barrels on the roof of the building would be beneficial. Gary is stable with rainfall, as shown in Figure 4. Since most of the year is dry, but efficient enough to fill the barrels, they can be used. If not used by a certain time period, the barrels could grow bacteria or attract unwanted vermin. The use of a garden hose will be the most suitable for watering the plants on the rooftop.

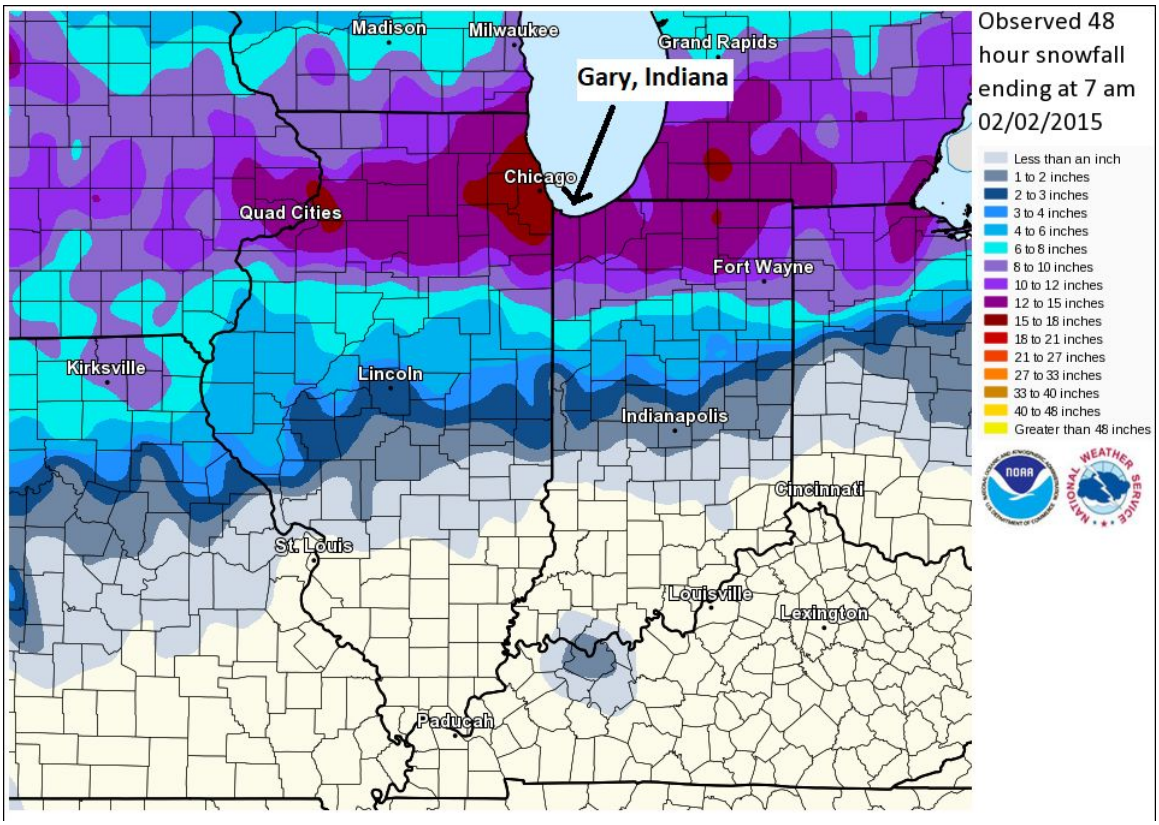


Figure 6. Snowfall in lbs/ft^2. US Department of Commerce, & NOAA. (2015, April 23). Historic Winter Storm of January 31-February 2, 2015. Retrieved November 29, 2018, from https://www.weather.gov/lot/2015_Feb01_Snow

Snowfall was included in the weather data collection to determine the weight that will be placed onto the roof and the effect the snow could have on the plants. Gary receives on average 25 lbs/ft^2 every year in snowfall. Also, a cover crop, such as a winter wheat, will benefit the crops for summer and autumn. The wheat will provide nutrients and protection for the crops planted later in the year. Spring will be another problem for the roof, due to the issue of the snow melting and causing a flood in the building.

ROOF SURFACE	DEGREES FAHRENHEIT ON A SUNNY, 90-DEGREE DAY
Black roof	140-190
Aluminum reflective coated	Up to 68 degrees cooler than black roofs
Gravel	125-140
Unpainted metal	138-145, but feels warmer to the touch than a black roof
Painted Metal (ex: BASF Cool Paint)	105-115 or up to 42% cooler than unpainted metal

White	102-120
Vegetative	90

Figure 7. Roof Temperatures
sentryroof.com

Soil Data

Soil is an important part of the rooftop garden. This is the medium that the plants will be growing in and needs to be sustainable. There are basic components of soil that will have to be mixed in order to obtain the best soil for this rooftop garden which caters to the plants and the climate in Gary. To understand all of these, the team has developed research on the basic components of soil. This research will be used to determine the mixture needed and then conduct a test with different mixtures until the desired results is obtained. There are four main components to soil, clay, loam, sand and silt. These four mainly make up most of the soil types. However, not all soils are equal parts clay, loam, sand and silt. Different mixtures of these four main components are ideal for growing different types of plants. Also, different mixtures are ideal for growing crops in different regions with varying temperature and climate. Sand is suitable for growing plants in warmer weather. While loam is suitable to grow plants in dry climates as it can contain moisture for a longer period of time. Also, clay is suitable to grow in wet climates. Figure 6 shows 12 different types of soil based on different mixtures percentage of the four main components.

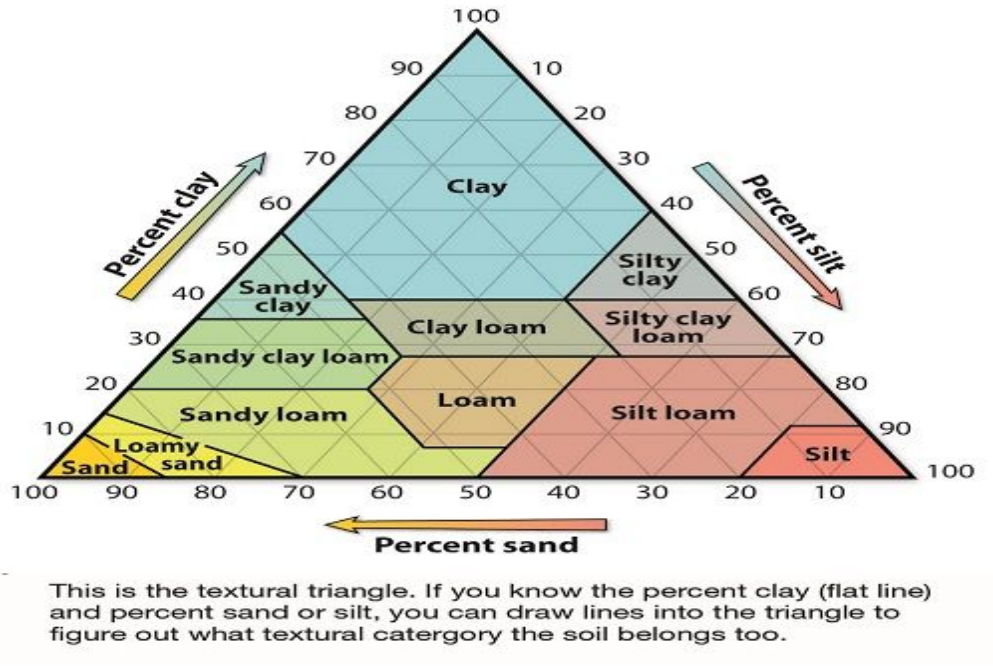


Figure 8. Different soil types.K-12 Soil Science Teacher Resources. (n.d.). Retrieved November 29, 2018, from https://www.soils4teachers.org/physical-properties/

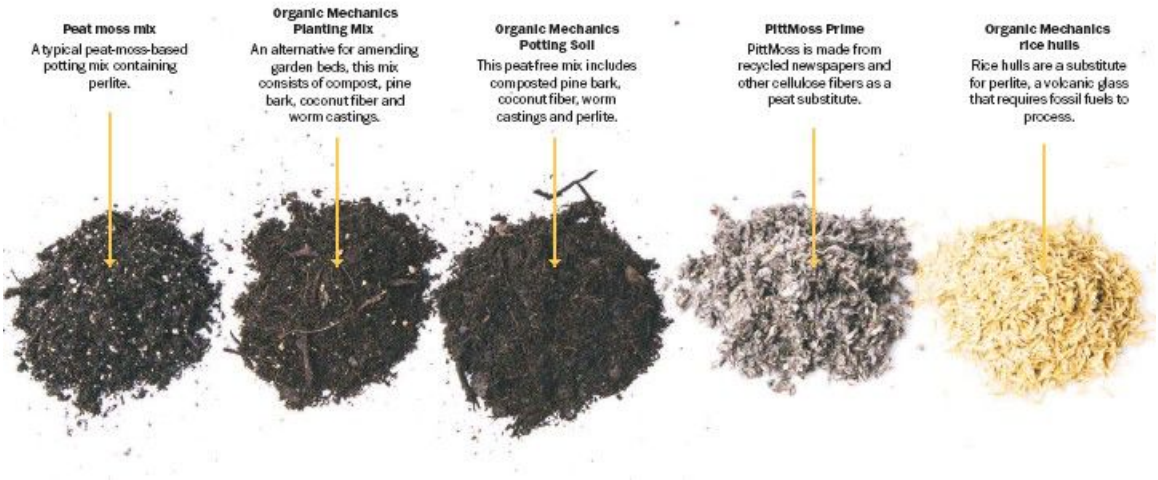


Figure 9. Soil types
https://img.washingtonpost.com/rf/image_480w/2010-2019/WashingtonPost/2017/05/09/LocalLiving/Images/PEATMOSS03.JPG?uuid=q5VXIjQyEeerA6op9lbxPg

Along with nutrients and other properties of common soils, the team has researched weight, since the soil will be placed on top of a roof. Weight is an important criterion

since adding weight to a building can compromise its structural integrity. In figure 9 has a general estimate for four different types of soils that have been researched. The table also have data on how water and plants will affect the weight (Engineering)

General Soil Types	Density (lbs/ft^3)	Weight of Soil 12'x12'x8' (lbs)	Total Weight With Water and Plant Weight
Clay Pebbles	21	14	32
Peat Moss	72	48	66
Loam	80	53.4	71.4
Silt	81	54	72

Figure 10. General Soil Weight

Soil Selection

After extensive research and meetings with faucity in the college of Agriculture. Our team met with Professor Orvis and she gave us a lot of insight about our project and how to go about it. After consulting with her and the research, the team concluded that potting soil or greenhouse soil will be the best soil for this rooftop garden. After meeting with Nathan Deppe, the greenhouse facility manager at Purdue, our team received a lot information about greenhouse soils and distributors of soils in our area. After contacting one of the distributors our team has received information about pricing, weights, and water capacity of 5 types of soil that is being considered for the rooftop garden. Figure 9 describes the 5 soils our team is considering for the green roof and major criteria for each of the soils.

Product code	Description	Weight (lbs/ft^3 saturated)	Cost per cubic ft	Water retention (%)	Water Permeability (mm/min)
APPS	A blend of pine bark, peat moss and coir, also comes with a controlled release fertilizer	62.8	4.50	75	17.6

CM63	Grower mix with pine, has bark and compost I and sand	70.5	3.80	67	11.9
CM66	Grower mix with perlite. Lots of peat, perlite sand and compost	63.8	4.44	62	12.8
PM35	Planter soil mix with pine, soil sand and compost	88	3.00	56	15
MW intensive	Green roof medial with lightweight aggregate and compost	76.7	Unknown	52	19.6

Figure 11: Soil Information for Soils from Midwest Trading

Plant Data

Gary is located in the Plant Hardiness Zone 5b (Figure 10.). Zone 5 is characterized as having a moderate length growing season (Sharp 2012). There are two important dates in Zone 5, May 15th and October 15th. These dates signify the last frost date and the first frost date respectively, of the season (Zone 5). Due to these dates, most vegetables can grow in Gray without any problem. Please refer to the **Figure 10** depicting Zone 5's recommended planting schedule.

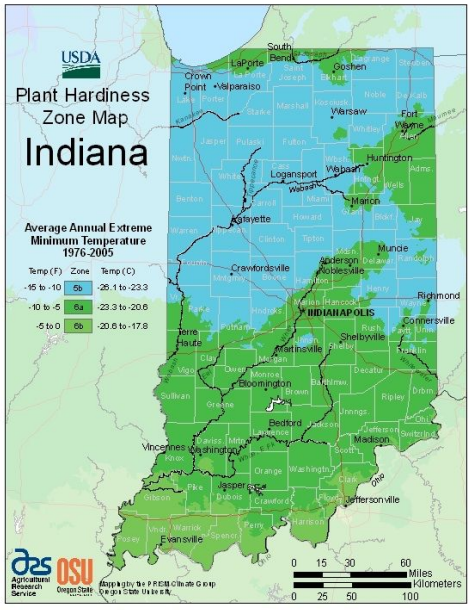


Figure 12. Indian's Hardiness Zones

http://hoosiergardener.com/?p=7270

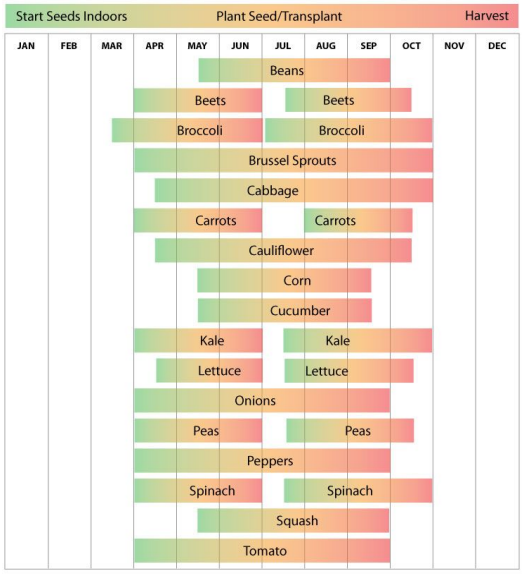


Figure 13. Growing seasons for common vegetables
https://www.ufseeds.com/learning/planting-schedules/Zone-5-Planting-Calendar

Taking figure 9 into consideration, three different plant growing groups were hypothesized in Table 1. Partnering with the information from figure 10, these groups were created by determining compatible plants with similar pH levels, nutrient and water requirements, and temperature range.

Group 1	Group 2	Group 3
• Potatoes • Beans (no pole) • Corn • Peas • Melons • Squash • Pumpkins • Strawberries • Turnips	• Tomatoes • Carrots • Celery • Cucumbers • Onions • Peppers	• Beets • Cabbage • Broccoli • Kale • Lettuce • Swiss Chard • Spinach • Collard Greens

Figure 14: Growing groups

Testing Plans

After deciding on a soil and general plants the team has made a plan to test these in real conditions. To test the three soils we decided on from Midwest trading the team will be

making a control for each and then several different deeps with the same plant in each. These will be tested in pots on the roof of Armstrong, hopefully the EPICS team still needs to be granted permission.

Lettuce is going to be the control plant		
APPS	**CM63**	**CM66**
12in depth	12in depth	12in depth
8in depth	8in depth	8in depth
12in medium on top of 12in of mulch	12in medium on top of 12in of mulch	12in medium on top of 12in of mulch
8in medium on top of 8in of mulch	8in medium on top of 8in of mulch	8in medium on top of 8in of mulch

Figure 15: Testing plans for soils

Laws Related to Selling Produce

Apart from soil, one of the aspects that we looked into is complications that could potentially arise due to different laws related to selling and producing produce in Gary. Potential problems that could arise are barriers for selling at corner stores and farmers markets, acidified foods laws, producing regulations, and any Gary specific rules that may be encountered.

After contacting Amanda Deering, Clinical Assistant Professor of the Department of Food Science at Purdue, she provided viable information about rules and regulations of selling and producing. First, information was provided about barriers on selling produce. A scheduled process on each specific product must be kept and adhered too in order to sell produce. This scheduled process must be documented and specifically followed. To sell produce in the State of Indiana, there must be a record kept, including information about our raw input materials, what is added during the growing process, and what is added during the packing of the produce in order to sell in farmers market and at corner stores (Deering 2018). Along with the scheduled process and record, there also must be information kept on final pH levels. This is an important step of harvesting, because it determines if you product is considered an acidified food (Deering 2018).

According to the information given on the Indiana State Department of Health (410 IAC 7-21 Section 47 - Acidified Foods), finished goods that fall under acidified foods have to be at an equilibrium pH of 4.6 or lower. Acidified foods can be considered a risky product to sell. This is due to the health risks that the products can present if not properly produced. Acidified foods have their own set of regulations that must be followed (21 CFR 114 and 21 CFR 108.25). To be considered an acidified food, the pH has to be 4.6 or lower and have a water activity of greater than .85 (Virginia Tech 2012). Acidified foods are usually pickled.

Along with acidified food problems, problems could arise if the produce is not heat treated during processing. Depending on the way the produce is packaged, which it will have to be if sold at corner stores, then there will have to be a specific heat treatment to eliminate any microorganisms that are present on the produce. These microorganisms can be a public health concern if not correctly dealt with (Deering 2018).

Survey

The intention of creating a survey was to incorporate and empower the community of Gary in deciding the produce and plants the garden would have. It was advised to us by a mid-semester design reviewer, that we gave the community agency in deciding what kind of produce they wanted, as they are one of the primary stakeholders in this project. The intended survey participants are households and families in Gary that Marty Henderson has direct access to through Peace Garden and Farms.

There are various ideas for a survey format. The final product should be based on something that is easy and convenient in order to ensure substantial responses. So far, ideas for surveys include a food diary for one meal, every day, for a week (preferably dinner). This could either be done through manually writing down what one ate or taking a picture of their meal. Another idea would simply be asking people what they already like about the food outreach programs and what they would like to see differently or in addition to what is already being provided. This would be more so based on feedback and also would be simpler for participants to fill out. The issue with a food diary would be honesty, accountability, difficulty, time, and perhaps the food someone is currently eating is not what they would like to have in the future or if other options were to be provided. Demographics and personal information may not be vital to the survey. It would be best to keep the survey as anonymous as possible in order to possibly avoid needing Institutional Review Board (IRB) approval. Some demographic information that may be useful could include number of people in a household.

One of the barriers in creating a survey is whether or not IRB approval will be needed in addition to an individual having CITI training that is involved with the survey. The individual with CITI training could be the class TA, it just needs to be someone with

consistent presence in the project. There is still uncertainty whether the survey counts as pure research or something for product development. It is important to create the survey regardless, as the IRB will need an example of the survey to approve. The approval process can take a couple weeks to a month, so it will be important to budget time accordingly. Another challenge for the survey will be ensuring that the team will be getting results back. One thing that may help with this is using email, an app, or a website to make it easier for people to send something back, however it is important to consider if everyone has access to this technology. If the survey is on paper, it will be important to provide a self-addressed envelope to Purdue with a stamp so participants do not have to seek those things out on their own.

Finally, when involving human participants it is important to include the risks of participating. Although the risks for filling out a survey of this nature are relatively low, consulting the IRB website provides more specific information and examples about risks.

The individuals on campus that provided guidance, advice, and knowledge about making a survey for this project were Andrew Flachs who is an Anthropology professor and Carla Zoltowski. Carla works directly with EPICS and is a valuable resource for information about IRB, CITI, and relevant information about the EPICS program.

Next Steps

The next steps for this project include testing the soils, planning the growing seasons, planning the crop rotation, soil maintenance, and beginning to think about all other factors that could impact the rooftop garden. For spring of 2019 it is important that a soil medium gets tested and data is collected to make sure that these soils are suitable for the roof. There are plans for this testing in the greenhouse testing plans section. Next we need to plan when each plant will be planted and harvested. This is important since Marty wants to sell these produce they need to be harvested at different times so he always has something to sell. The crop rotation also need to be planned this is important to keep the soil in good condition. Next, a soil maintenance guide needs to be made showing how much organic matter needs to be added and how much fertilizer. Along with a what to do if there is too much salt or the pH of the soil is off. Our team also should look into sensors to put into the soil and the water to check the pH and salt levels. Finally the team needs to make a list of all other factors that could affect the garden and come up with ways to deal with all of these. Some major ones are fertilizer and temperature of the soil on the roof. Another thing the team could look into doing is creating a chart or excel sheet that shows the possible yield of the roof and how it would change with different crops. Next semester we will also need to send the survey that was made to get a good understanding of what types of produce the residents of Gary, Indiana would like.

Conclusion

As of end of semester, our team has developed a stakeholder analysis, our problem statement, and finishing up on research on relevant topics. The team has done research on topics of soil, plants, weather, and demographics. Our next steps are to start experimental research and determine the soil and plants that will be grown on the rooftop garden. The soil mixture will be determined by using different mixtures of potting soils and greenhouse soils in multiple experiments. Experiments will begin next semester, so we can continue our progress with the project efficiently. For the team to determine the best soil for this project, criteria for the soil will need to be set. These criteria will need to meet the constraints of the project and our stakeholders requests. After this, the team will use a decision matrix to make a decision about the soil with the criteria that determines the best soil. Cost is always a factor in projects; this project will be very expensive to carry out once all of the factors are determined. A good way to help fund this project would be grants in the Gary area. Being able to create the best rooftop garden possible is important and so is finding the money to do it. The project is going to be a great way to help Gary, Indiana be a more beneficial city with the rooftop garden.

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