

Experimental Garden Designs for Seed Wayne



Prepared for:

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Executive Summary

This technical report discusses the feasibility of Seed Wayne planting experimental sustainable gardens at Wayne State University. The report aims to benefit the adaptation of a sustainable food system in Detroit, Michigan that is centered around the university. Seed Wayne currently has a farmers market that sells produce seasonally, but they lack gardens that are actually sustainable. Consequently, the challenge discussed is for Seed Wayne to implement experimental gardens that are sustainable, so they can reach the goal of their mission statement, and successfully establish a sustainable food system in the city of Detroit.

As a project team, we have conducted primary research through interviews and surveys to collect data of how beneficial sustainable gardens could be in the community. We had members conduct interviews with Seed Wayne to get an insight on their potential goals and what they have planned for the future. We have also used credible sources such as books, academic journals, and professional websites to aid our research of sustainable garden designs and our evaluation criteria.

Five alternative garden designs:

- Vertical Design: most urban friendly, and uses limited space.
- Hugelkultur Design: self-maintaining, and visually unique.
- Indiana State Design: unique to location, and visually beautiful.
- Alley cropping Design: utilizes effective recycling, and sustainable methods.
- Carlson Design: most water efficient, and innovatively sustainable.

The designs were evaluated based on the following criteria:

- Use of space: amount of land that the design needs to implement.
- Maintenance: the labor that is required for maintain the garden.
- Material cost: the monetary loss and gain that follows implementation.
- Water efficiency: conservation of water in the design.
- Innovative techniques: the sustainable methods that the design utilizes.
- Visual appeal: aesthetic factor in a university setting.
- Composting method: how the design feeds the chosen crops.
- Waste management: the way the design uses or discards organic waste.
- Reduce-Reuse-Recycle: the overall conservation in the design.

This report concludes with our recommendation of implementing the Hugelkultur and Alley cropping designs at Wayne State University.

Introduction

This report discusses the feasibility of Seed Wayne implementing experimental gardens designs at Wayne State University. A huge challenge that Seed Wayne currently faces is planting gardens that are actually sustainable. It needs to adapt newer sustainable garden designs to further their mission of establishing a sustainable food system in Detroit, Michigan. To contribute to their on-going efforts of planting sustainable gardens, we have conducted research to suggest alternatives to their current garden designs. Our team found a total of five experimental designs that could easily be integrated by a sustainable food systems initiative like Seed Wayne, and evaluated them on the basis of sustainability. Out of the five sustainable garden designs, we conclude that the Hugelkultur and the Alley cropping designs are two that could be beneficial to implement at Wayne State University.

Overview of Alternatives: Five Experimental Designs

Our team has researched many designs implemented by other sustainable food systems initiatives at other universities, including community gardens, and personal gardens across the globe. We found many that were reasonable, but eventually narrowed it down to five experimental designs that could be implemented by Seed Wayne. We considered location, cost, use of space, and technique when we decided to pick these five designs. These designs are unlike anything that Seed Wayne has currently, and could significantly help further their goals.

Alternative 1: Vertical Design



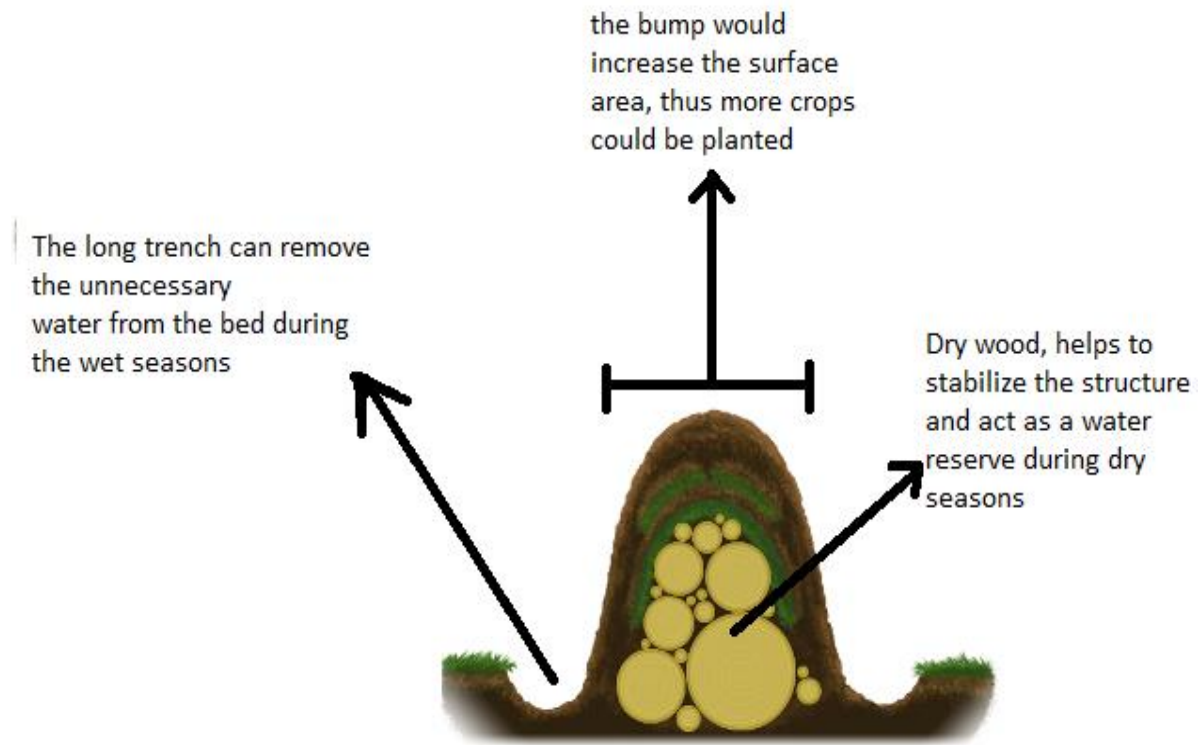
Now days many farmers are utilizing vertical gardening due to its countless benefits, and broad applications. Vertical gardening can maximize the limited space by utilizing the space above, which it is very useful in urban areas where there isn't much space available for gardening. Also it is very practical in cold environments, because it can reduce the energy needed for heating greenhouses; lastly by minimizing the planting space we also minimize irrigation making it more water efficient. By gardening vertically, we can also utilize less shading, which will increase the sunlight, and air circulation. This will reduce diseases, and yield healthier and higher amount of crops; therefore, vertical gardening is also favorable for the plants as well. Finally, there are many other trends that make vertical gardening more favorable over the old fashion of flat gardening. For example, it increases the accessibility making it easier to labor (planting, watering, transplanting, and harvesting....etc); also it enhances the visual appeal and the beauty of the garden as well as reducing pollution by improving the air quality. It is also cleaning the outside air of pollutants and dust resulting in a positive impact on human health.



Alternative 2: Hugelkultur Design



Hugelkultur or Hill Culture is a design which involves planting on raised beds that require no digging, no fertilization, and less irrigation. With its unique structure it provides much more space than other cultures for growing crops. It is basically wood buried in soil; as time pass by the wood would decay and act as a sponge which makes it an excellent water and nutrients reserve. Hill culture can be applied to small gardens as well as big farms and can be built with or without machines depending on desired size. Small designs can reduce irrigations and bigger designs can eliminate irrigation for years with five times better quality due to the large accessed amount of nutrients. The simple trick to this design is just a first layer of cardboard and a second layer of logs, wood, and twigs; followed by a layer soil and finally a layer of straw as shown in the below picture.



Alternative 3: Indiana State Design

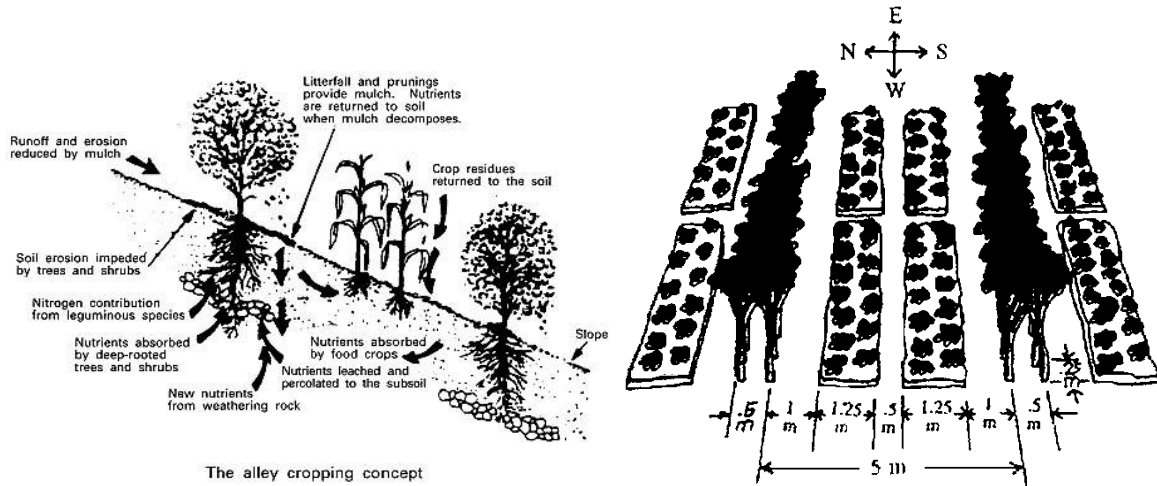


The Indiana State design can be a creative design that can be implemented at Wayne State University. This garden that already exists at University of Indiana is split into three subset designs which all combine together and make a sustainable garden. The outer most part of the garden has a semi-circle shape which makes it easy to access for the student population. It contains basic food such as tomatoes and beans. The second section of the garden is within the first section and it is a rectangular plot which involves stacking rectangle compost boxes on top of each other to garden in a vertical fashion. Finally, the innermost part of the garden is the ellipse plot which is land that is divided into eight pieces. On five of the strips, an annual herb is grown and on the other three a cover crop is.

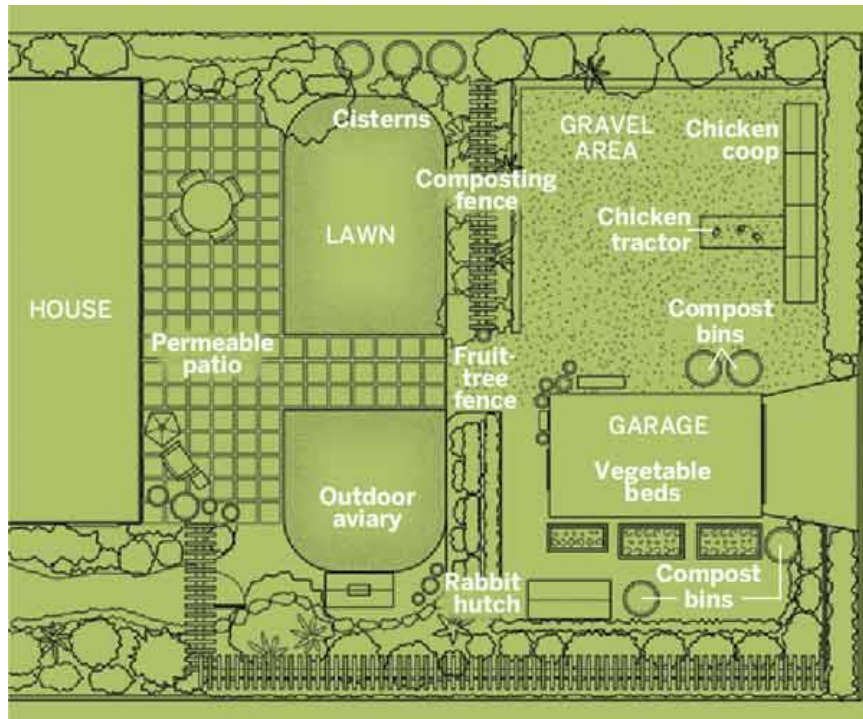
Alternative 4: Alley Cropping Design

One of the many gardening designs that we can incorporate at Wayne State University is the alley cropping system. In this system, we can plant several rows of trees or woody plants and plant the crops in between the trees. After that, we can prune the trees letting the leaves fall on the soil and crops around them. This results in two main benefits, which are improved soil health and improved crop health. As pruning provides mulch, which when decomposed returns the nutrients to the ground. Basically, it helps in reducing soil erosion and water infiltration. This also adds organic carbon to the soil, which in return recycles it and improves the nutrient retention of the soil. It improves crop health by protecting the crops in-between from wind damage and insect pests. It also reduces moisture loss from the soil. Additionally, reducing the wind effects increases the pollination activities by beneficial insects, which result in increased yields

of various crops. Overall, this is a reasonable design especially when used with perennial seeds which produces food year around.



Alternative 5: Carlson Design



One innovative garden design that we were particularly intrigued by is the sustainable garden of Jennifer Carlson from Seattle, Washington. Her design meets the very definition of sustainability as it basically takes care of itself with minimum intervention. She has utilized the heavy rainfall that the city of Seattle receives, and incorporated it

into her sustainable garden. The rainwater is collected from her roof into three cisterns that hold 1875 gallons of water for the summer. A self-built composting fence separates certain beds, which stores yard waste, fallen leaves, clippings, and any type of organic matter. Her garden also contains a permeable patio that controls runoff, and perfectly perchorates the soil. The design also makes use of the location, and beds are positioned to receive necessary sunlight. She plants fruits, even edible flowers, and many drougout tolerant crops that are easy to maintain. In addition, she also uses coffee grounds to enrich sandy soil for future gardening beds. Droppings of rabbits are used as fertilizer, and chickens to even out the soil.

Research Methods

Our primary research was conducted through a survey of the student body and interview with Seed Wayne members in order to collect data on sustainable food systems. The goals was to get input from our primary and secondary audience. These methods provided quantitative data which were incorporated in our study. One of our members, Yahiya also attended one of the Seed Wayne meetings in order to gain some insight on what their potential goals are, and determine how our goals can intertwine. Furthermore, our secondary research was conducted through the use of books, academic journals, case studies and online data base. This helped conduct the research that was needed in our study and provided evidence to persuade our intended readers. The sources used gathered from credible and professional websites like Google Scholars and the Wayne State Library database.

Our research involved many questions that varied from how beneficial our study will be for Seed Wayne economically to how our study will help make a healthy community. These research questions were created to clarify the goals of the study. Provided below are an example of primary research questions that were on the survey:

- How much knowledge do you have of the environmental group here at Wayne State called Seed Wayne?
- What specific part of Seed Wayne’s mission draws you in the most?
- If one of these issues were being represented through a volunteering experience, how many hours of your time a semester would you be willing to volunteer towards projects associated with Seed Wayne?
- What type of projects do you see Seed Wayne taking on or type of projects you would like to be a part of?

Aside from the primary research questions, other questions that were asked related to secondary research. Following are the secondary research questions:

| Question | Type | Technique | Researchers |
|---|--------------------|---------------------|-------------------------------|
| What kind of experimental garden design could Seed Wayne implement? | What techniques..? | Websites, Databases | Jai, Hussein, Yahiya, Bhavini |

| | | | |
|--|-------------------------|---------------------------|------------------|
| How a sustainable food system (or our experimental garden design) could benefit the environment? | What strengths..? | Journal articles | Bhavini |
| What will Seed Wayne and local communities gain from our experimental garden design? | How well would this...? | Observe, Websites | Hussein, Lauren |
| Why current (unsustainable or sustainable) food systems are unfavorable? | What is the theory...? | Journal articles | Jai |
| How will Seed Wayne benefit from our feasibility study? | How is a current...? | Websites, Databases | Safayeth, Yahiya |
| Why communities and anyone affected should care about this? | What are the facts...? | Interview, Questionnaires | Lauren, Safayeth |

As a team, our main goal is to stay connected, and that is why our team decided to use wiki pages on Pbworks to draft and revise the report. This was due to the fact that Pbworks was a part of our class and our team was able to use some of its advanced features with relative ease. Our team also considered the use of resources such as Google Docs for simultaneous drafting or editing, but later decided not to use such resources because of time constraints and experience. The team also decided to use one of its member, Jai Govind's Box account as a way of previewing, and distributing formatted documents. As for communication, our team decided to use iMessage and texting as a way to stay connected. The team members also provided email addresses, and phone numbers as a secondary method of communication.

As for individual qualification, Jai Govind became our team leader, and coordinated the specific duties of all team members. The reason why he was chosen as the team leader was because he has previous leadership experience, and had completed six group lab reports for material science. Jai was also our Chief Editor, and helped team members draft their research information into the report. Hussein Elhaj was our Community Researcher, and worked on the community aspect of the study. He had great communication skills, and worked on collecting data through primary research. Bhavini Patel was our Environmental Researcher, and worked on the environmental effects of garden design. She had experience planting trees, and contributing to community gardens. Yahiya Saif was our Food Researcher, and researched food security as well as health related issues with sustainable gardens. He is a Chemistry major, and was very interested in the food science aspect of our study. Lauren Harmon was our Planner, and had researched the benefits of sustainable food systems. She also planned out the schedule, and aided in data collection for our primary research. Safayeth Khan was our Organizer, and aided in the research of other team members. He had excellent organization skills, and worked on researching other topics related to growing a sustainable garden.

For the writing process our team decided to follow a divided approach between its members. In any case, executive summary was drafted by Lauren, and the introduction was drafted by Jai. Alternative overview was co-drafted by Hussein, Jai, Safayeth, and Yahiya. The criteria was drafted by Hussein, and research method was drafted by Safayeth. The research results section was co-drafted by Bhavini, Hussein, Jai, and

Yahiya. The evaluation section was co-drafted by Hussein, Jai, Safayeth, and Yahiya. The conclusion and the recommendation sections were drafted by Jai. All sections of the report were then revised by several team members, and later co-edited to complete the report. Finally, the report was successfully completed through extensive collaborative with our instructor. Dr. Jared Grogan has aided our study by reviewing report formatting, research results, and design evaluation.

Research Results: Seed Wayne Survey

We conducted a survey as a group to try and gain a good understanding of the interest or awareness level of Wayne State Students in Seed Wayne. Our questions were designed in a matter that would allow us to know what percentage of students are aware of Seed Wayne and what exactly their awareness level was. Also, if they were not aware of Seed Wayne, we included Seed Wayne’s mission statement in order to see if students would be interested in joining such group based off that mission statement. Finally, if students where interested in joining Seed Wayne we asked a couple questions to see what exactly drew them in and the amount of hours they would be willing to put into this organization.

The following are some key finding:

Knowledge about Seed Wayne

| Answer Choices | Responses |
|---|--------------|
| A great deal- part of the group or worked with the group | 2.00% 1 |
| Moderate amount-visited their site multiple times or spoke to members | 16.00% 8 |
| Very little- generally heard of them | 44.00% 22 |
| Never heard of it | 38.00% 19 |
| Total | 50 |

Based off these findings, a majority of the student population does not know much about Seed Wayne if any at all. 82 percent had very little if any knowledge of them with only 2 percent knowing a great deal.

Student Volunteering Hours for Seed Wayne

| Answer Choices | Responses |
|----------------|--------------|
| 10-20 | 80.43% 37 |

| Answer Choices | Responses |
|--------------------------|--------------------|
| – 20-30 | 10.87% 5 |
| – 30-40 | 6.52% 3 |
| – 40 and above | 2.17% 1 |
| Total | 46 |

Clearly these findings are an area of improvement for Seed Wayne. We hope through projects proposed in our study more students will be interested in joining Seed Wayne.

Aspects of Seed Wayne that Interested Students Most

| Answer Choices | Responses |
|--|---------------------|
| – Issues of Environmental Engineering | 38.78% 19 |
| – Issues of Urban Sustainable Agriculture | 28.57% 14 |
| – Healthy organic food consumption | 53.06% 26 |
| – Issues of food security in the Detroit community. (providing food) | 36.73% 18 |
| – Policy issues or local politics | 18.37% 9 |
| Total Respondents: 49 | |

Based off these findings, a focal point in our gardening designs will be to implement healthy organic foods and make that a focal point to the students. Doing this will hopefully draw more volunteers towards Seed Wayne.

Future Projects that Interested Students Most

| Answer Choices | Responses |
|---|---------------------|
| – Sustainable Gardening at Wayne State | 51.02% 25 |
| – Sustainable Gardening in nearby Detroit communities | 57.14% 28 |
| – | 30.61% |

| Answer Choices | Responses |
|---|------------------|
| Selling of our crops | 15 |
| – | 53.06% |
| Helping educate people on benefits of being environmental friendly | 26 |
| – | 51.02% |
| The creating or designing of Gardens | 25 |
| Total Respondents: 49 | |

These results are very promising. More than half of the students surveyed are interested in sustainable gardening, education, and most importantly the creating of gardens. We feel the work needed to implement our gardening designs are focused around these areas which will help draw in the students and help fix the problem regarding lack of volunteers.

Although discouraging, most students are not willing to put in much of their time towards Seed Wayne, we feel that this problem that can be solved. The survey showed that students showed a great deal of interest in many aspects of Seed Wayne such as gardening designs and healthy food consumption. More specifically, more than 50 percent of the students surveyed were interested in these areas mentioned above which is exactly why we believe that Seed Wayne should strongly consider implementing one or more of our gardening designs into their project ambitions. Clearly the student’s main interests are garden designing or different aspects of sustainable gardening which is exactly what we are bringing to the table with projects regarding our garden designs.

Seed Wayne Interview

One of our team members, Yahiya Saif met with one Seed Wayne group to investigate how Seed Wayne is currently operating. We found out that Seed Wayne is divided into many groups during the interview with Seed Wayne (dig group), we noticed that they are short on workers; they need at least 15 participants with each participant contributing at least 1-2 hours a week (this number changes with the number of participants). Their future plans are; first, to increase the garden beds they have (from 5 –10, their gardens are made with 4*8’ and 1ft height wood beds); second, is to expand the WSU formal market with also changing the location due to traffic.

With that being said, we feel that incorporating our gardening designs will definitely add many more gardening beds while adding something new that Seed Wayne can experiment on. According to our survey results more than 50 percent of the students were interested in designing gardens and sustainable gardening. We strongly believe that incorporating our gardening designs will draw the interest of the students which will in turn solve the lack of volunteering.

Sustainability Impacts of Community Gardens

Social & Cultural Impact

Community gardens are a lot more than just a food source. Community gardens have the power of bringing communities together and making the community a much better place to live. According to the USDA (urban agriculture and community gardening) community gardens strengthen community bonds and create recreational therapeutic opportunities for communities. A study was done in a Chicago neighborhood that showed the effects a community garden can have on a community by researching gardening areas vs. non gardening areas. Results showed that those living in areas with gardening events taking place felt a significantly stronger role to the community and reported that the community is taking measures to improve. Statistically speaking 83 percent of people living near gardens took place in helping out with garden activities and 90 percent of people preferred green areas. Furthermore two similar studies, one done by Texas A&M University and the other by the University of Illinois showed that areas with above average greenery (gardens, greenhouses, farms etc....) had a lower crime rate than those with below average greenery. This was consistent for both poor and rich neighborhoods in both cases respectively.

Seed Wayne

Seed Wayne is very active in trying to get the nearby communities especially the Detroit community to go green. One project that Seed Wayne is currently working on is building a 4000 square foot solar greenhouse near a soup kitchen in order to provide the soup kitchen with healthy foods. This allows soup kitchen workers, volunteers, consumers, and anyone in the community to come together in building this greenhouse and sharing in its riches. Another project that Seed Wayne is working on called policy-making in the soup kitchen is centered around getting members of the community to get together once a week to discuss how they can provide healthier food choices for children. This is a great way for the local community members to get together and socialize for a common cause. In addition to that, Seed Wayne constantly hosts events at Wayne State as well as the nearby community which is open to anyone who wants to come such as the Farmers Market which allows people from both Wayne State and the communities to interact.

Economic Impact

Community gardens or “green areas” have many positive effects on the economy such as improving property value, providing jobs, and helping business owners. According to the USDA the “Green industry” is one of the fastest growing segments of the Nations agriculture. Its estimated economic impact is said to be “* \$147.8 billion in output * \$64.3 billion in labor income * \$6.9 billion in indirect business taxes * 1,964,339 jobs * \$95.1 billion in value added”. Furthermore, studies of three neighborhoods showed that a property’s value decreases about 4.00 dollars for each foot away from a greenbelt. Small business owners say that agriculture is the first thing they consider when trying to pick a location for their business. It’s clear, community gardens and urban agriculture are a major plus for the economy.

Seed Wayne and the Economy

Seed Wayne is heavily involved with local business owners to try to benefit their financial status while distributing freshly grown crops. For an example, Seed Wayne asked three local liquor stores if they would be willing to sell freshly grown crops from Seed Wayne and asked the local community if they would use the liquor store to buy groceries. Both parties said it was a great idea and this benefits Seed Wayne financially as well as the business owners. Furthermore, Seed Wayne receives products from local farmers and in turn label products as “grown in Detroit” which helps benefit these farmers financial status by selling more crops. Seed Wayne does many other projects similar to the ones above and is continuing to interact with local community business or using community gardens as means to help benefit the Detroit economy.

Ecological Impact

Our project is aimed to better understand how gardening practices might affect the ecological viability of community gardens. Impacts of a location may be direct by having indirect measurable impacts on biodiversity and ecology at the site itself or indirect when impacts occur away from the site. Proper gardening practice play a role in long term ecological viability of urban agricultural systems because gardening practices entail the effective management of soil nutrients, sunlight, rainfall, and biological resources. Gardening practices can be environmentally beneficial like composting local sourcing of plants and materials or even limiting the use of synthetic chemical pesticide and increasing the diversity of plants.

Another benefit ecologically is adding native plants that generate nitrogen dioxide on its own. It's a natural way for the plants to consume it as well as create it. There is no need for any fertilizer which can potentially damage the land. Native plants are better for the environment than exotic plants, generally requiring less fertilizer and other additives, less water, and less effort in pest control. They are especially important to native wildlife, such as pollinators, that may have coevolved with a particular species. Pollinators often rely on a certain type of flower as a source of food, while the flower depends on the pollinator to transport its pollen to other flowers for reproduction. Production of crops that does not rely on toxic chemicals pesticides, synthetic fertilizers, genetically modified seeds, or practices that degrade soil, water, or other natural resources. Overall Sustainable farming will minimize the use of non-renewable ecology resources therefore it is highly beneficial for the environment of the surrounding community. All of that will prevent pollution of WSU surrounding area, which mean it will also be beneficial for our university. Sustainable farming could bring biodiversity for the local community as the farms produce different kind of crops and animals which would make perfect conditions for scientific researches, which it is very beneficial to WSU.

In conclusion, Preserve, protect, and expand green space and demonstrate new opportunities for greening in Detroit. Encourage participation in sustainable gardening practices that improve soil, water and air, and increase biodiversity. Expand community leadership and the base of support for Seed Wayne.

Health Impact

We can think of food as the building materials (nutrients) that our bodies need to methodically work and function, therefore if we give our bodies the cheap material, the metabolic pathways of our bodies will be distrusted causing a decline in health. Therefore, food is number one reason for bad health. Food that is grown in a sustainable fashion has plenty of those nutrients that can help us achieve optimum health. Also, industrial agriculture relies on harmful substance such as pesticides, inorganic chemicals, antimicrobial compounds, and unhealthful food additive. In the other hand, sustainable agriculture is defined as growing crops or raising animals in environmental responsible manners that utilize methods which can save and protect the environmental ecology. Therefore, sustainable food can prevent us from exposing our interior bodies from those toxic substances.

According to Karsten, industrial food usually contain high amount of fat, fructose corn syrup and processed food that has a lot of negative effects on human health including high cholesterol level, higher chance of getting cancer, colon problems...etc. Also, industrial agriculture farms are usually located far away from the urban areas which can lead to decrease the quality of those types of crops due to the long storage and transportation. Furthermore, industrialized crops are mostly genetically engineered and modified, which can reduce certain nutrients; such as, vitamin E (an important antioxidant), vitamin A (important for vision, reproductive system and immune system), Omega 3 (an important fatty acid that is essential for brain and cardiovascular). As indicated in the table, all of those factors and effects can lead dangerous problems, for example in USA, in 2012 65% of Americans are considered overweight and 35% of Americans suffer from heart diseases, diabetes, or strokes (Flegal, 491-497). Finally, the chemicals that are used in pesticides has harmful side effects to farmers and to consumers as well (if the crops was not properly washed); those effects are lower in body mass and reproductively; delay the development for children, decline in the immunity system, damage to organs and cancer.

| EFFECTS OF FAST FOOD ON THE BODY | | |
|---|-------------------------|---|
| <u>Region</u> | <u>Effects</u> | <u>Reason</u> |
| <u>Digestive and Cardiovascular Systems</u> | High blood pressure | Too much sodium |
| | High cholesterol | Trans fats |
| | Stroke | Due to the high cholesterol and high blood pressure |
| | Heart disease | Dou to the high cholesterol and high blood pressure |
| | Type 2 diabetes | High amounts of carbs |
| | Obesity | Extra calories lead up to extra weight |
| <u>Respiratory System</u> | Asthma | As a result from obesity |
| <u>Central Nervous System</u> | Depression and headache | Unhealthful Sugar |

| | | |
|-----------------------|---|---|
| <u>Skin and Bones</u> | Acne | Chocolate and greasy foods |
| | Risk of eczema (inflamed, irritated patches of skin) | Allergy |
| | Dental cavities | High in carbs and sugar leads to acid that destroy tooth enamel |
| | Osteoporosis (thin, fragile bones) | Excess sodium |
| | | |

However, sustainable food is unprocessed food, in fact it contain numerous amount of numerous that are essential for the human metabolic pathways. For example, sustainable crops such as whole grains, fresh fruit and variables contain a lot of mineral, organic acids, protein, amino acids, carbohydrate, fatty acids, water and fiber that are very beneficial to our health. Additionally, sustainable food is also important because it can lower the risk of heart diseases, improve the quality of the body organs (liver, intestines, brain...etc), also, it can decrease the risk of developing colon cancer (Frith).

In conclusion, humans are one of those creatures on this plant that do not avoid the dangerous matter that can threaten their survival. Food is one of those matters, we human should start think about our food as a risky issue instead of three times a day habit. Food can be toxic and can kill us slowly through diseases and suffering.

Consequences of Unsustainable Agriculture

There are many issues related to current agricultural systems widely used throughout the world. Many of these systems are unsustainable, and put more emphasis on the monetary benefits that come from mass industrial production. Large-scale industrial agriculture utilize pesticides, and synthetic chemicals that can cause harm to human health. According to Northrop and Conner, “These pesticides affect human health by entering ground water and drinking water through runoff, through meat from animals that have ingested pesticides, through ingestion in produce, and through the air (drift from crop dusting, etc.)” Produce from such agriculture contributes to malnutrition for over a billion people worldwide, and some are also associated with cancer risk. The following table lists some agricultural pesticides that are associated with cancers that cause nearly 10,000 deaths each year in developing countries.

Pesticides and Associated Cancers

| Type of Pesticide | Associated Type of Cancer |
|-------------------------------|---|
| Phenoxyacetic acid herbicides | Non-Hodgkin’s lymphoma, soft tissue sarcoma, prostate cancer |
| Organochlorine insecticides | Leukemia; non-Hodgkin’s lymphoma; soft tissue sarcoma; pancreas, lung, breast cancers |
| Organophosphate insecticides | Non-Hodgkin’s lymphoma, leukemia |
| Arsenical insecticides | Lung, skin cancers |
| Triazine herbicides | Ovarian cancer |

Furthermore, such production practices also further unsustainability by causing environmental degradation, biodiversity loss, fertilizer pollution, and topsoil erosion. One big consequence that follows such conventional practice is topsoil erosion, which destroys usable land. Many farmers layout their land to match heavy farm machinery, and welcome severe topsoil erosion in the process. Topsoil loss eventually results in decreased crop yields as the soil can no longer hold water and nutrients effectively.

Topsoil erosion, harm to human health, and environmental degradation are some of the major consequences of current unsustainable agriculture practices. These consequences themselves define the need of a new paradigm that can overcome the losses set by current farming methods. Sustainable agriculture is the answer to many of these issues, and can offer viable alternatives. Crop rotation is one alternative that sustainable agriculture offers opposite to mono-cropping, which is planting the same crop across many acres. Crop rotation helps reduce topsoil loss by planting many different varieties of crops next to another in the same acre. Another sustainable method called cover-cropping calls for planting nitrogen rich crops, which helps reverse organic matter in soil. Sustainable agriculture does not use any kind of pesticides, therefore, it cannot cause any harm to human health. Such sustainable agriculture practice can easily negate the consequences of current agricultural systems, and create a system that can also secure future needs.

Criteria

Before we even begin discussing alternative sustainable gardening designs, we must define exactly what it means to be sustainable. The term “sustain” in itself means long-term existence. With that being said our primary concern when evaluating different gardening designs was to assure their long-term existence. More specifically, sustainable agriculture according to the National Agricultural Library is “capable of maintaining their productivity and usefulness to society indefinitely”. So sustainable agricultural systems must be environmental friendly, conserve resources, socially acceptable, commercially competitive, and cost efficient.

Basically, being environmental friendly means that our gardens must be able to preserve water, maintain water quality, use renewable energy sources, maintain soil quality, assure air quality, and avoid use of any harmful chemicals. In terms of being socially acceptable, our gardens must be able to benefit the nearby communities in some way. The garden cannot be a burden to the community. Our gardens must be commercially competitive meaning that they are benefiting the economy rather than hurting it or having no effect on it. Finally, our garden designs must be as such that it requires little if any monetary support from the university itself that is outside of the already set budget that Seed Wayne has.

More specifically, we are going to judge the **amount of space** that the design takes up because there is limited space on campus. Designs will also be evaluated based on the amount of **maintenance** that they require, because Seed Wayne has limited volunteers, and sustainable garden should be self-maintaining to some extent. **Material cost** is another factor that we will consider while evaluating designs, because the design cannot be too expensive for Seed Wayne to implement. **Water efficiency** of the garden designs will also be weighed against another, because sustainable gardens need to be very water efficient and eco-friendly. **Innovative techniques** that are sustainable will also be considered, because sustainable agriculture has many such beneficial techniques. **Composting methods, waste management**, and the “**reduce-reuse-recycle**” system of the garden designs will also be evaluated. Lastly, we will judge the designs based on their **visual appeal** for a university campus setting.

The set of criteria mentioned above were used to evaluate the five experimental garden designs that we researched for Seed Wayne.

Evaluation

Vertical Design

The vertical garden has many unique qualities that match with our desired set of criteria. First, the use of space; the utilization of the upward space would maximize the limited space by up to 200%. Due to Wayne State University's location, this feature is very useful to our school because it take care of the limited space problem. Second, the irrigation efficiency, by vertically stocking the crops on top of each other, we can prevent the water from being wasted or absorbed into the ground because any extra water will go down to the plants below. Third, the visualization; this type of gardening is beautifully unique and odd to the eye; it can catch the attention of anyone passing by. In addition to the amazing view that it can provide to campus, it also can improve the quality of air around it.

However, even though these types of garden increase the accessibility to crops, vertical gardening can be messy thus it requires a lot of maintenance, especially if there is water leak that can destroy the structure and causing the soil falling off the bed. It is also harder to grow large size crops. Finally vertical gardening can be a problem in hot-dry environment, because due to gravity the water will keep moving downward which can cause an uneven distribution of water.

Hugelkultur Design

Hugelkultur has many positive features that fit with the definition of sustainability. The first feature is that it can sustain itself for a long time, which is due to the wood being present inside the soil that can take very long time to decay. This provides the field with a life time of nutrients, therefore it does not rely on chemicals or fertilizers; in fact, it can improve the quality of the soil without any supplements. Additionally, it does not harm the environment and it can lower the carbon emission because it prevents the burning of woods that can be very harmful to the ecosystem. The second feature that Hugelkultur has is the ability to save water via woods and the logs that act as a sponge for water during wet season and as a water reserve during dry season. Therefore, Hugelkultur require no irrigation. The third feature that Hugelkultur has is the beautiful view that it can give to the surrounding landscape which can make it socially acceptable. The last feature of Hugelkultur is that it can increase the limited space by 50 percent.

However, the Hugelkultur design also has some negative features, for example it requires a lot of work just to create it, and may even need big machines to carry the woods and bury it with soil. Also it requires a lot of woods which can be a problem in some areas where there isn't any wood to waste.

In conclusion, Hugelkultur meets all of our criteria. It is water efficient, chemical free, visually acceptable, uses limited space, and is eco-friendly. Also, it is very efficient due to its abundance of nutrients, and self-maintaining features. It can be sustained for a

long time, about 20 years or more if hardwood was used as a basis. Overall, it is a great design with lots of benefit.

Indiana State Design

The Indiana University Garden Design as mentioned in the overview section is split into three different plots, each providing unique features. This gardening design, with all three acres taken into consideration takes up about 900 acres of land. Being that the garden is extremely large a good deal of funding and volunteers which Seed Wayne lacks will be needed. Furthermore, although at Indiana University all funding came from volunteers and different stakeholders, if Seed Wayne is unsuccessful at doing so, the cost to maintain and gather everything it will be costly. However, the vertical garden design has great advantages in the water efficiency category. Water drains from one compost bed to the next and no water is wasted at all. Also, all three gardening designs use mulch as a tool to soak in water and preserve it for longer which is also an advantage in water efficiency.

Furthermore, outside of the vertical design, I was unable to find much research on innovative techniques for this gardening design. In terms of composting techniques, the vertical garden design as already mentioned aligns the compost boxes in a vertical fashion which is space efficient as well as water efficient. Also the use of mulch, top soil, and use of special plants in the compost boxes allows for soil preservation and soil quality. The ellipse design which consists of large strips of lands has advantages in that an annual herb can be grown on one strip while the next strip consists of strictly top soil which prevents soil erosion and assures soil quality. No significant findings are necessary for the three R's as well as waste management. Finally, the half circle plot gives the garden its attractive aspect. This plot is designed as such that all students, faculty, community members, and anyone else that happens to pass by the garden can easily see and access all the vegetables grown on this plot.

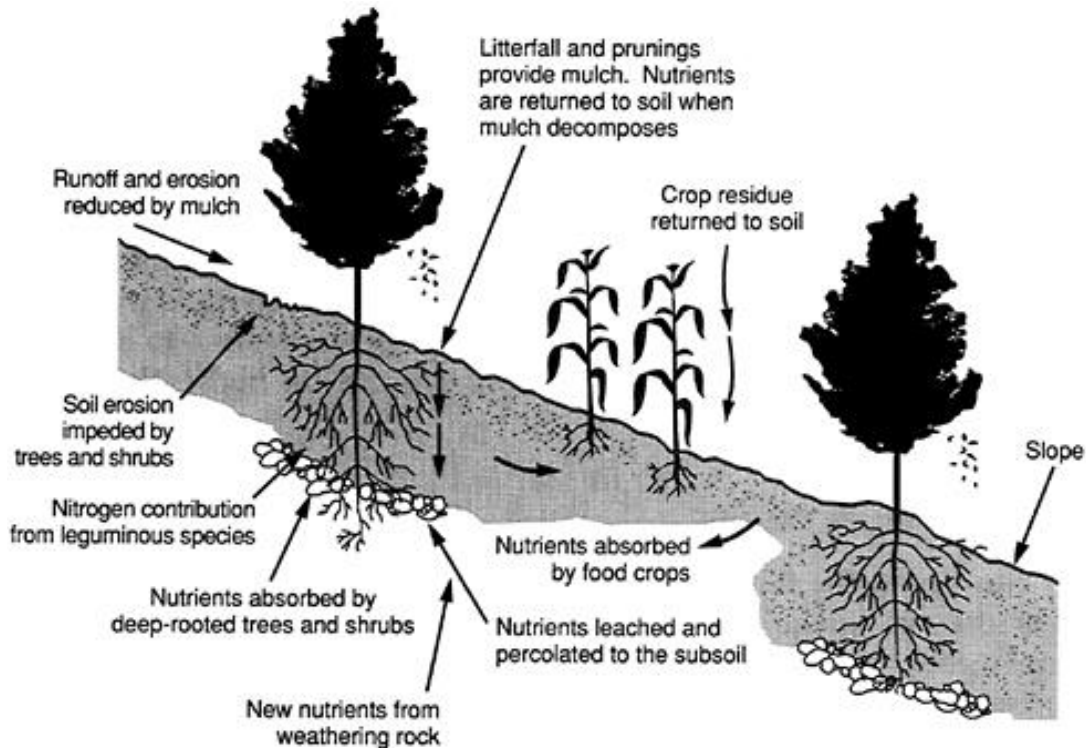
In conclusion, this garden design meets our main criteria which is it is sustainable being that it has already been going for 5 years and still going, its socially acceptable, and environmental friendly. If land use becomes an issue, one or two of the garden designs can be implemented rather than all three. Doing this will also require less volunteers, become easier to maintain, and also be less costly.

Alley Cropping Design

In the alley cropping system the space used can vary. It can be done with a small amount of space without too much trouble, which is great seeing how Wayne State University has limited space for planting or gardening. This method, however, is used often with large areas in order to achieve better results. The cost of maintenance is medium to high in this type of garden, as the hard labor involves pruning the trees, planting the crops, and watering them. It does, however, require management and training, which is needed in order to plant the trees and crops in a certain way. This method doesn't really need pesticides, especially with integrated pest management

system, which uses the trees to attract beneficial insects which helps with the costs. In this method, the material cost can vary depending on the trees used and the crops planted. Depending on what combination of trees and crops were planted the result of the production also varies, making this method somewhat risky. However, it yields good result most of the time, especially in a large areas.

The design aspect of the alley cropping system makes it visually attractive. It is an organized planting method and is pleasant to the human eye. In this method any types of crops can be planted to yield good results. But, for short term income soybeans and other short term yielding crops can be used. The trees can also be of any type, but using trees that produce fruits yields the best results, as you will then have two source of production. Moving on, this method also prevents water from being wasted, because the water cycled through the system is more thoroughly filtered. In this method there isn't too much waste and everything is re-used over and over (refer to picture below).



Overall, this is a great system which helps by reducing erosion, by improving water quality, protecting crops and by being aesthetically pleasing. However, this method does require quite a lot of maintenance in order to produce good yields. Besides that, this method incorporates a good method of recycling and re-using the materials which helps the soil, and helps in being Green. This method, however, requires planning ahead of time in order to figure out the end result, but overall is a good system to keep in mind when choosing from different methods.

Carlson Design

One of the many notable aspects of the Carlson design is how it uses available resources to maintain itself. It uses the water collected from rainfall for irrigation, and decreases material cost. Also uses organic matter collected from within the garden as fertilizer, and stores it in a composting fence. The fence does not take up much space, and looks better than having compost bins. The design is very pleasing to the viewer because of the setup, but it utilizes a huge amount of space. It needs space for a permeable patio that controls runoff, and the many different beds that house various crops. Beds contain many tolerant plants that need little watering, but are quite unique to plant. No pesticides are used in this design, but instead chickens are used to even out the soil. The design also takes into account the location of the beds within the garden, and are situated so that crops receive the necessary sunlight required.

This design is quite unique to its location, and could be difficult to implement at Wayne State. It requires a large amount of space, which is might be difficult to acquire here. Also the design is for a warmer climate, so it may need to be adjusted so that it suites our location better. The irrigation method of collecting rainfall might be prove to be problematic, because Michigan definitely does not receive as much rainfall as Washington. The designs also includes chickens, which is not going to be possible here. On the other hand, the composting and control of runoff are two innovative techniques that could prove highly beneficial.



Photo: Carlson's permeable patio.

Conclusion

All five of the experimental garden designs are quite reasonable to be implemented at Wayne State University by Seed Wayne. We fairly evaluated each alternative design against our set of criteria, and found that each one excels with its own unique features. The vertical design uses limited space, and is very urban friendly. The Indiana State design is very unique to its location, and is visually acceptable. Jennifer Carlson's design utilizes innovative composting techniques, and is the most water efficient. The alley cropping design makes effective use of its surroundings, and emphasis organic recycling. The Hugelkultur design requires the least maintenance, and is a unique visual shift from bed gardening. All of the designs are sustainable to some extent, and could be further experimented with to harvest their best features.

Recommendation

Out of the five designs that we evaluated, we found two that we believe should be implemented by Seed Wayne. The Hugelkultur design is one that should definitely be experimented with at Wayne State University. It does not require much space at all, and uses natural materials that can be found anywhere. There is little material cost involved as it only requires water, and crop seeding. The design is very water efficient as it utilizes the materials inside the hill as a reserve, and not let it run down further. The organic matter inside the hill can also act as a compost reserve that holds plenty nutrients for the crops chosen. It is a unique self-maintaining design that can also be a beautiful visual attraction to our campus. It only requires time to time watering, and organic waste can just be deposited inside the hill as compost. It is very environment friendly, and a great sustainable alternative for Seed Wayne to implement. The alley cropping design is another alternative that we believe can be easily implemented by Seed Wayne. This design utilizes the space in-between trees, and requires little space. Although it excels in many other areas, this method requires a modest amount of maintenance to yield great results. The material cost that is need for this design depends on the crops chosen, water, and management. This method requires pruning of the trees above it, so that mulching can be achieved. Mulching contributes to composting as it returns nutrients back into the ground, and pruning trees can build up organic matter as compost. The trees surrounding the bed can help control runoff, and help reduce topsoil erosion. The design requires no use of pesticides or synthetic chemicals, and utilizes two sustainable methods called cover-cropping and crop rotation. Alley cropping is a product of small-scale sustainable agriculture, and can be a beautiful sight for urban areas.

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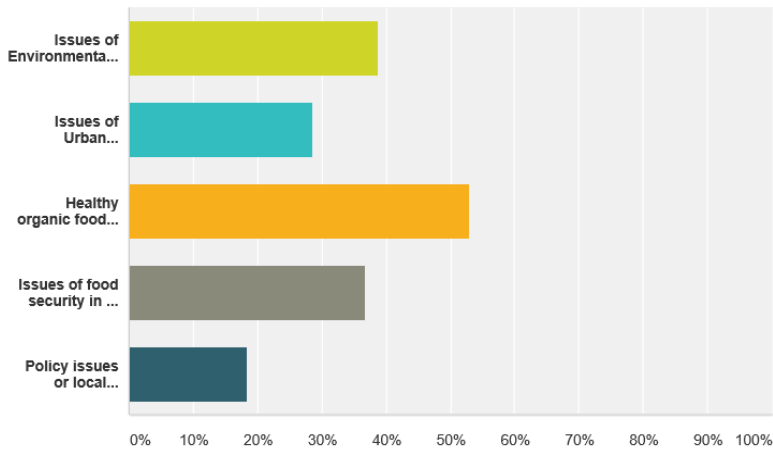
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Appendix

SurveyMonkey Data

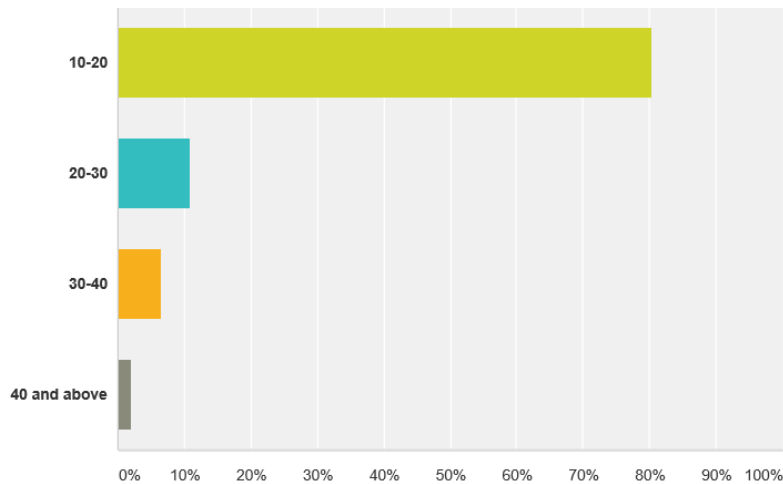
What specific part of Seed Wayne's mission draws you in the most? Check any that apply.

Answered: 49 Skipped: 1



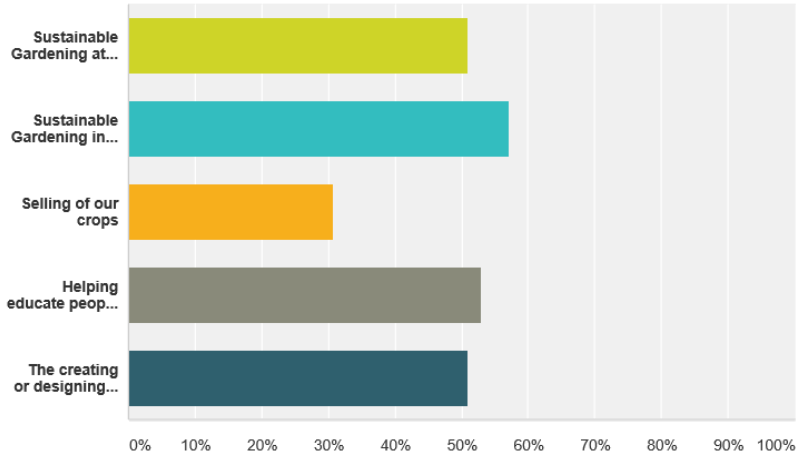
If one of these issues were being represented through a volunteering experience, how many hours of your time a semester would you be willing to volunteer towards projects associated with Seed Wayne?

Answered: 46 Skipped: 4



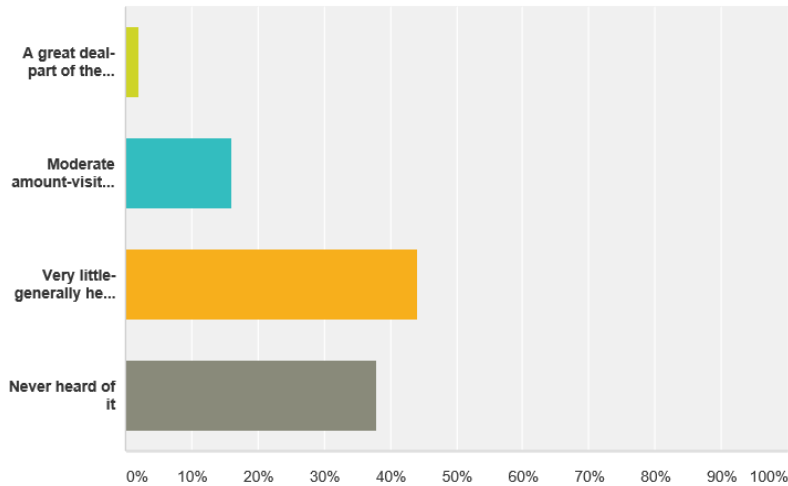
What type of projects do you see Seed Wayne taking on or type of projects you would like to be a part of? check all that apply?

Answered: 49 Skipped: 1



How much knowledge do you have of the environmental group here at Wayne State called Seed Wayne.? Circle one of the choices below.

Answered: 50 Skipped: 0



Seed Wayne Interview Data

Q) What do you want the student to know about Seed Wayne?

A) Students should know how sustainable food is beneficial for them. Not only is it good for themselves, but also good for the environment.

Q) What kind of future projects are you planning?

A) Our future plans are; first, to increase the garden beds they have (from 5 –10, their gardens are made with 4*8' and 1ft height wood beds); second expand the WSU formal market with also changing the location due to traffic.

Q) How many volunteers do you get per semester?

A) We work during the spring (planting) through the fall (harvesting), we are divided into different groups, my group there is 4 members (3 of them are students who been working for a long time there) and the leader is in his first year with the community. We need at least 15 participants with each participant contributing at least 1-2 hours a week (this number changes with the number of participants).

Q) What kinds of designs do you have and you are looking for? (small scale gardens?)

A) Designs are generally 4*8' wood beds.

Q) What kind of student work would you like? (Engineers for design, technical writers)

A) We are very short on participants, I am the fifth on in the group and we are expecting 9 more but none of them showed up.

Q) Any type of students underrepresented? (More engineers than other majors?)

A) We need all the students we can get from any kind of major. We are just short on volunteers and would welcome anyone to join.