Kenya: Sustainable Agriculture

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Abstract

Kenya has grown from 8 million to 38 million in a single generation. However, Kenya's farmers are using the same farming techniques and producing the same amount. 1 in 4 Kenyan is starving, that is a little under 10 million people. The demographic that is suffering the most are the people at the lowest end of poverty. A majority of whom are subsistence farmers. Kenya is in dire need of a farming revolution to resolve its food crisis and the way to this revolution is through the education of that demographic through more sustainable agricultural practices to create food security.

This project looked to design an educational curriculum and small-scale farm at a secondary school in Nanyuki, Kenya where students in attendance come from the most impoverished areas in Kenya. The hope being that sustainable agricultural design and practices could be instilled in the students through a school farm and that knowledge would be taken back to their families and communities.

In order to create the final design of this farm the cultural context had to be understood to understand the needs of the country and especially the communities that the students come from. That context gave form to educational goals to solve those problems. And those educational goals manifested itself into the design of the farm. The farm would then be a catalyst to teach those educational goals.

The implication being that through education, the students from the lowest end of poverty would be largely in charge of helping their communities out of poverty through sustainable agricultural practices. Through time solving Kenya's food crisis and creating stability within the destitute demographic allowing the country to develop positively.

Acknowledgements

I want to thank my Project Committee members: Claire Napawan, Patsy Owens and Stephen Wheeler. I want to thank the staff of Daraja Academy, especially Alice (Garden Manager) and Ruth (Head Kitchen Staff) for helping me understand their needs and how they worked together. I want to thank Peter Murange for teaching me about the issues that faced Kenya's Agricultural System. I want to thank fellow classmates Inna Nosenko, Beth Bokulich and Barbara Nazarewics for coming and putting in their input and time to help build part of the Daraja Farm.

Most importantly I want to thank the students of Daraja Academy who have the warmest hearts and biggest aspirations.

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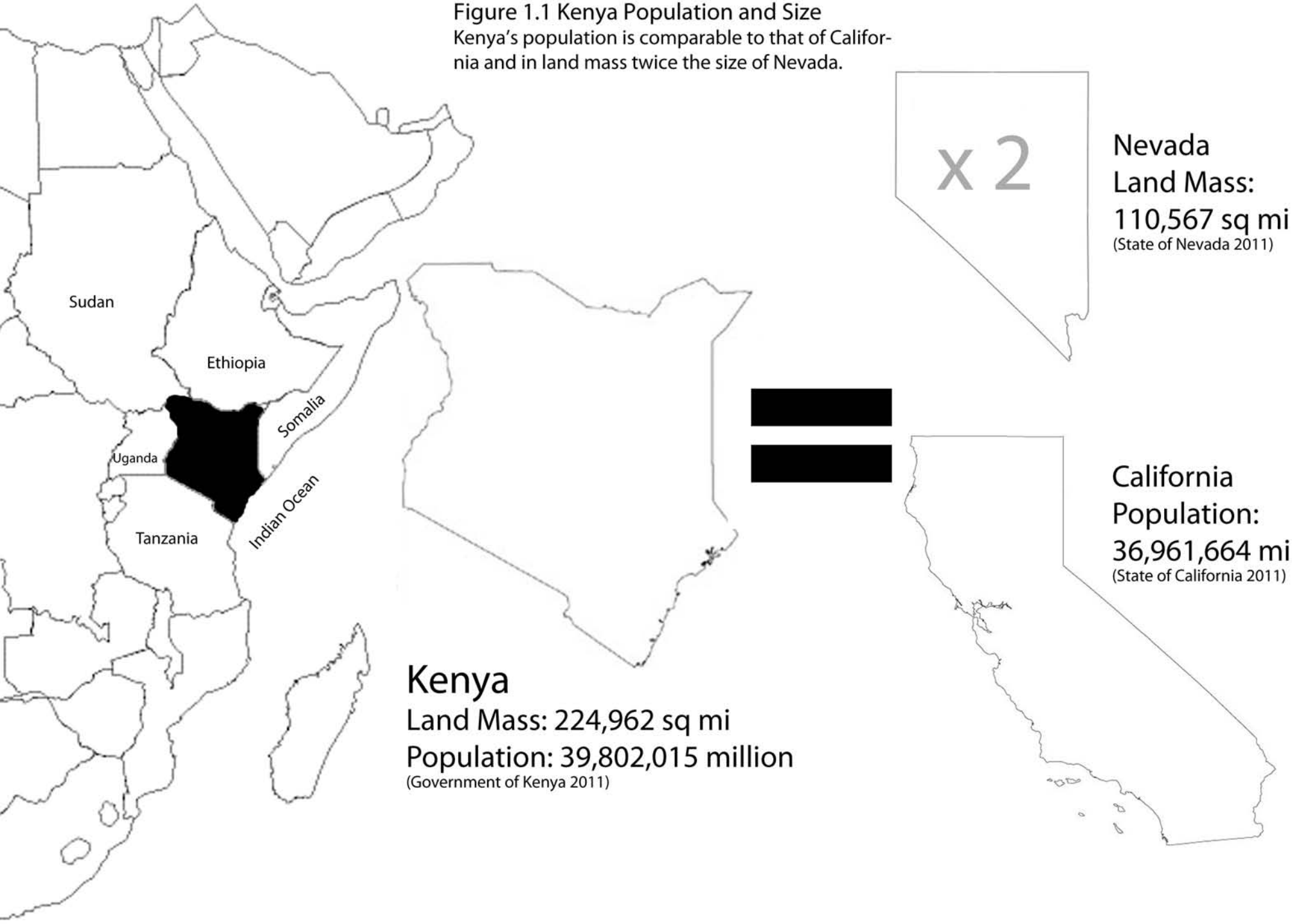
Kenya Population and Size

Figure 1.1 Kenya Population and Size
Kenya's population is comparable to that of California and in land mass twice the size of Nevada.



Kenya's agricultural system is deeply connected to the countries environmental, economic and social issues. Between 7 and 8 percent of Kenya's land is good for agricultural endeavors and the industry comprises of 24 percent of Kenya's GDP. It provides labor for 18 percent of the countries work force and comprises 50 percent of the countries revenue from exports. However, Kenya's agricultural industry is unreliable and unsustainable (Library of Congress 2007).

The major factors that contribute to the instability of Kenya's agricultural industry are deforestation, unsustainable agricultural practices and drought. These three are deeply interconnected in a cycle that pushes Kenya into poverty and dependence.

Deforestation is occurring at a rapid rate in Kenya with half of the countries forested land being lost in the last three decades. One of the leading causes for the loss of forested land is the overuse by Kenyans for agricultural expansion (Government of Kenya 2011). This agricultural expansion is due to unsustainable farming practices that degrade soil to the point that they do not produce, causing the communities to etch out further into the forest for better soil (KOAN). As they move deeper into the forest they destroy the environmental functions that the forest provided: the watersheds are destroyed, less water is able to stay on the site thus with less water and less trees pumping water into the atmosphere droughts are becoming more and more frequent (Wass 1995). With fifty percent of the agricultural industry on subsistence farms that are rain-fed there are huge consequences socially and economically.

Consequences

Unemployment

Kenya has an unemployment rate of 40% with an annual income of $360 (Library of Congress 2007). When there is instability in Kenya's Agricultural sector it paralyzes the whole country. With agriculture compromising a quarter of the GDP it keeps the country from gaining economic stability. The most effected are the 50% of the countries subsistence farmers that live in poverty, when their is instability they have no means of regular revenue and getting out of poverty. They constantly become unemployed depending on climatic conditions and require aid .

Increase in Slums

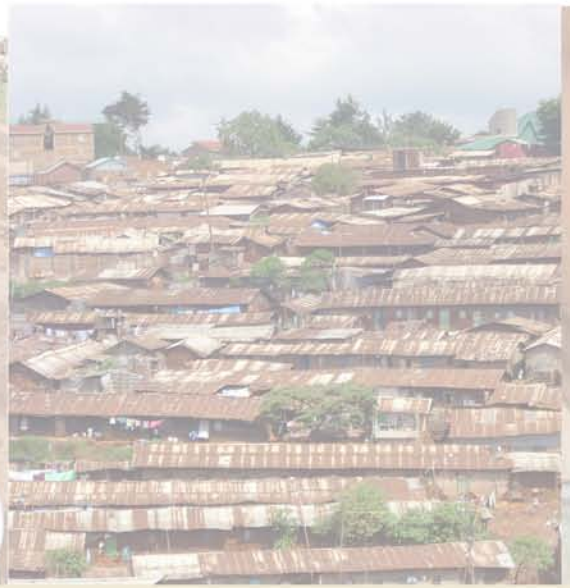
It is very common for educated youth to move from their rural homes to cities in search of more stability and to escape the rural poverty. However, Kenya's cities do not have the infrastructure or job demand to support the rate of rural dwellers moving into urban areas. 22% of Kenya's population lives in cities of which 8 million (71%) are living in slums. Every year Kenya's slums grow 6% (Library of Congress 2007).

Starvation

1 in 4 Kenyan is starving. That is 10 million people (Government of Kenya 2011). These Kenyans come from the most destitute in Kenya. These two groups are typically the subsistence farmers in rural settings, the people depending on them, and the people living in the slums. When an agricultural crisis occurs these people do not have a safety net. They then have to focus all their energy on surviving by skipping meals and searching for food. This leads to high levels of malnutrition, death and conflict. It paralyzes these groups and leaves them further in poverty. The country also spends its money to aid these people further creating the countries dependence on foreign aid.

Uneducated Youth

42% of Kenya's population is between the ages of 0-14. The average number of children per woman is four, which is the 37th highest rate in the world (Library of Congress 2007). The population is growing most rapidly the areas that are most suseptible to the fluctuations in agriculture. Wen crisis occurs these children not only deal with malnutrition and starvation, but for survival they have to drop school because it is to expensive and they need to look for labor to support their families.



A Solution in Agricultural Education

All though the issues on the previous page are huge in scale and effect, there is a simple solution in education. How are people supposed to overcome poverty if they do not understand the cycles that put them there? People of poverty can overcome it by understanding the interrelated nature of social, economic and environmental issues pertaining to agriculture. By this means they can put an end to detrimental cycles that push them further into poverty and reorganize themselves to have a more stable and sustainable agricultural system. As Kenya develops it is possible to ingrain positive sustainable systems before the country develops and grows through bad and shortsighted systems.

The most opportune way to do this is by educating the youth that is most deeply effected by agricultural crises: the poorest of the poor. That way they can grow with that mentality and bring their communities out of poverty through educating them and giving them foresight into a means of changing their situation through sustainable agricultural practices.

So what this project sought to do was to look at the the issues plaguing the agricultural system in Kenya and then condense it into a simple format that displayed the issues and their connectedness to social, environmental, and economic issues and then give simple techniques or procedures to help with those issues. The techniques and procedures would have to have little or no monetary cost if they are expected to be practiced by the rural agricultural communities. The main point is just to bring the big picture into their understanding so that the communities could foresee their future and if wanted chang it through the simple techniques suggested here.

The school that this project was done for is a secondary school in Kenya that brings students from that very demographic discussed and gives them free boarding and schooling. Daraja Academy's students come from that very demographic that is most affected when the agricultural economy shifts due to under-production, disease or drought.

The students are selected by three criteria: top performing primary school grades, absolutely no means of continuing their education and leadership qualities. By educating Daraja Academy students about sustainable agricultural practices they will be able to take that know-how back to their communities in their effort to lead their communities out of poverty. By leading their communities out of poverty through sustainable agriculture they will create stability and that stability will harbor prosperity within their communities.

Figure 1.2 Section of Outdoor Classroom
Section of the Outdoor Classroom in the farm where students will be taught sustainable agricultural practices.

Daraja Academy

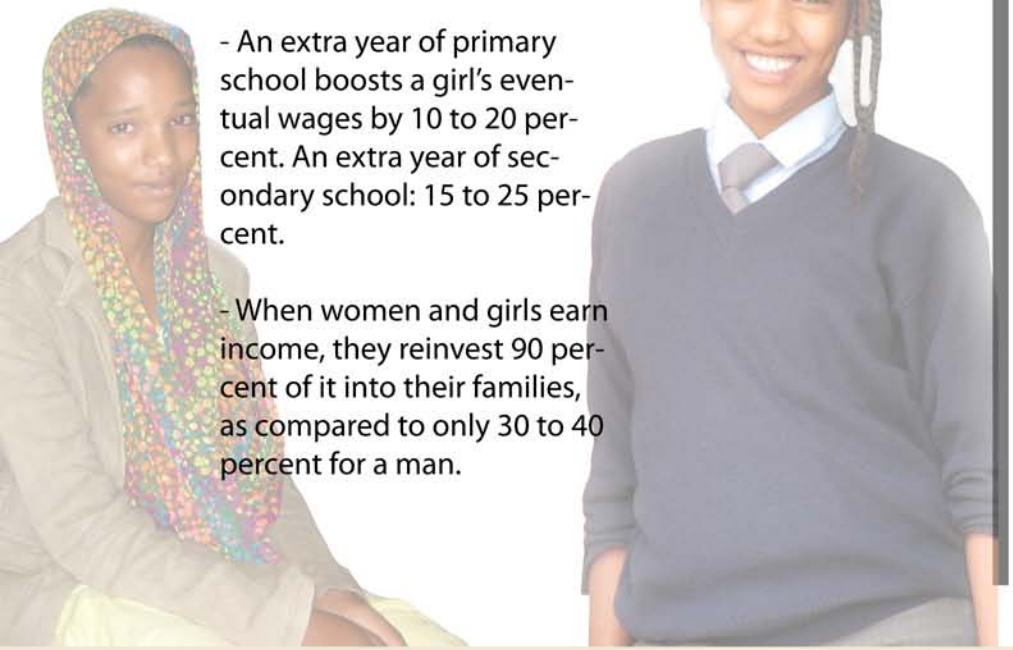
Daraja Academy is a free secondary boarding school that believes that through the education of girls living in poverty; girls can help their communities transcend poverty. In order to do so the school scours the most impoverished areas of Kenya and looks for female students that have the top performing nationwide primary school exit exam scores and display leadership qualities, but have absolutely no means to continue their secondary schooling because of their economic standing.

The school opened in 2009 with the mission to "cultivate a community of individuals with a sense of cultural awareness, social conscience, and environmental responsibility, all while instilling talents that will enable them to open doors to a global society."

- When a girl in the developing world receives seven or more years of education, she marries four years later and has 2.2 fewer children.

- An extra year of primary school boosts a girl's eventual wages by 10 to 20 percent. An extra year of secondary school: 15 to 25 percent.

- When women and girls earn income, they reinvest 90 percent of it into their families, as compared to only 30 to 40 percent for a man.



Where do the Students Come From?

Figure 1.3 Map of Student Location
Daraja Academy is located in the center of the country on the western slopes of Mt. Kenya. Students come from all over the country from the nomadic tribes in the North, Lake Victoria communities in the West, to the slums of Kiberia in Nairobi (the capital).

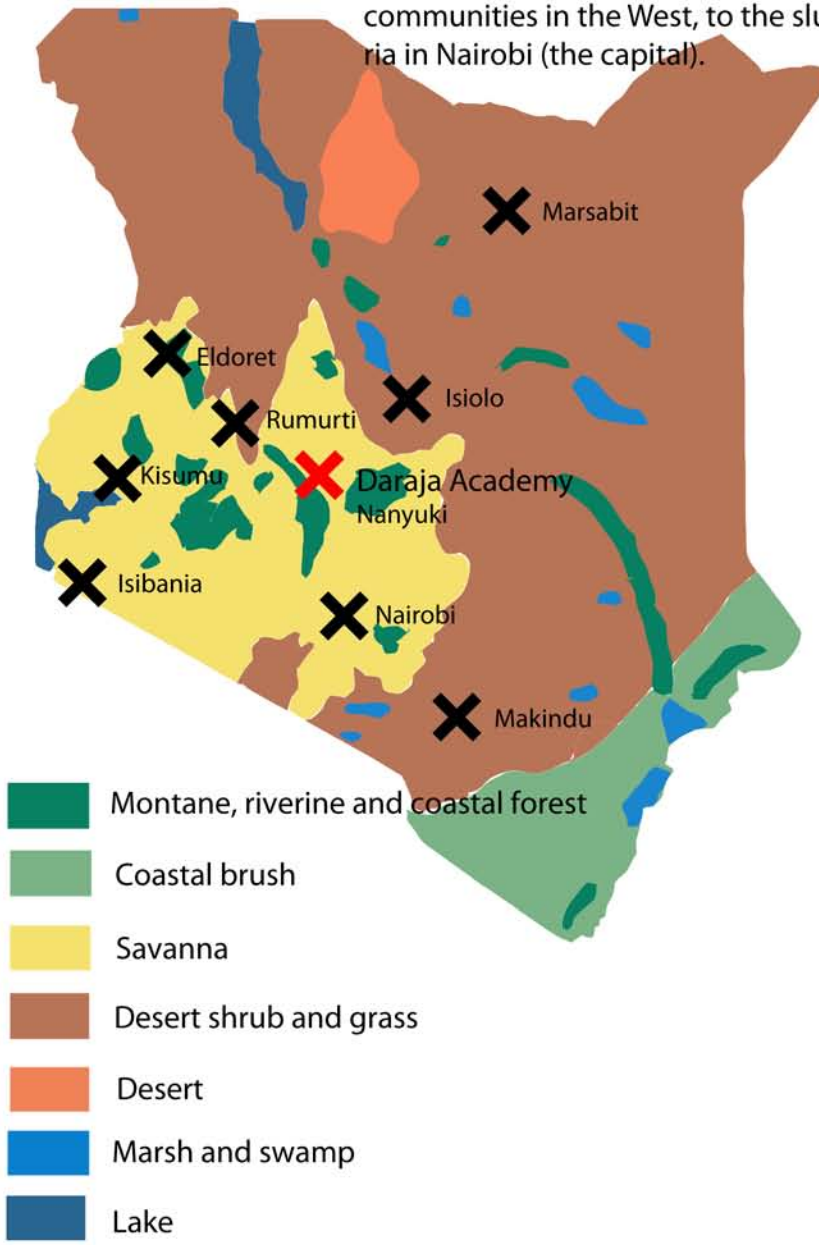
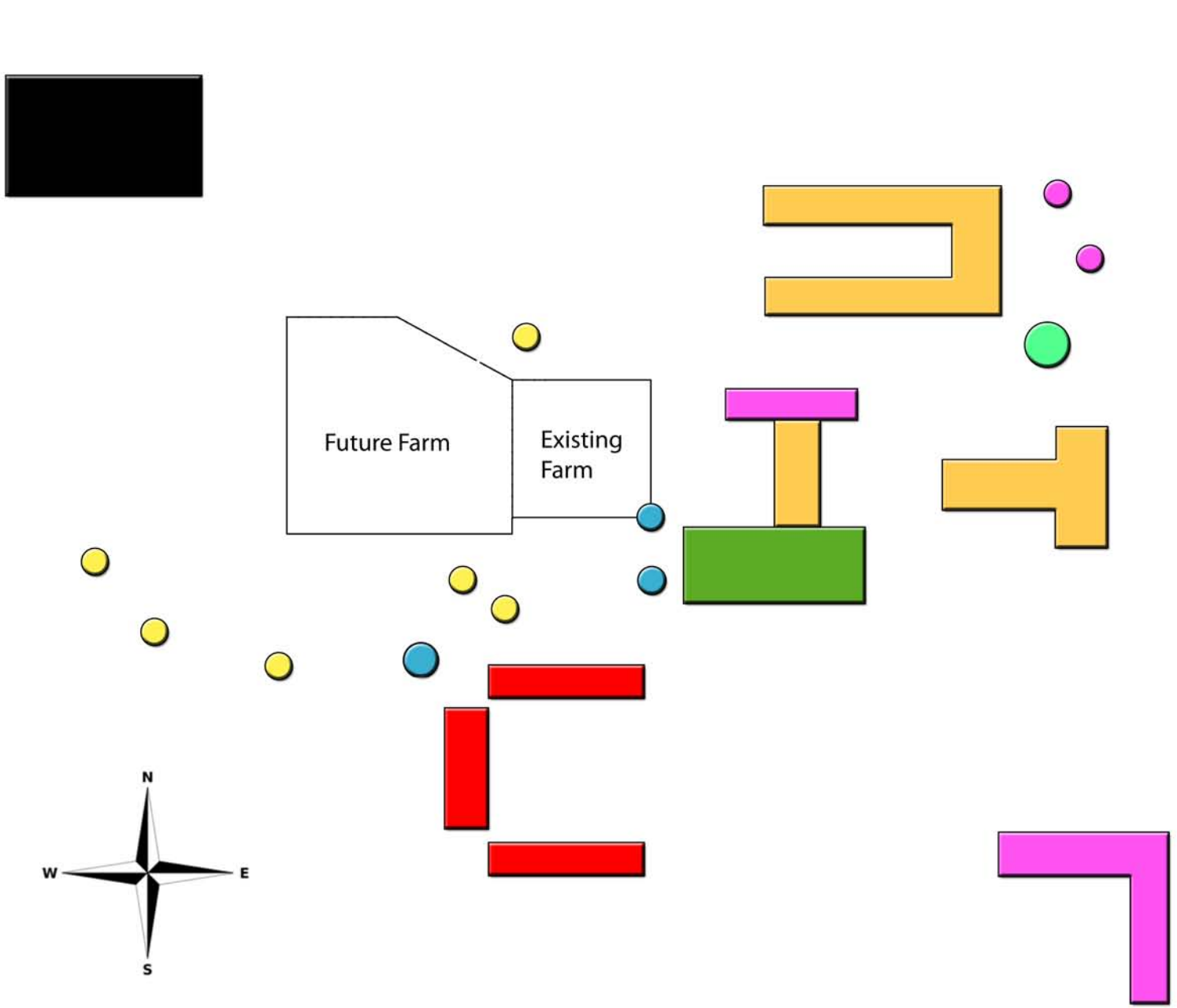


Figure 1.4 Campus Map



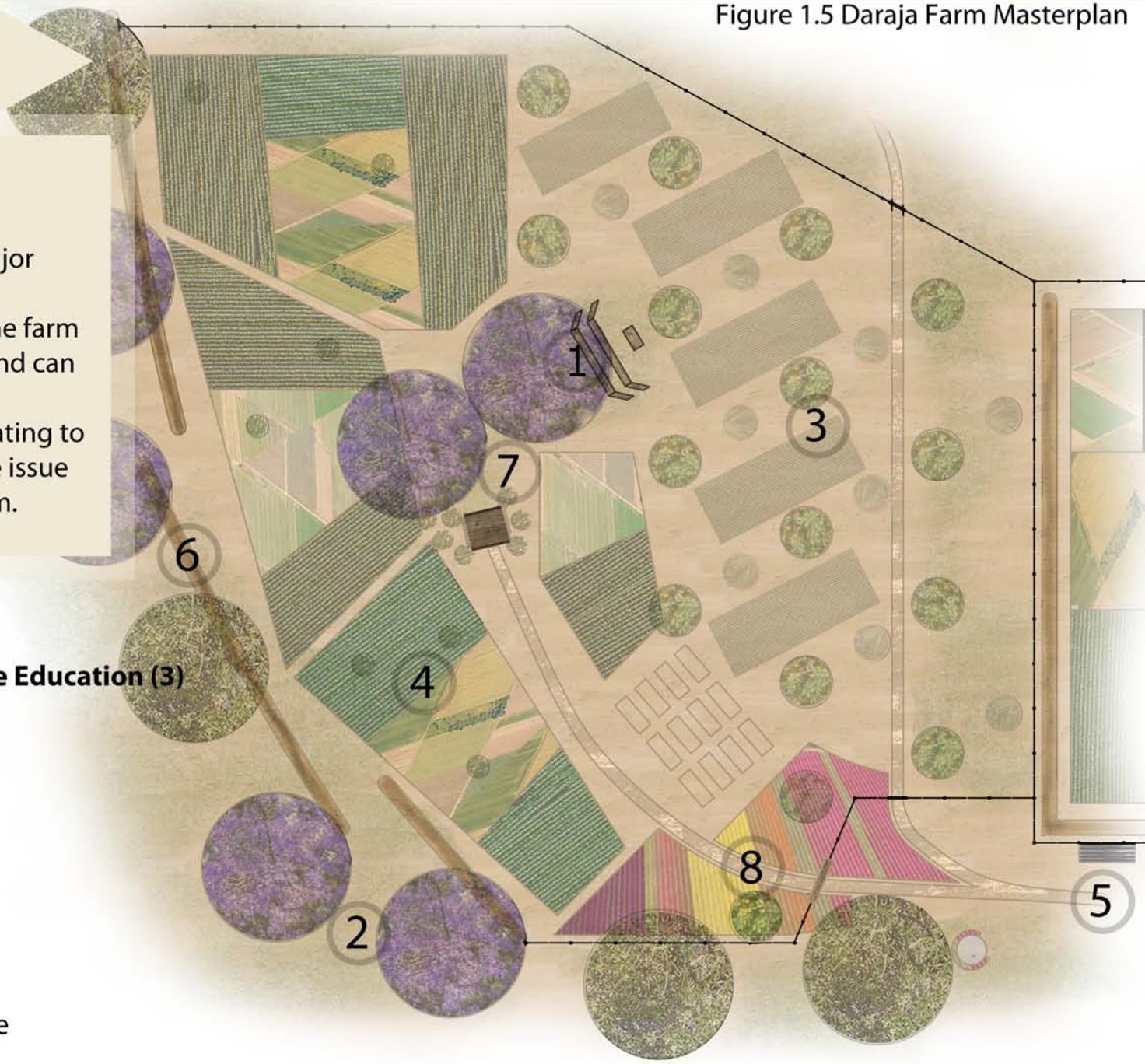
Approach

In order to design a farm that served the students and gave them tools to take back to their communities, it was important to understand the issues that made Kenya's agricultural system so vulnerable. Below is the approach taken to inform the final design of the new farm.

Figure 1.5 Daraja Farm Masterplan

How-to-Use

1. Below in bolded text are the major issues identified in Kenya.
2. Under each issue is an area in the farm that hopes to address that issue and can be used as an educational tool.
3. Follow the page number correlating to the issues to learn more about the issue and how it is addressed in the farm.



A Need for Sustainable Agriculture Education (3)

1. Outdoor Classroom

Deforestation (8)

2. Nature Walk

Monoculture (12)

3. Food Forest
4. Rotational Cropping
5. Compost Area

Pesticide Use (18)

6. Focal Seating Area
7. Pollinator-Attracting Entrance

Drought (20)

8. Swales

Kenya's most valuable natural asset is its physiological and biological diversity. The diversity has been threatened however because poor communities who have no means of acquiring profitable land or building wealth live off the wildlife to sustain themselves. In the past three decades Kenya's forested land has been cut in half, leaving only 3 percent of land area as old growth forest. Estimates put 12, 355 acres of forest further into the growing number of land lost each year (Dharani 2002).

The deforestation of Kenya has huge consequences for the country environmentally, economically and socially. Environmentally the loss of forests causes erosion and loss of top soil causing environmentally productive land to become desert; it causes an increase in droughts because forests that functioned as natural water catchments, attracted cloud cover and supported streams, rivers, and lakes no longer function; and both these lead to the loss of biodiversity. Economically this has huge consequence with two of the most major contributors to Kenya's GDP: Agriculture (24%) and Services (63%). More droughts due to deforestation will cause a huge decline in the agricultural production if not paralyzing it. Then Kenya's services sector, which is dominated by tourism primarily due to Kenya's rich biodiversity, would decline if species begin to decline. Tourism is on the rise in Kenya and helps the country invest in protecting its land and invest in the country itself. Tourism alone generated 803 million dollars in 2006, up from 699 million the previous year (Library of Congress 2007. This is huge in bringing and spreading wealth in Kenya. Finally socially the country will be in huge conflict for resources as resources become more scarce, droughts increase and the government will not be able to provide help if the country has little economic ability.

Major Causes of Deforestation

Figure 2.1 Major Causes of Deforestation

Currently the increasing threat to Kenya's wildlife is subsistence activities, such as logging for building material and charcoal, the hunting of wildlife for food or protection of cattle, cattle grazing and agricultural expansion. It starts with clearing trees and shrubs for building materials and charcoal. Then, the rural subsistence farmers will create short-term farms and once the productivity of the land decreases due to improper management leaving the soil degraded, they will leave the site and go deeper into wildlife repeating the same technique. This leaves behind degraded land that is then usually used for cattle or goat grazing which does not allow the natural vegetation to come back and the area becomes dominated by invasive and tough grasses, therefore changing the landscape forever (Wass 1995).

Besides the habitat and biodiversity from big mammals to small ants being removed from the site, with larger populations and more expansion the land is so degraded and changed destroying all the environmental functions that used to take place. It causes the rivers and streams to shrink due to less rain in these areas because of lack of tree and shrub cover that trap moisture and attract cloud cover. The forests release all the carbon dioxide into the atmosphere forming a barrier that does not allow the suns energy to radiate back to space, increasing the earth's temperature and causing severe droughts and extinctions (Dharani 2002).

The Solution: The Right Mixture of Preservation, Restoration and Management

Preservation

Since Kenya is world famous for its safari wildlife 12.3 percent of its land area is currently under some form of protection. The country has 1,103 species of birds, 261 mammals, 407 reptiles, 76 amphibians and 6,500 species of plants (Library of Congress 2007). These areas are covered with healthy ecosystems that trap moisture, keep temperatures cool, and allow for plentiful and natural rainfall patterns. With a healthy habitat, dependable water and low to no-use these areas are thriving with biodiversity and environmental functions.

Restoration

One of the cheapest ways to restore forest cover and mitigate the local effects of climate change is simply to plant native trees back on degraded sites. This will not return the amount of biodiversity that was once on the site, but it is one of the first and easiest steps for Kenya's rural farming community to try to reverse the effects they have had on the local climate for their own benefit and the benefit of the habitat.

Management

To avoid agricultural expansion more sustainable agricultural practices need to be used. Practices that will change the short term, soil degrading farming into long-term, condensed, soil maintaining operations. Practices such as rotational cropping, layering and composting (these will be discussed in the next section).This will lessen the need for agricultural expansion and the dependence on livestock for livelihood.

Figure 2.2 Preservation, Restoration, Management
With proper long term farming techniques Kenyan's could preserve more natural land.

Functions of a Single Tree

Canopy Releases Oxygen and Holds Carbon Dioxide

Through the process of photosynthesis the trees intake carbon dioxide from the atmosphere and release oxygen reducing the effect carbon dioxide has on climate change (Mollison 2009).

Provides Habitat

The tree provides a habitat that feeds and shelters a vas array of creatures.

Creates rainfall

During the night the air in and underneath the canopy stays humid because of water released from the leaves of the trees. When the morning comes and the humid air is warmed, it releases into the air and forms clouds. The tree then releases more water that it uptakes from the soil releasing it from the leaves and in the process purifies the water. The tree is constantly creating this cycle of pulling water from the ground, purifying it and releasing it into the atmosphere. Unlike exposed soil the water is kept on the land for longer because of the trees creating a water cycle that returns as rain. Half of the rainfall over forested land comes from this water cycle that the tree creates (Mollison 2009).

Retains Moisture

The tree canopy shades the soil from the rays of the sun allowing the soil to stay moist, making available water to both the tree, nearby plants and giving the water time to leach into the nearby watershed creating creeks and streams that feed rivers and lakes (Wass 1995). Especially when it rains the canopy helps capture the rain and deposit it at the root zone of a tree allowing the soil under the tree to receive two to ten times as much rain than open ground. Again the canopy tree slows the amount of evaporation occurring providing moisture longer and more available to the ecosystem (Hemenway 2009).

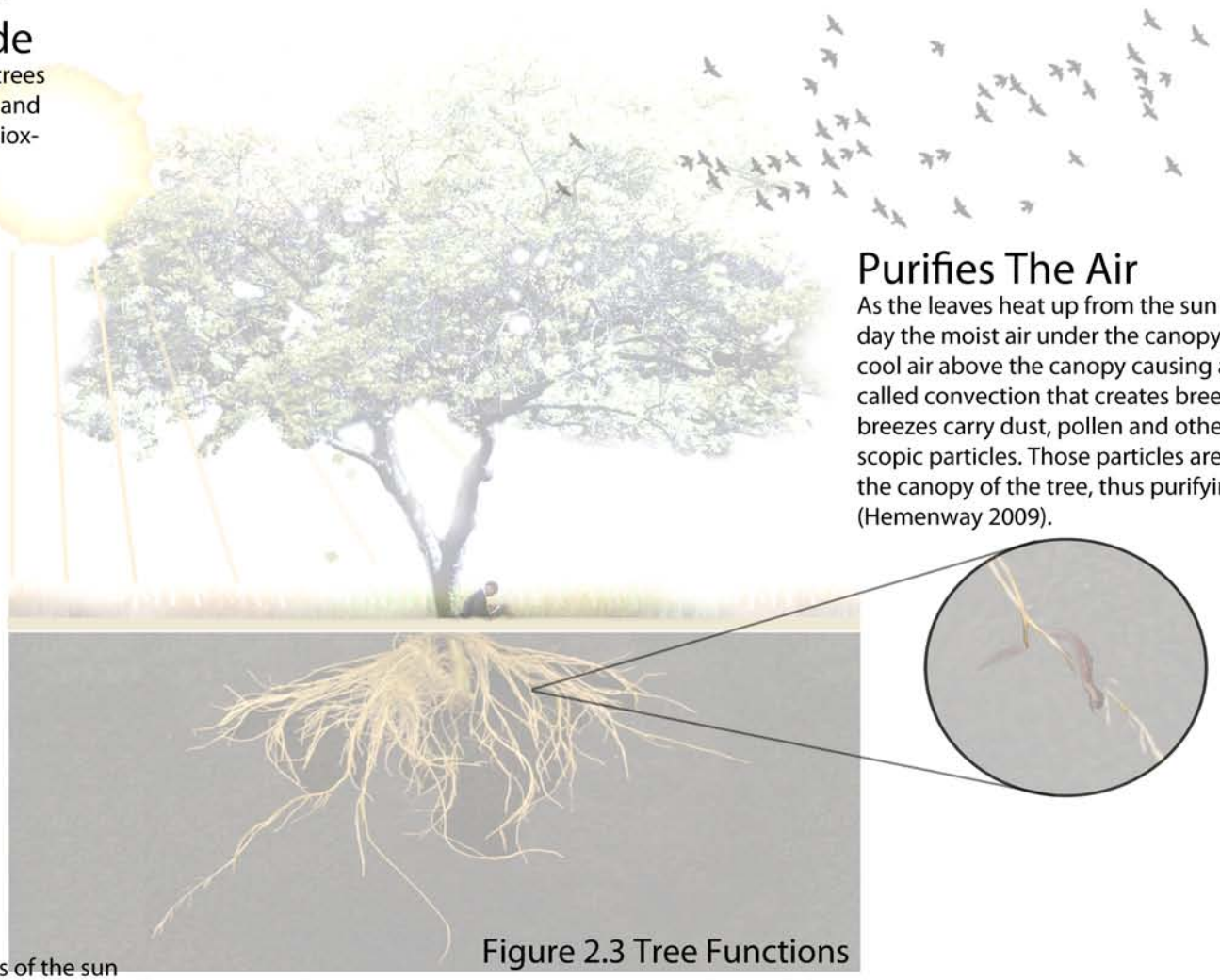


Figure 2.3 Tree Functions

Purifies The Air

As the leaves heat up from the sun during the day the moist air under the canopy meets the cool air above the canopy causing a process called convection that creates breezes. These breezes carry dust, pollen and other microscopic particles. Those particles are caught by the canopy of the tree, thus purifying the air (Hemenway 2009).

Extensive Root System

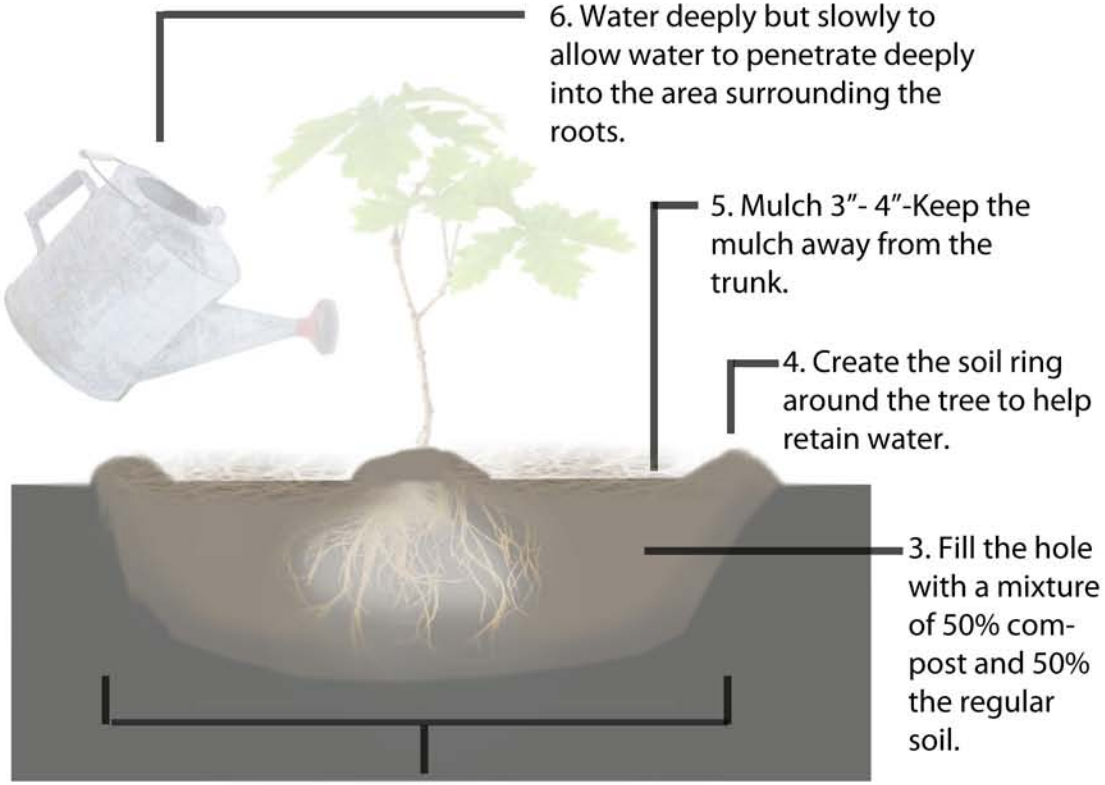
The trees roots are extensive spanning tens of feet down into the earth and as wide as the trees canopy itself. The roots push through the soil breaking it up and allowing air to fill its pockets and providing space for water retention, as well as decomposing and growing, providing nutrients and organic matter for the soil, and provide food for organisms that enrich the soil (Dharani 2002) .

Builds and Keeps Top Soil

The canopy prevents the water from rain to directly hit the soil. By the canopy taking the impact the water does not erode the soil. As the leaves begin to fall the form a layer on top of the soil. The leaves are rich with bird and insect dropping, nutrients brought to them from the roots, dust and pollen caught by the canopy from the breeze, thus creating strong mulch. That mulch provides home for decomposers that turn it into rich topsoil.

How to Plant a Tree

Figure 2.4 How to Plant a Tree
By using the proper procedure to plant a tree it will increase the probability that the tree will survive and be healthy.



1. Dig the hole width two to three times the diameter of the root-ball

2. The depth of the hole should make it so that the rootball is level with the ground level.

Figure 2.5 Student Planting Tree
A student of Daraja Academy teaches a boy who is apart of the local community and is apart of a herder family, how to properly plant a tree. The Daraja students did a planting project to plant natives right outside the Daraja Academy campus to help benefit the community. The boy was watching and Betty (the student) asked him to join.

Nature Walk

Figure 2.6 Nature Walk

For the nature walk, native plants will be planted on the South and East edge of the garden to provide the benefits that trees provide descriped on the previous pages. In the future it will be like a little aboretum to the campus to learn the natives and the importance of trees and habitat. Below is a list of native trees to semi-arid areas in Kenya that provide good habitat and enhance the biodiversity.

Acacia brevispica
Acacia drepanolobium
Acacia mellifera
Acacia senega
Acacia seyal
Acacia tortilis
Acacia xanthophloea
Acokanthera friesiorum
Albizia gummifera
Balanites aegyptiaca
Calodendrum capensis
Carissa edulis
Catha edulis
Combretum-molle
Comiphera
Cordia abyssinica
Cussonis holstii
Dombeya rotundifolia
Dracaena Sp.nov
Dononaea viscosa.
Euclea divininorum
Euphorbia candelabrum
Euphorbia magnicapsula
Ficus natalensis
Ficus vallis-choudae
Juniperus procera
Kigelia aethiopum
Maerrua crassifolia
Olea africana
Phoenix reclinata
Podocarpus gracillior
Syzygium guineense

Monoculture

Monoculture is the primary form of agriculture in Kenya. The reason behind using monoculture is purely economical. It produces high yields with minimal labor. On large-scale operations it has the same environmental implications that it has all over the world: soil degradation, habitat destruction, and a high input of unsustainable chemicals from fertilizers, herbicides and pesticides needed to maintain it (KOAN).

However, as quoted earlier half of Kenya's agricultural production occurs on subsistence farms. Monoculture is not only environmental taxing but more importantly to these subsistence farmers is the fact that monoculture is extremely susceptible to drought, disease and under-production. The problem is that when these farmers who are already living on very little are hit by one of these agricultural set-backs they lose their economic stance from having very little to being destitute. Furthermore, the farmer's family becomes dependent on that one crop to survive till the next season. The family will be reliant on a crop like Maize and very little else, which does not provide the nutritional value or diversity needed. Now the family not only loses its economic stance but the family members lose their health pushing them deeper into poverty (Murange 2011).

The solution comes in understanding why monoculture is prone to drought, disease and under-production and finding ways to make subsistence farmers less at-risk. The reason behind the weakness of monoculture is very interconnected. The first issue being that monoculture makes the soil very deficient in nutrients. This occurs because one crop is planted over a large amount of space, that crop then depletes that soil for its nutrient needs, and then those nutrients are not returned to the soil because the product is harvested. The same soil also loses its health through its exposure to the sun because of row farming typical to monoculture. The sun bakes the soil and takes the water above and in the soil through evapotranspiration. Both these cause the soil to lose its structure, nutrient value and organic life. If the soil is not healthy it retains less water to give to the crop and has less nutrients to produce a good harvest. The poor soil biology caused by monoculture is the reason behind its susceptibility to drought and under-production (KIOF).

The second issue is with the ease that a disease can transfer when the same crop is planted in close proximity and in large amounts to each other. So if one of the plants in a crop gets a disease it is very easy for that disease to spread and devour a large portion of that crop. This increases when the crop is weak due to the lack of water and nutrients that come from the soil degradation discussed above (KOAN).

Layering vegetation in a farm helps conserve water and moisture because the vegetation covers the soil from the rays of the sun; prevents the soil from being diluted of one particular nutrient which keeps the soil healthy and able to support more biodiversity that protect from the spread of disease; provides habitat to beneficial insects and birds which also protects from the spread of disease; and provides a diverse array of fruits and vegetables that make the farm more economically and nutritionally viable for its users (Mollison 2009).

Figure 3.1 Layering
Their are six major layers: Canopy, Low tree, shrub, herbaceous, soil surface, and rhizosphere.

Food Forest

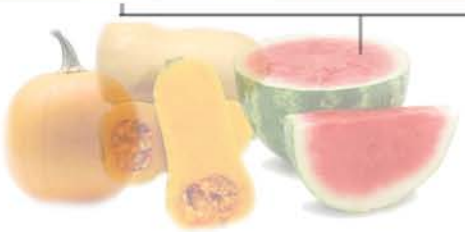
Figure 3.2 Food Forest

The food forest intertwines the different layers and provides all the benefits of layering.

Inter dispersed between the fruit trees are non-harvest trees.

Leucaena is a nitrogen-fixing tree that brings nitrogen from deep in the soil to the top of the soil for the benefits of itself and other plants.
The Moringa tree is called a green-manure tree because it has large, nutritious leaves that fall on top of the soil and provide a nice mulch that slowly decomposes putting nutrients and adding organic matter into the soil, which provides habitat for beneficial insects, helps retain water and builds the soil. This tree is also extremely drought tolerant and is used by Kenyans to substitute vegetables when drought kills more vulnerable vegetables (Dharani 2002).

Fruit trees, along with bringing all the benefits that trees bring like moisture retention, habitat and the prevention of soil erosion, they also provide a diverse amount of fruit into the food forest from Apples to Avocados. Each fruit has its own nutrient needs and nutritional value.



The groundcover of the food forest will cover the soil and keep it from the exposed sun. This will support the life of the soil, beneficial microorganisms and insects, and help the soil retain water. While doing that the ground cover will provide vegetables.

Rotation cropping is the process of rotating crops on a field from parcel to parcel. Rotation cropping helps protect the soil quality, prevents pest and disease problems, and helps maintain productivity. The nutrients in the soil are protecting because as described before a single crop on a parcel drains the soil for certain nutrient requirements, with rotation cropping that soil is given a break when the crop is rotated with another crop that has different nutrient requirements (KOAN). The nutrients depleted then have time to go back in the soil through bird and animal droppings, highly nutritious compost and mulching. Secondly, by rotating the crops pests and bacteria that feed on a certain crop is kept under control. When a singular crop is kept in a location, the pest and disease population grows because of the availability of food, however when a crop is rotated off that site the population decreases immensely (Gebremedhin 1998). Thus, rotation cropping will reduce need for pesticides. Finally, both these factors provide a higher and more nutritious yield.

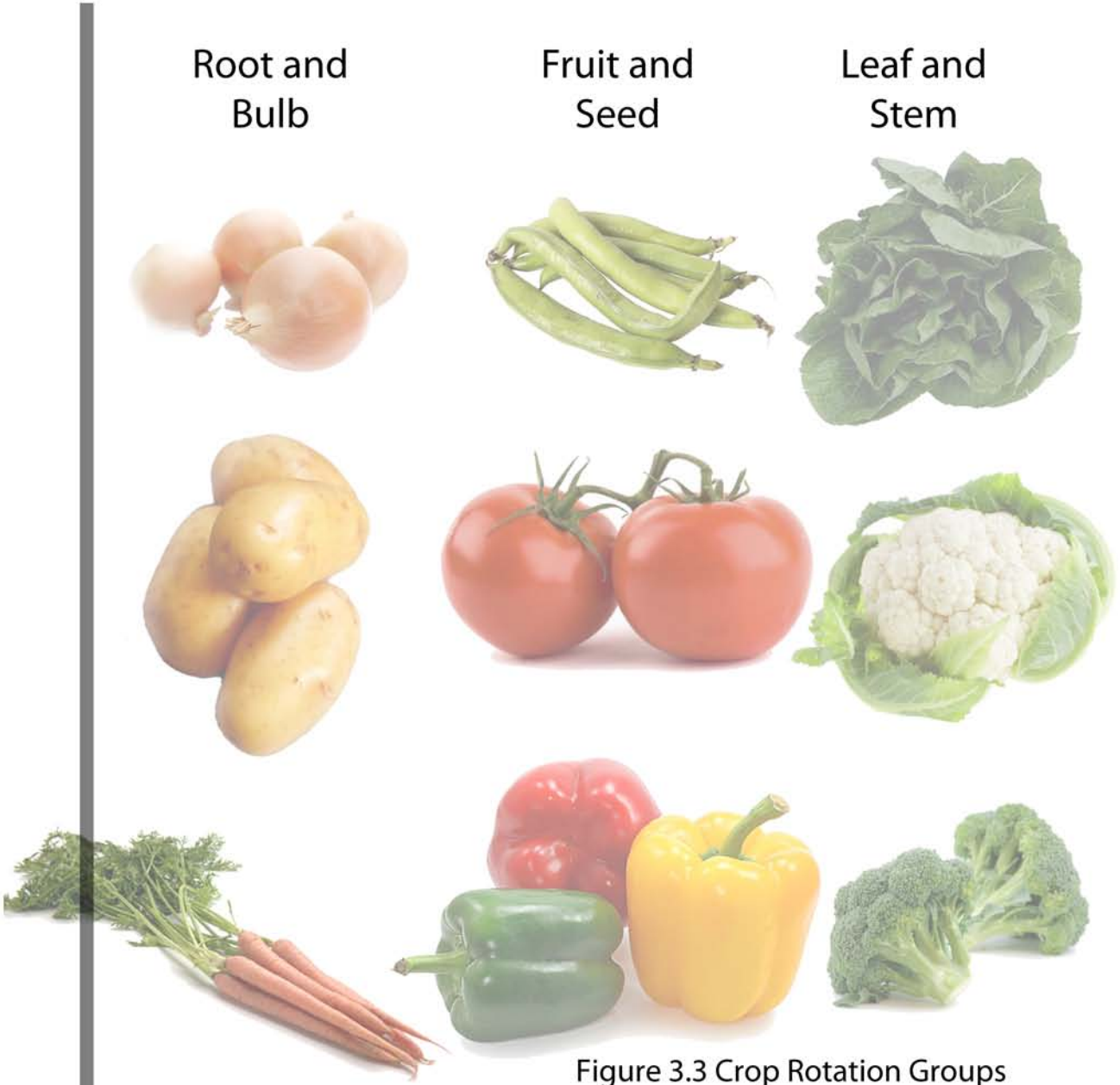


Figure 3.3 Crop Rotation Groups
The Crop Rotation is seperated into three different groups: Root and Bulb, Fruit and Seed, and Leaf and Stem. Each group takes up the same type of nutrient.

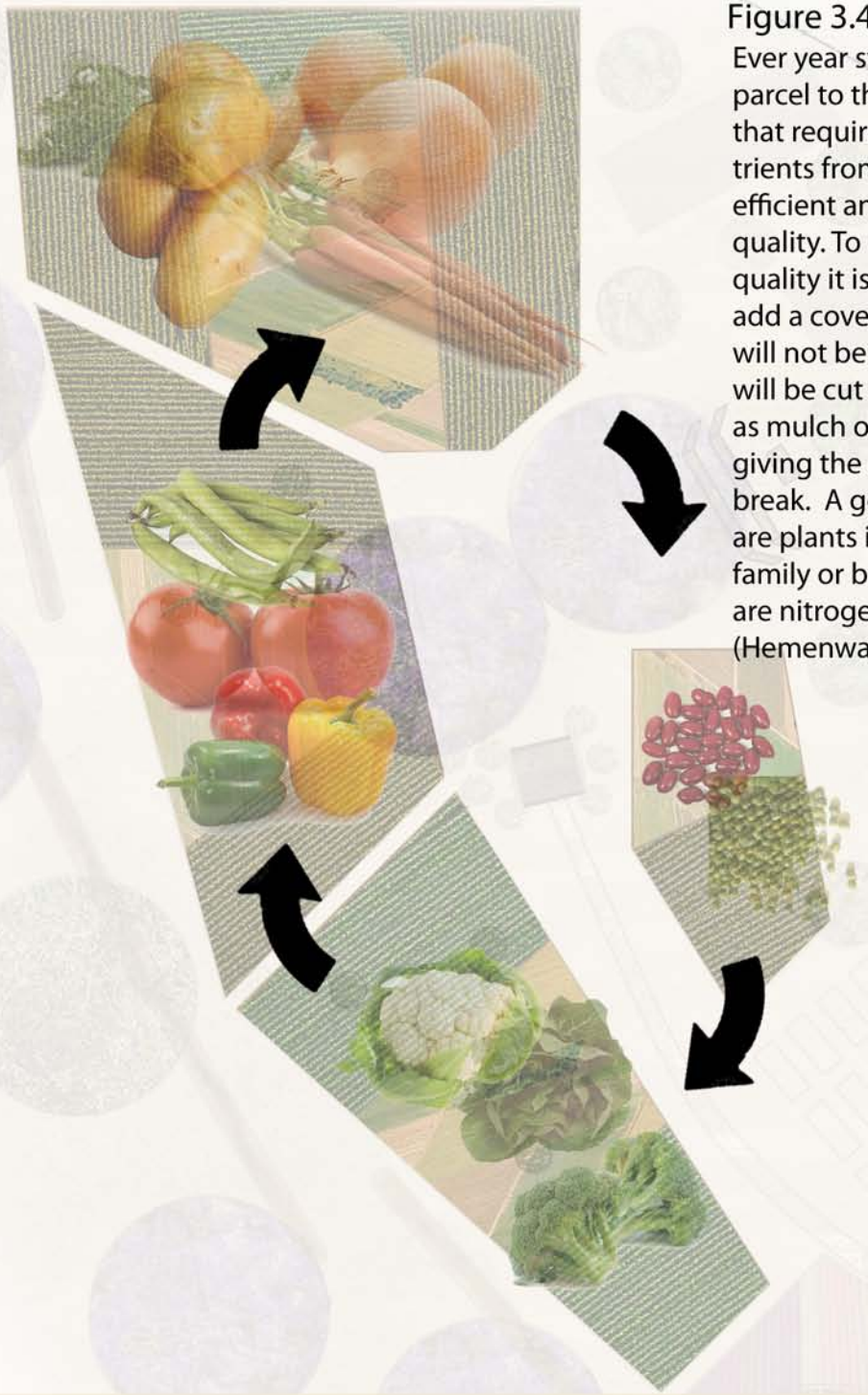


Figure 3.4 Crop Rotation
Ever year switching the parcel to the next group that requires different nutrients from the soil will be efficient and maintain soil quality. To increase soil quality it is even better to add a cover. The cover crop will not be harvested but will be cut down and used as mulch on the parcell, giving the land a complete break. A good crop cover are plants in the Fabaceae family or beans family that are nitrogen fixers (Hemenway 2009).

Composting

Composting involves bringing natural materials together to create what naturally occurs in nature that helps bring life and nutrients into the soil. This is the humus layer in natural landscapes, which is a huge part of the cycle that keeps soils and vegetation healthy. Humus is simply the breaking down of vegetation that releases nutrients back into the soil and feeds not only new growth in vegetation but also all the organisms living in the soil.

On farms, however, this layer of humus does not develop because the nutrients and vegetation is constantly being harvested. Thus, the nutrients are removed and do not return to the soil to support healthy food and maintain yields (Mollison 2009).

By collecting products that are considered waste on a farm, it is possible to recreate this humus through compost and use it to the farms benefit. Good compost added regularly to the garden will support healthy and rich soil and in turn the crops will thrive in this soil to produce healthy and nutritious food (KOAN).

Chemical fertilizers do not use the natural processes used to build healthy soil, which is why it lacks a lot of essentials to really return everything to the soil especially the aspect of the soil that keeps the soil alive with microorganisms. When microorganisms are not flourishing it creates an imbalance and allows for pests to dominate causing the need for harmful pesticides needed to maintain the farm (Pesticide Action Network 2006).

Compost is a sustainable and cheap way to use "waste " and turning it into a productive product that supports the biodiversity and health of the soil, in turn producing a healthy sustainable yield. This also brings an important concept into awareness of the possibility of using waste to create something productive. Fortunately all these materials are usually available from the waste produced from the farm. This is a delicate mixture of carbon, nitrogen, oxygen, water and microorganisms that create strong healthy compost.

The Mixture

Figure 3.5 The Mixture to Create Compost

Carbon sources are typically considered the dry, brown material from products found readily on the farm or surrounding nature like wood chips, dry leaves to products thrown out through consumption in the school like paper, newspaper and cardboard.

Nitrogen sources are typically considered the more wet, green material from fresh cut grass to left over food scraps from the kitchen.

High Nitrogen sources are animal manure, which is available from large cow to little chicken droppings.

The actual decomposition is done by microorganisms that feast on the mixture to create the nice humus. With the right mixture they will flourish, but it is important to attract and support the right microorganisms.

The organisms that are important to attract are aerobic bacteria that thrive under conditions that provide proper oxygen. Worms help facilitate these microorganisms by constantly creating air passages as they move through the compost.

Moisture is extremely important too because if the heap is too dry the decomposition process will stop and if too wet the heap will support anaerobic bacteria that will change the how the soil forms.

It is important to get the right mixture of the two. Too much carbon the decomposition process will be slowed down. Too much nitrogen will make the compost stink and attract the wrong bacteria. It is important to break down the pieces put into the compost so that they can decompose faster.

Figure 3.6 Compost Station

The compost station created for Daraja consisted of 5 different bins that brought all the ingredients into one designated spot to create the right mixture for compost.

Carbon

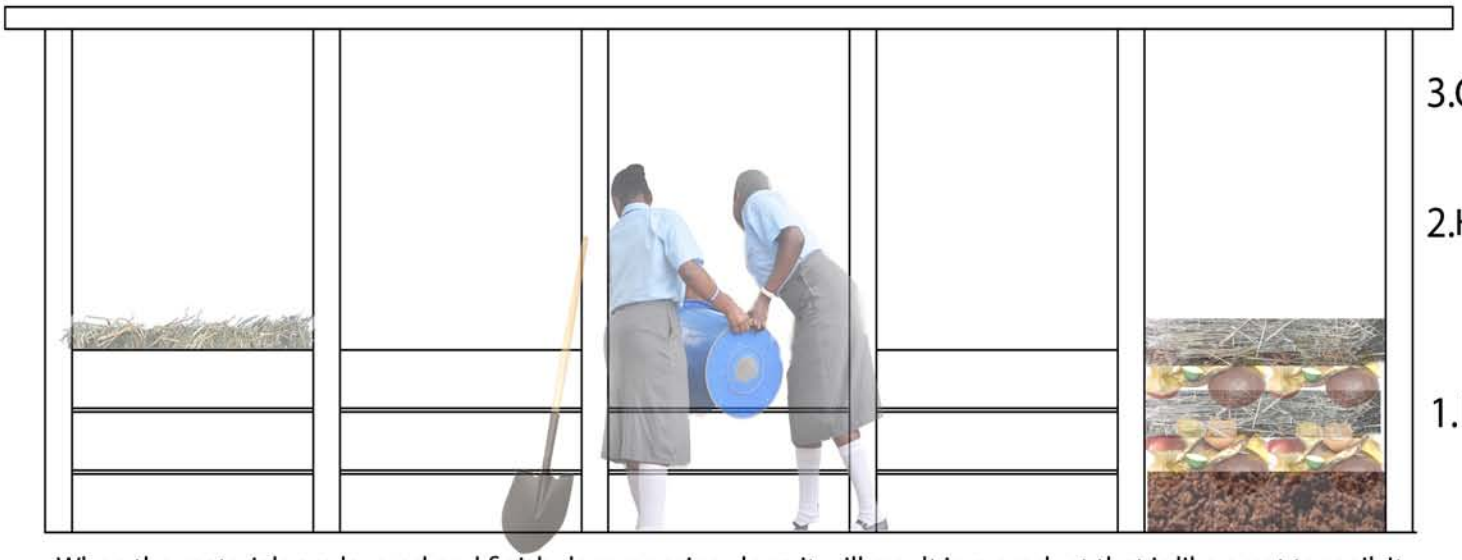
Carbon will be collected in this bin from around the campus from grass that is cut for maintainence to old homework assignments.

High Nitrogen

Collect high nitrogen sources and store them in this bin, including cow and chicken droppings.

Layering the Mixture

In these bins the food scraps from the Dining Commons are brought and the students begin the layering process that will decompose into soil.



REPEAT

The worms will move throughout the mixture creating air passages preventing the pile from becoming anaerobic.

When the materials are layered and finish decomposing done it will result in a product that is like great topsoil. It should be dark fine and spongy and smell like the earth. The compost can be directly put on the soil of the farm at a minimum of 2 inches . It is important though to foresee areas where the soil will be exposed to direct sunlight and apply mulch so that the fresh compost does not dry out and die (KOAN).

Africa has one of the lowest rates of pesticide importing in part of the expense. However, pesticides that become banned in North America and Europe are sold in developing countries like Kenya at a huge discount. So despite the fact that Africa is the lowest importer of pesticides, the pesticides purchased are highly toxic and have a huge impact on the people using the pesticide, the consumers of the product that the pesticide is used on and of course the environment. Subsistence farmers have become dependent on cheap pesticides in Kenya. Kenya has one of the more developed and sustained markets for pesticide products in Africa and is rated one of the highest in the sub Saharan African countries (Pesticide Action International 2010).

Subsistence farmers tend to purchase the cheapest pesticide available, which is usually something that is not supposed to be on the market due to high levels of toxicity and hazards to health. Then these farmers do not have the proper protective clothing to use the pesticide and they use the product indiscriminately because often they cannot read the label or there is no label. This leads to a health decline in the farmers, large amounts of chemical on the product that effect everyone that eats it and causes environmental degradation (Murange 2011). The environmental degradation lessens the productivity of the crop and creates dependence on the product to ensure that pests will not return. When pesticide is sprayed it not only kills the pest but it kills everything: organisms in the soil, neutral and beneficial insects that contribute to the farm and the predator to that very pest. Thus, it destroys the cycle of the ecosystem and that pesticide is needed to keep that pest at bay.

Protecting and Supporting Beneficial Insects

Areas of natural high biodiversity in agricultural operations where the landscape has been left untouched on the farm are extremely important. These areas protect against erosion by blocking wind from the fields and collecting water. However, most importantly they preserve wildlife. The birds and insect predators that live in these spaces are paramount in keeping farm pest under control. The wildlife in these areas also bring pollinators like bees and butterflies that support and create higher yields in flowering crops and fruit trees. Whereas pesticides would destroy the natural cycle maintaining a good ecosystem is actually more sustainable in dealing with pests (Hemenway 2009).

Figure 4.1 Focal Seating
In the center of the farm, land is left untouched to provide the benefits described above. Also, it is a focal seating area where students can be in the center of the agriculture and reflect.

Figure 4.2 Entrance
The edge of the farm is enhanced with the nature walk described in the previous section supporting more biodiversity. At the entrance of the farm, plants supporting pollinators, like lavender and lantana are planted. Next to this area is a man made pond that has shallow water in it to support thirsty pollinators.

Drought in Kenya

Kenya is a drought-prone country with only a few areas with high and regular rainfall but the majority of the country receives an annual rainfall of 8 to 20 inches with periodic droughts. These arid and semi-arid conditions comprise 80% of the countries land.

Kenya has had three major food crises in the past decade that have all been triggered by drought. In 2000 Kenya was hit with the hardest drought it had seen in 37 years leaving 4 million in need of assistance. In 2004 crop production ceased due to a lack of consistent rains that typically occur from March to June leaving 2.3 million people in need of assistance. Most recently in 2005, again 2.5 million in Northern Kenya needed assistance due to famine caused by drought (Kandji 2006).

The communities requiring the aid are the rural poor who depend on rain-fed agricultural fields and livestock for their livelihood. Not only do crops die but thousands of cattle and goat die, leading poverty-stricken communities further into poverty, leading to social consequences such as tribal and family conflict over scarce resources, high-levels of malnutrition, child abandonment and increased school drop outs.

The Climate Change Panel predicts that because of climate change and desertification, Kenya's dry lands will be even drier due to longer and more frequent droughts in the 21st century. Furthermore, the population in these areas is increasing due to steadily increasing birth rates and immigration from other countries seeking refugee from the conflict in their countries. A recent census estimated that one fourth of Kenya's population lives in drought-prone areas and is increasing leaving more people susceptible to climatic change and creating more competition for scarce resources (Government of Kenya 2010).

Implications of not Catching Rain

Figure 5.1 Short Term Thinking with Water

In Kenya storing water is costly or not even on the radar of small agricultural communities. When the rains do occur the water runs off the land taking away with it not only the water but also precious topsoil. Normally, the water would saturate the soil before it runs off as surface water. However, in dry areas the soil is usually clay that has become hard panned because of over pasteurization and tree removal which leaves the soil exposed to the sun (KIOF).

Figure 5.2 Lack of Rain in Kenya

When the rain stops for long periods of time or do not come when they are expected; Kenya's are out of work, their crops suffer and they are forced further into poverty leading to the social and health problems discussed on the previous page. Furthermore, women in rural areas then spend hours a day traveling to or in search of water for their family (Murange 2011).

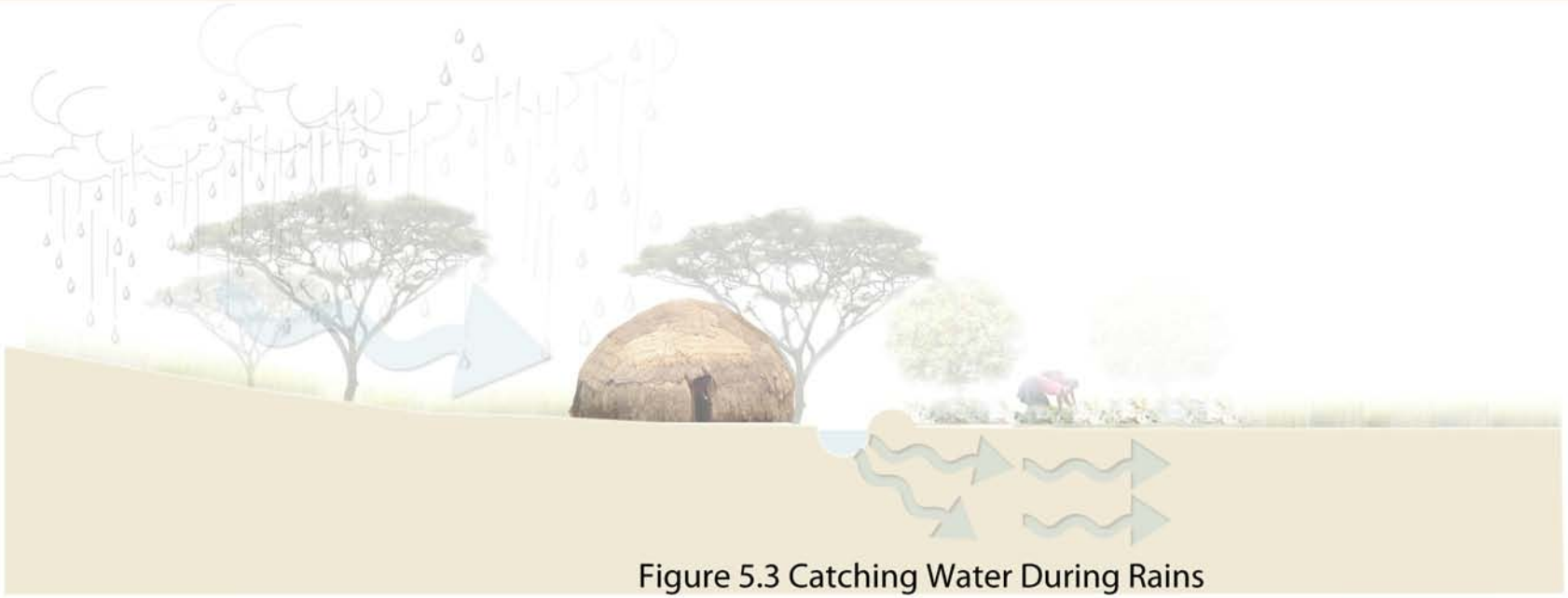


Figure 5.3 Catching Water During Rains

The cheapest place to store water is in the soil. Swales are ditches in the ground that go with the slope and contour of the landscape to catch water, which gives the water more time to percolate into the ground creating a reservoir of water that spread and stores in the soil. The swale also catches the soil that would be usually carried off with the run-off.

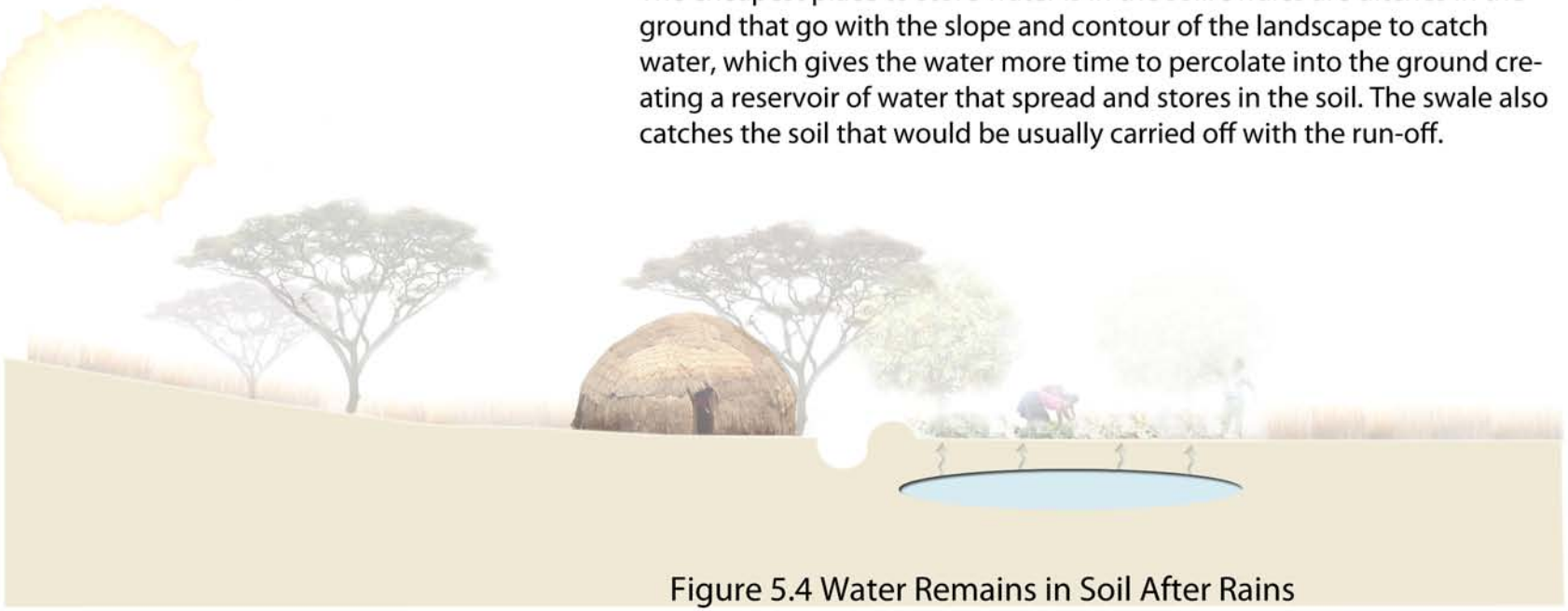


Figure 5.4 Water Remains in Soil After Rains

That reservoir of water is then available to the plants in the garden after the rains have occurred and lasts longer because it is not exposed to the sun, lessening the amount of evaporation (Hemenway 2009).

Finding Contour

The swale needs to be on contour with the landscape to allow water to fill the swale equally level to allow the most water to percolate into the soil. If the swale is not on contour the overflow will cause erosion. To get the swale on contour an A- Frame is required.

Figure 5.5 A- Frame Device
In the picture to the left, volunteer Sean Walashek constructed an A-Frame from local sisal plant, string and a rock.

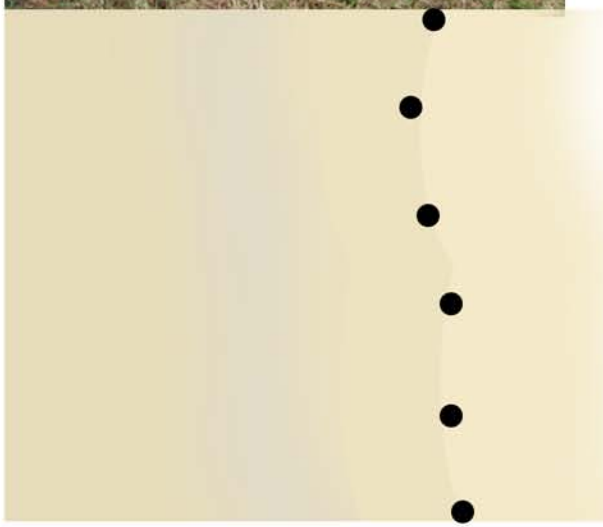


Figure 5.6 Finding Contour
Looking at the hillside in a plan view see the different contours in this gradient of colors. The A-frame will help find the contour by moving it along the hillside horizontally and marking where the rock is in the center of the A- frame to get the contour. Each dot represents a point on contour. Once the contour is found the swale can be dug.

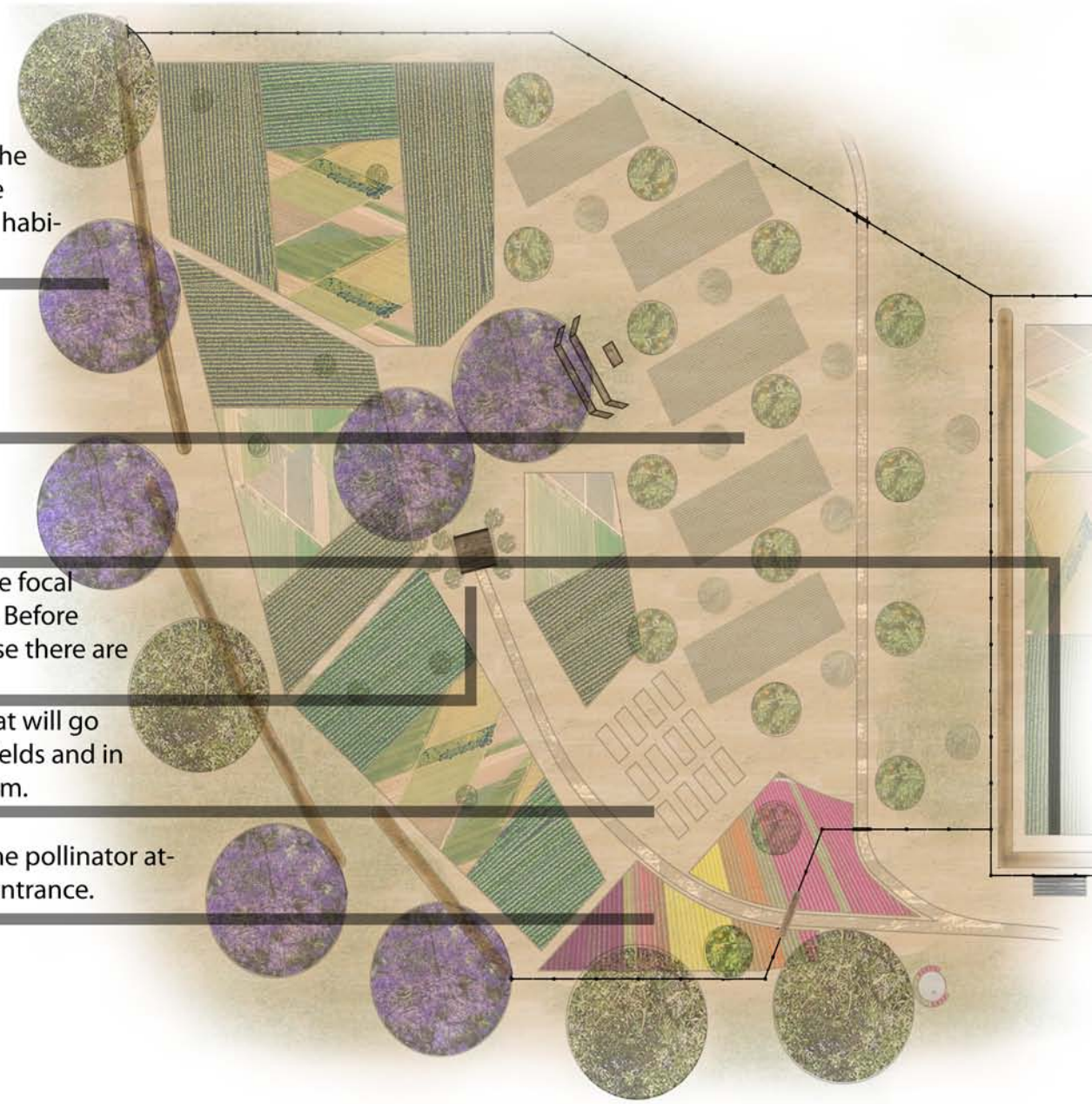
Size and Vegetation

Swales can be however long and wide, but should only be 1 to 3ft deep with a berm at about the same size.

On the upslope of the swale plant natives trees and shrubs that are used to the water regime so that they can provide benefits to the swale and garden without requiring much water. They will provide stability to the swale with roots, shade the swale lessening the amount of evaporation, and provide leaf-litter that will mulch the swale lessening the evaporation as well but also put nutrients in the water and soil for uptake by other plants.

On the down slope plant thirsty plants, in this case agricultural crops so that more water is available to them. On the berm plant fruit trees to stabilize the berm with their roots and provide food.

Phase Plan for Farm



1. Dig swales on contour and plant edges with native plants . The swales will start catching water and saving it in the soil and the native plants will help build up the biodiversity in the soil and habitat for pest predators.

2. Plant the tree layer of the food forest. The tree layer takes the longest to develop so it should be one of the first steps. The sooner the trees are planted the sooner the farm can benefit from all the services the trees provide.

3. Build the compost area so that students can start collecting the resources to build healthy compost. Once the compost starts being built it can be added into the farm.

4. Build the built structures. The outdoor classroom, the focal seating area and the fence around the farm will go up. Before planting any of the crops the fence has be built because there are free roaming cows on the campus.

5. Plant the beds with the crops that will go into the future rotation cropping fields and in between the tree canopy in the farm.

6. Plant the pollinator attracting entrance.

Phase Plan for Farm: Swales and Nature Walk

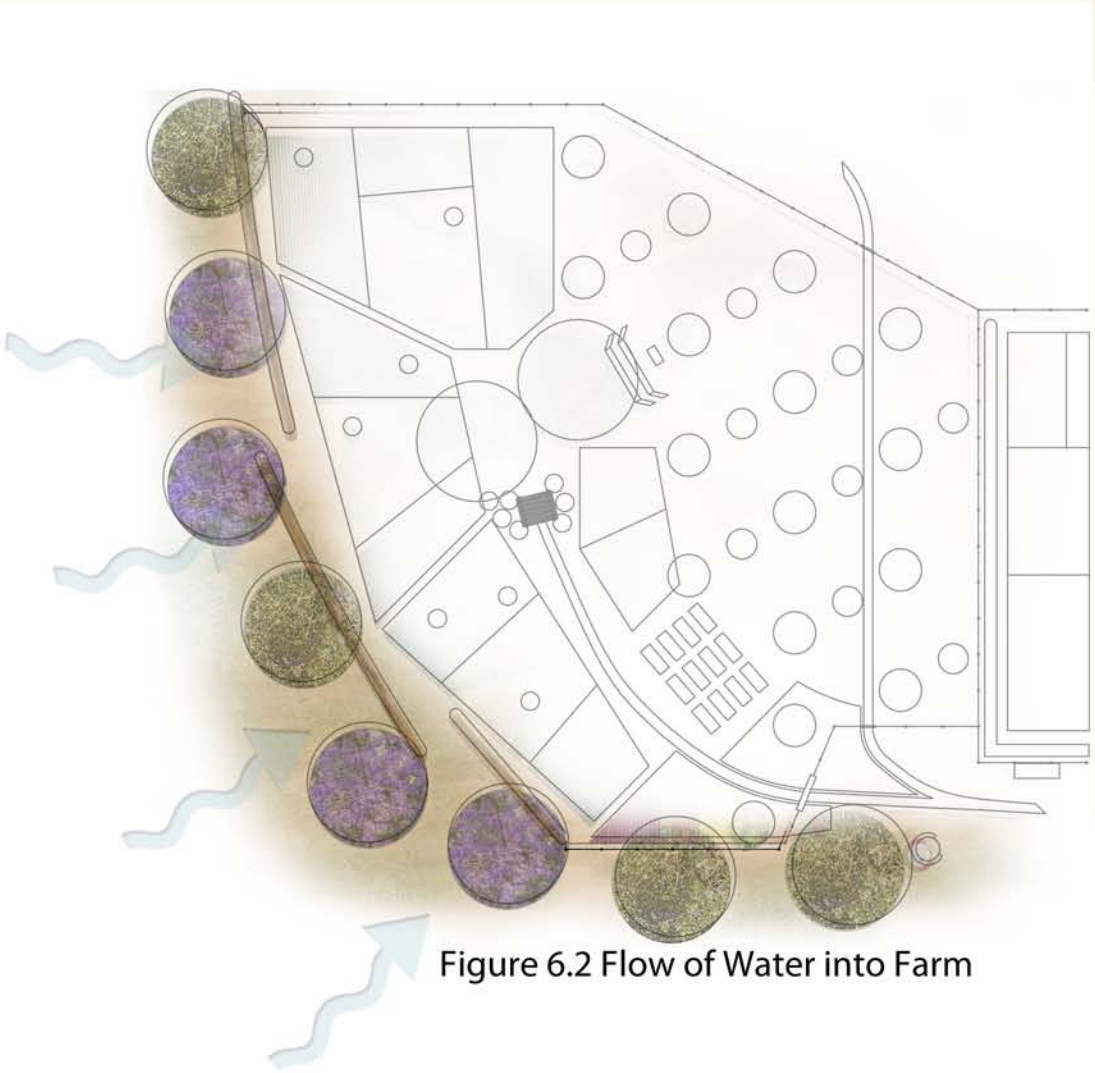


Figure 6.2 Flow of Water into Farm

Figure 6.1 Digging Swales

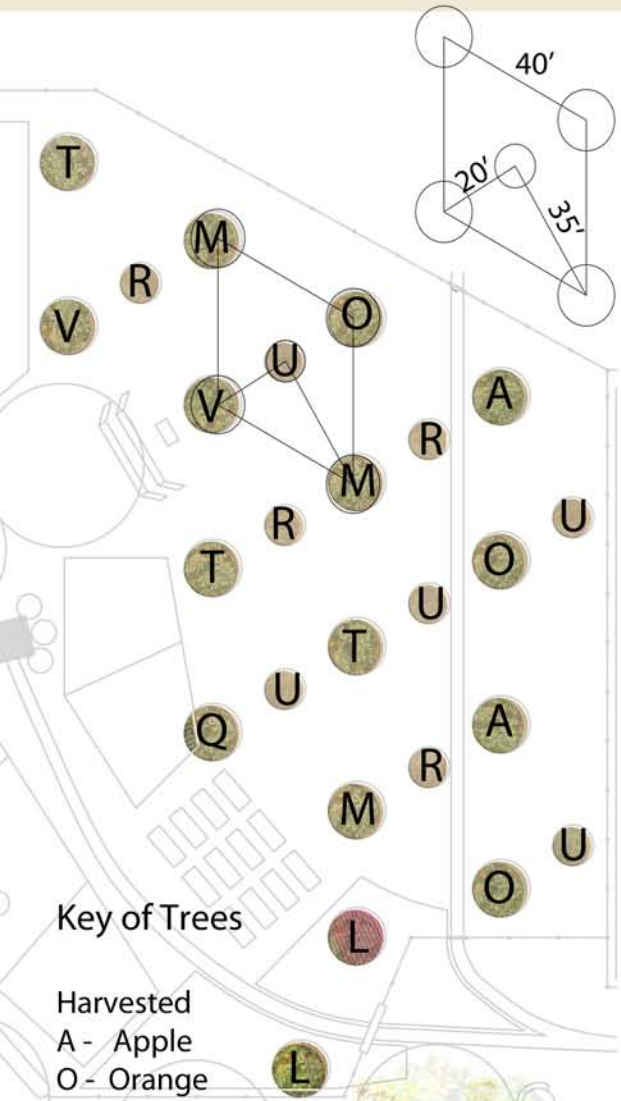
The swales were staked out on contour using the A- frame system described on page 28. The swales were made 3 feet deep and 4 wide since this area is prone to a vast quantity of water in a short amount of rain that causes flash floods and heavy amounts of erosion.

Nature Walk

On the edge of the swales native plants will be planted. The ones bolded below are the readily available plants that were available at local nurseries. The rest are plants that would add native biodiversity.

Acacia brevispica
Acacia drepanolobium
Acacia mellifera
Acacia senega
Acacia seyal
Acacia tortilis
Acacia xanthophloea
Agave sisalana
Balanites aegyptiaca
Combretum-molle
Euclea divininorum
Euphorbia candelabrum
Kigelia aethiopum
Maerrua crassifolia
Olea africana
Podocarpus gracillior

Phase Plan for Farm: Food Forest



Key of Trees

Harvested
A - Apple
O - Orange
L - Lemon
M - Mango
V - Avocado
T - Tangerine
Q - Loquat

Non- Harvested
R - Moringa
U - Leucaena

Figure 6.3 Food Forest Organization (Left) Planting organization and spacing of trees in food forest.

Figure 6.4 Built Food Forest (Above) Inna Nosenko, Barbara Nazarewicz and Elizabeth Bokulich stand next to the newly planted food forest. The trees were spaced out to allow for ground cover crops to be planted once the trees are more established.

Figure 6.5 Planting Trees (Right) As part of a layering exercise the students planted Leucaena and Moringa in the existing farm after learning about how layers make a farm stronger.

As the compost begins to develop in the bins the students and garden staff will use the finished product for the existing garden and for the help of growth of the newly planted trees in the food forest.

Figure 6.6 Painted Compost Bins (Above) The students painted the compost bins with what each bin is for and how to layer the materials to get healthy soil. This way the staff, students and future students can see how the compost process is done by just looking at the compost bin.

Figure 6.7 Learning About Compost (Upper- right) The students learned about the compost bin and were put in charge of maintaining the compost bin.

Figure 6.8 Students Using the Compost (Lower- right) Students taking the food scraps from the kitchen and pouring it into the compost bin.

Phase Plan for Farm: Built Areas

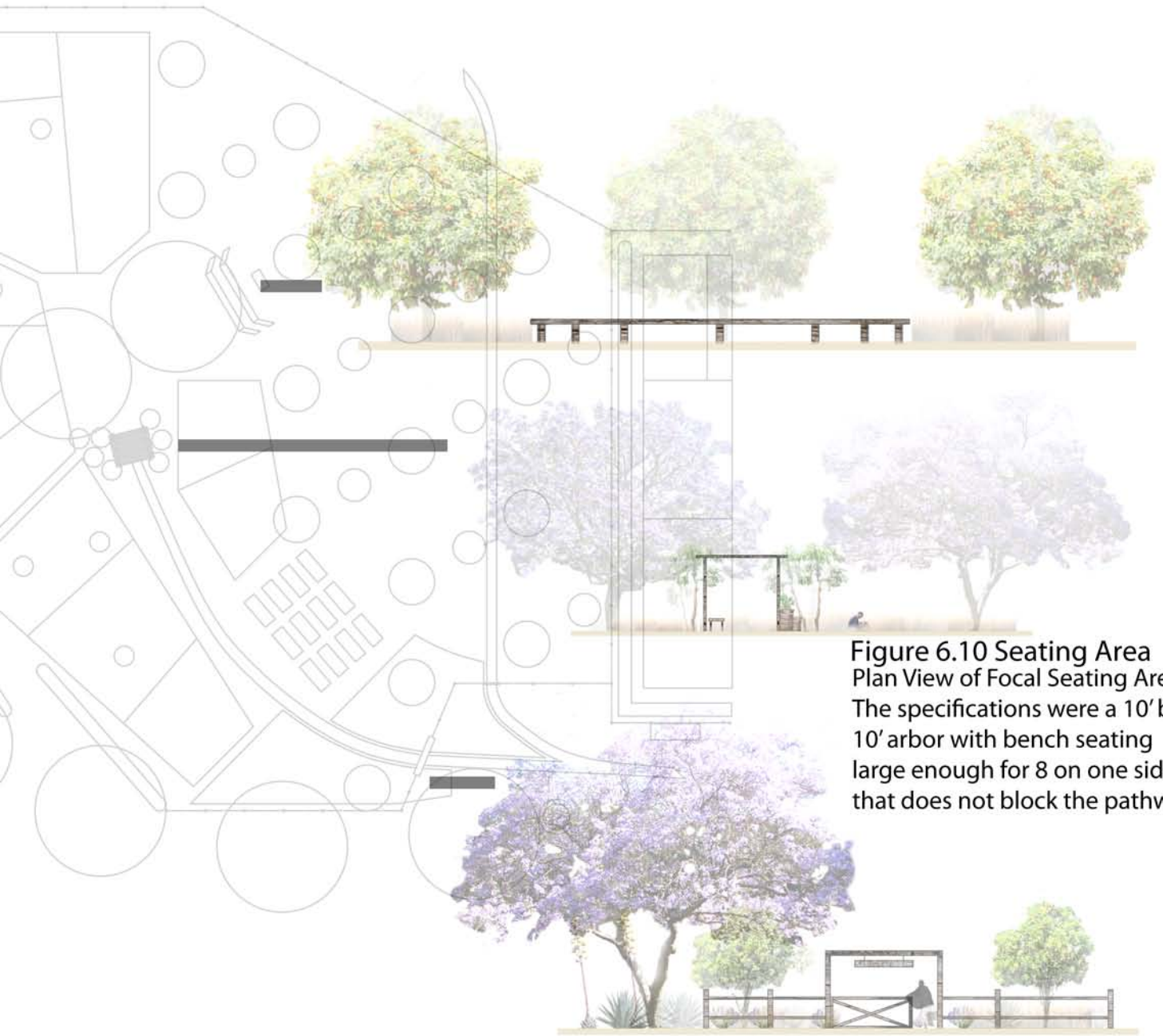


Figure 6.9 Benches

Plan View For Outdoor Classroom:
Daraja maintenance keepers already have a way in which they create benches. The only specifications necessary is that there are two sets of benches that curve in and are able to fit a minimum of 35 students at a time.

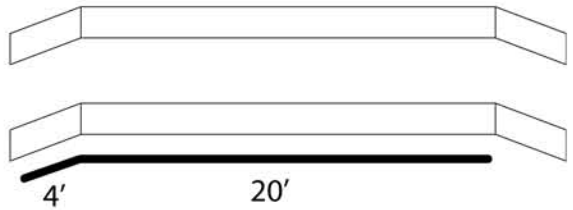


Figure 6.10 Seating Area

Plan View of Focal Seating Area:
The specifications were a 10′ by 10′ arbor with bench seating large enough for 8 on one side that does not block the pathway.

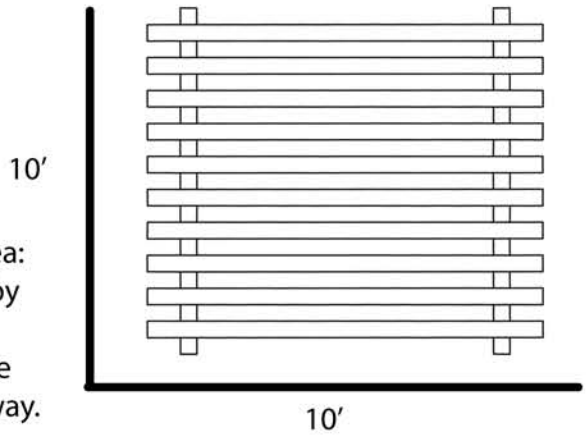


Figure 6.11 Entrance

To the left is a section of the entrance to the new farm. Daraja already has its own fencing system that will be placed around the whole new farm site

Phase Plan for Farm: Crops

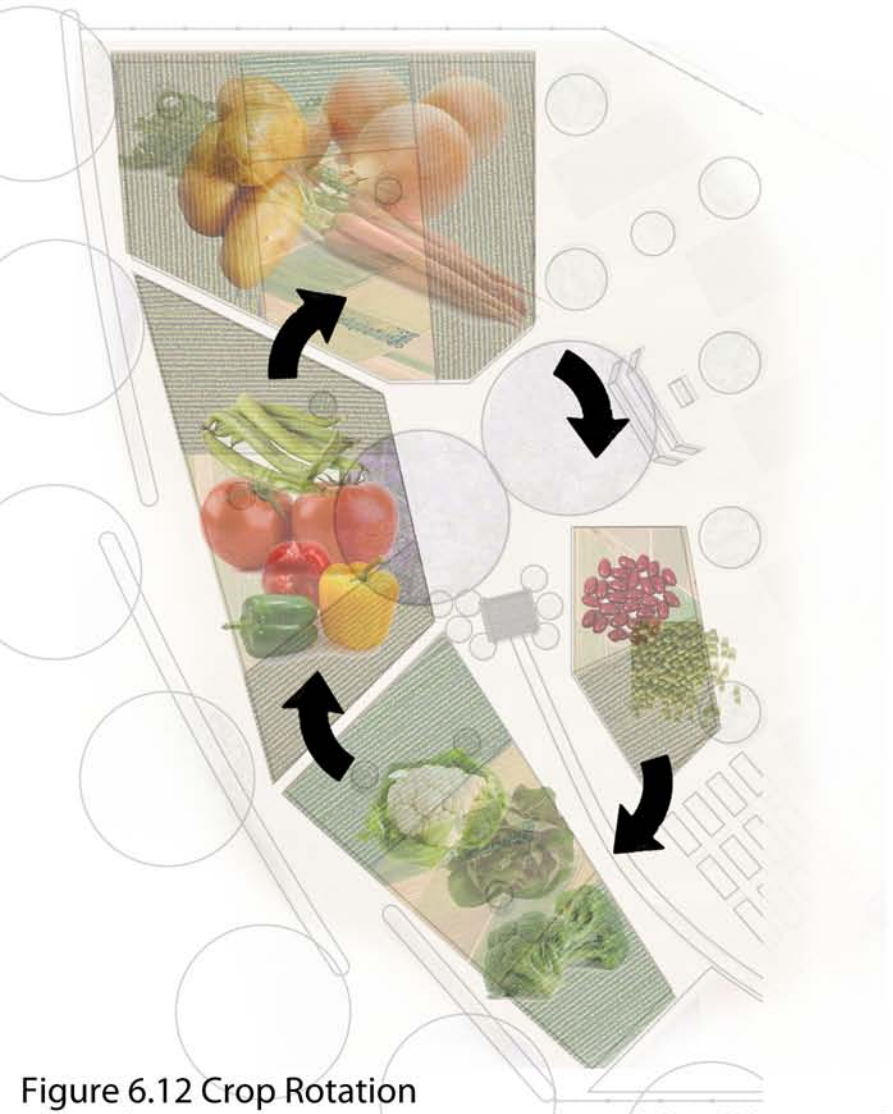


Figure 6.12 Crop Rotation

Before the crop rotation process starts. The soil should be properly built up by adding compost and allowing the native grass to grow and cutting it back every month but leaving it on the site. Once the native trees around the swales and the trees in the food forest have matured at least 2 years begin the crop rotation process. Follow the chart on page 15. This is also the time to start planting. This is also the time to plant the ground cover crops (zucchini, squash, pumpkin, strawberry) in between the food forest.

Phase Plan for Farm: Entrance

The pollinator entrance will be planted with flowers that are low maintenance and drought resistant. The local nurseries had a few plants available that are shown below.

Figure 6.12 Pollinator Attracting Plants

Bottle brush | Lantana | Lavender

Rosemary | Sunflower

Final Thoughts

At times it seems the worlds issues are at such a grand scale that it seems impossible to help remedy them. This leads people into inaction. However, the first step to accomplishing anything is doing a little/ starting small/ moving an inch/ making an attempt.

This project focused on understanding the issues plaguing rural subsistence farmer's in Kenya and finding easy ways that they can help themselves overcome those issues. This project hoped to create farm that would educate Kenyan youth from impoverished areas so that they could take that knowledge back to their families. The youth that is suffering the most because of the issues that the country is dealing with. The youth is the future and through their education they can change the systems in Kenya to take a turn from what is currently going on in the country, to a future where their children do not have to be born into suffering.

That being said I believe the foundation to creating sustainable change is giving people the opportunity to help themselves and that is done through giving them access to education, whether it be to broad schooling or specifying in sustainable agriculture.

People crave education there because they understand it is a way out of their poverty. It is the duty of people that have knowledge to share that knowledge to the people who are need it the most. It is not about changing people or preaching but offering and giving the simple opportunity for people to change their circumstances if they want to.

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Senior Project Committee Members

Approval of Senior Project

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