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ABSTRACT

This is a proposal for the creation of a permaculture garden at the Cloud Forest School- Centro de Educación Creativa (CFS-CEC), in Monteverde, Costa Rica. This garden will be used for food production, but will also be used for educational purposes. Permaculture gardens teach students how to live with nature. They are able to produce food for themselves in a way that uses the least amount of land as possible, thus leaving this land for forest species. The garden provides various teaching tools such as native species, gap area, gardening techniques, mimicry complexes as well attracts various species. It will also provide crops for the school lunch program, so that students will receive a nutritional meal daily that they grew themselves. The garden also provides a place for students to simply go and enjoy nature. Enclosed is a layout for the garden, a budget for the project, as well as identification guide for the different species.

RESUMEN

Se propone la creación de un jardín de permacultura en el Centro de Educación Creativa (CEC), en Monteverde, Costa Rica. Este jardín se utilizará para la producción de alimento, pero será utilizado también para propósitos educativos. Los jardines de permacultura enseñan a los estudiantes a convivir con la naturaleza y ellos son capaces de producir alimento para sí mismos de manera que utilizan la menor cantidad de tierra posible, preservando así esta tierra para las especies del bosque. El jardín proporciona varios instrumentos docentes, tal como especies nativas, áreas abiertas, técnicas de horticultura y complejos mímicos que también atraen a varias especies. También proporcionará cosechas para el programa del comedor escolar, de tal manera que los estudiantes puedan recibir una comida nutritiva diaria que ellos mismos cosecharon. El jardín también proporciona un lugar para que los estudiantes puedan simplemente ir y gozar de la naturaleza. Se adjunta un plano del jardín, un presupuesto y una clave de identificación para las diferentes especies.

INTRODUCTION

Tropical Montane Cloud Forests, such as those found in Monteverde, Costa Rica, are one of the most endangered ecosystems in the world (Nadkarni and Wheelwright, 2000). To date, an estimated 350 million hectares of tropical forests have been deforested and another 500 million hectares have been degraded (Lamb *et al*, 2005). The world population is over 6 billion people and continuing to grow (Rosen, 2004). As the population continues to grow, more resources are going to be needed, however because of current practices these resources are depleting quickly. It is imperative that current

agricultural and living practices are changed so as to prevent further depletion of necessary resources.

Permaculture is a term that was coined in 1978 by Bill Mollison and one of his students. It combines "permanent agriculture" and "permanent culture" (National Sustainable Agriculture Information Service website). The goal of permaculture is to create human systems that are efficient and use the least amount of land as possible (Mollison, 1988). Permaculture layouts create ways of living that will sustain current as well as future generations (Gliessman, 2000). It is not simply for garden plans, but can also be applied to entire house and community layouts (Mollison, 1988). It is a unique form of agriculture that integrates ethics into the production of food The three ethics of permaculture are (1) care of the earth; (2) care of people and (3) setting limits to population and consumption (National Sustainable Agriculture Information Service website). Permaculture farming offers a healthy alternative to the monoculture practices that are taking over the Tropics. It is ecological sound by incorporating polyculture, soil building, organic fertilizers and biological controls for pest. It eliminates as much as possible, non-natural materials and energy inputs (Mollison, 1988).

Permaculture gardens must compliment nature rather than work against it (SEED website). The way this is done is through the creation of guilds. Guilds allow for species to interact and provide necessary resources to one another (Mollison, 1988). The interaction of species is important so that all of the elements in the garden benefit each other and have multiple purposes (ATTRA website). This is done through intercropping. Intercropping is planting two, or more, crops in the same area; this increases the productivity of all the crops and reduces the need for external inputs (Gliessman, 2000). All of these elements combine to ensure that the most important factor of permaculture ethics is met, that all of the nutrients needed for the system are provided by the system (Mollison, 1988). Permaculture is a sustainable form of agriculture because all of the energy needed by the system is created in the system and there is no need for external inputs (Gliessman, 2000) which degrade the environment and have negative health effects. Permaculture is a better form of agriculture than organic or other sustainable practices because of the ethics that are incorporated into production. It requires people to live with nature and encourages people to think about where their resources are coming form and what effects their actions have on the environment.

The Cloud Forest School-Centro de Educación Creativa (CFS-CEC) is a bilingual school surrounded by the Cloud Forest Region of Monteverde, Costa Rica. It began in 1991, as an effort by local parents to increase educational opportunities in the area and incorporate environmental awareness into the classroom. The campus includes 40 hectares of protected Cloud Forest contagious with the Monteverde Cloud Forest Preserve. The school is unique because of its strong environmental education. Students often undertake projects such as reforestation, organic gardening, and organic biodegradable waste. The campus also includes greenhouses, a recycling center as well as trails through the forest (CEC website). All the projects that the students work on are incorporated into the classroom, so the students are not simply doing, but also learning why the different tasks are important.

The CFS-CEC has received funds from various organizations over the last five years in order to support different projects, such as reforestation, bat garden, native plant garden, and peace garden. The school has proven successful at being able to generate and

maintain these projects. The reforestation project has been especially successful as students have collected, planted and maintained over 500,000 native plants. It is clear that CFS-CEC has the organization and support necessary to carry out proposals that are adequately funded.

While the CFS-CEC already has very strong environmental programs and education it needs a permaculture garden on school grounds. Permaculture is important for students to learn about because it is an energy efficient form of farming that creates its own energy on the least amount of land possible. It is imperative that the next generation learns sustainable practices so that they will incorporate them into their lifestyles and teach future generations these practices. The hope is that the students will be inspired by the ethics behind permaculture and incorporate them into all aspects of their lives.

The creation of a permaculture garden at CFS-CES would allow the students to learn about a sustainable, healthier form of not just agricultural practices but also a life style. Many of the species that are planted in this garden are native to Costa Rica. Non-native species are included because they have importance in the Costa Rican diet or culture. This garden allows for students to augment their appreciation for nature by creating a garden that resembles nature as much as possible, thus allowing students to see the full beauty of nature and all that it offers. It encourages students to live with nature because they learn about the benefits nature provides as well as how to generate needed resources while staying in tune with nature.

MATERIALS AND METHODS

To learn about the practices of permaculture, I consulted the book Permaculture A Designers' Manual by Bill Morrison (1988). I also met numerous times with Virginia Kennard, who took a permaculture class and is the local expert on permaculture in the Monteverde area. The Internet was also used as a source of information to learn about the practices of permaculture. It provided some good examples of permaculture garden layouts.

The location of the garden on school grounds was determined through meetings with Karen Gordon, the Environmental Director at the Cloud Forest School. She set parameters for what the school wanted the garden to look like as well as the main functions of the gardens. She made suggestions on several drafts of the garden design so the garden would meet the school's needs. I talked with Willow Zuchowski, a local botanist, to determine which species of trees, understory plants and flowers would grow in the Monteverde area, produce fruit, and coexist well. I also used her books, A Guide to Tropical Plants of Costa Rica (Zuchowski, 2005) and An Introduction to Cloud Forest Trees Monteverde, Costa Rica (Haber *et al*, 1996) to get more ideas and information about the specific species. Karen G. and Willow Z helped to determine which vegetables should be included in the garden. The Costa Rican Organic Home Gardening Guide (Bernhardt, 2003) was used as a resource for Spanish common names and scientific names of the plants as well as provided generally information on the vegetables. Milton Brenes is the land manager at the Cloud Forest School. He has an organic farm at his house and helped to identify species that could be used as biological controls in the vegetable gardens. For medicinal plants to be included in the garden, a past CIEE student's paper *Medicinal Plants of Monteverde (*VanZandt, 2002) was consulted.

The budget for this proposal was calculated by visiting the local hardware store and finding prices of the materials needed. Javier Méndez helped me with the Spanish translations. The price for the permaculture class was determined by finding a class online that is held in Costa Rica. The cost of workers was established by determining the hourly wage of land managers at the Biological Station. Javier agreed that this was an appropriate amount of money to pay for this type of work. Maria Jost created the final layout of the garden.

RESULTS

I propose a 30-meter by 15-meter garden on school grounds using permaculture principles. The selected area for the garden is a space that is currently occupied by king grass, an invasive African grass planted by the farmer who owned the land previously. This plot currently cannot be utilized, but makes the perfect location for the garden because of good soil and protection by forest from strong Northeast winds.

Upon entering the garden, the first area one reaches is the outdoor classroom. The majority of the months in Costa Rica are during the rainy season, thus it is imperative to have a semi-enclosed classroom. This allows students to be in the garden while they are learning about the different aspects of the garden. This enforces that this garden is primarily for education, with the production as a secondary benefit. By coming upon the classroom first, it puts people in the mindset to learn. They will be ready to learn the principles and practices of permaculture, gardening techniques, mimicry complexes and various species that are found in the garden.

There are benches placed throughout the garden to allow students to have a place to go and study of simply just have quite time to think and enjoy the beauty of nature. The purpose of the benches is to encourage the students to spend as much time as possible in the garden, learning and observing. It is imperative that the students have a place to sit and enjoy the garden or else it will just be something they are forced to take part in and learn about and not something they actually enjoy. The students need to enjoy the garden and all that it entails in order to be excited to incorporate these ethics into their lives.

The main production focus of this garden is two vegetable gardens, one traditional and one composed of vegetables needed to supplement the schools lunch program. In the vegetable garden is Beans (*Phaseolus vulgaris namus),* Squash (*Cucurbita maxima*), Potato (*Solanum tuberosum*), Yuca (*Manihot esculenta*, Garlic (*Alliom satrium*), Chile Peppers *(Capsicun sp.*), Carrot (*Daucus carota*),), Peas (*Pisum sativum*), Corn (*Zea mays*), Onions (*Allium sepa)*. These gardens are located off to the two sides of the classroom. Basil (*Ocimum basilicum*), Oregano (*Origanum vulgare*) and Rosemary (*Rosmarinus officinalis)* will be planted throughout the two vegetable gardens to be used as biological controls. These species have been found to keep pest away. These species are natural organic pesticides for the garden that are produced in the garden and enhance the schools lunch program.

A pile of compost is located next to the organic vegetable garden. Permaculture requires that all energy needed by the system is produced in the system. The compost meets this criterion by being used in the two vegetable gardens in the place of external fertilizers. The compost will be made from the fallen leaves of *Ficus pertus* and *Trema*

Micrantha along with the dead banana trees and palm husks. Therefore the compost is created from the waste in the garden and used to enhance the production of the garden.

Next to the traditional garden is a small area of banana plants. The two species included are Green Banana (*Musa cavendishi*) and Platano (*Musa paradisiacal*) both of which are important species in the Costa Rican Diet. The inclusion of these two species is for consumption as well as to supplement the compost. The husks of the dead banana trees make a perfect addition to the compost.

Located near the traditional garden is a medicinal garden. In the medicinal garden are plants that are found in the forest around Monteverde. The purpose of this section is to teach students about the variety of resources that are available in the forest. It is necessary to include locally grown species because these are the remedies that are the most likely to be known by the students from past generations. This also allows the students to be able to recognize the species so they can simply go into the woods and find the treatments they need. The species in this garden are Agujilla (*Cinchona pubescens*), Carqueja (*Baccharis trinervis*), Guitite (*Acnistus arborescens*), Sensitive plant (*Mimosa pudica*), Sida (*Sida rhombifola)* Uruca (*Trichila avensis*), and Urera (*Urera caracasana*). These plants provide a variety of remedies for various ailments.

Next to the medicinal garden is a small garden that will contain *Asclepias curassavica, Lantana cantana* and *Epidendrum radicans.* These three species have similar colored flowers and show two forms of mimicry to attract butterfly pollinators. Flowers of *A. curassavica* and *L. cantana* both provide nectar; therefore these two species demonstrate Müllerian mimicry. *E. radicans* is nectarless and shows Batesian mimicry, by using having the same color flowers as the other species to trick butterflies into visiting them (Zuchowski, 2005). Next along the path is a row of coffee *(Randia matudae*) trees intermixed with blackberry (*Rubus costarocamis*) bushes. Next is a small flower garden with a bench in the middle to allow a place for students to sit that is very aesthetically pleasing. The flowers attract a variety of insects, butterflies and hummingbirds. Included in this garden is, *Begonia involucrate, Heliconia latispatha, Heliconia imbricata, Malvisus palmanus,* and *Renealimia cemun.*

Next is a gap area. This area is used to teach students about the dynamics of gap falls and how they change the dynamics of the forest. It can also be used to represent deforestation, as these are the species that will grow in a pasture caused by deforestation. The species included in here are Bracken fern, (*Pteridium aguilinum,* Umbrella tree (*Schefflera roriguesiana), Solanum umbellatums*, Fan fern (*Sticherus bifidus),* and *Witheringia meiantha*. It is necessary to learn about gap specialists so that they can understand how a forest changes, aesthetically and biologically, when disruptions occur. While some of these disruptions could be natural, such as a tree fall, there are also many gap areas that are human created.

A circle of palms, with a bench placed in the middle. The species of palms are Peach Palm (*Bactris gasipaes),* Costa Rican Bamboo Palm (*Chamaedorea costaricana)* and Palmito Morado (*Pouteria fossicola)*. This area is an important teaching tool because palms are very important species in Costa Rica. They also provide heart of palm, which is a principal element of the Costa Rican diet. It is also a necessary part of this garden because the husks supply material for the compost. Therefore they help create the energy that is needed by the garden.

The rest of the garden is covered in a more traditional forest area. It has canopy, subcanopy, understory and epiphytic layers. Most of the species in this area are native and most produce edible fruit. The variety of species attracts insects, butterflies, hummingbirds, mammals, birds and bats.

Enclosed is

- Layout of the garden along with accompanying literature on species, their natural limits and why they were chosen for the garden
- Description and photo of each species included in the garden to be used as a gardener's guide for planting the garden.
- A description of the different sections of the garden and the reason for their inclusion, in the gardens.
- A budget and cover page to be used for the grant proposals by the school.

The total budget for this proposal is $3,600.00.

DISCUSSION

This garden plan follows permaculture ethics because most of the energy that is needed by the system, if not all, is created by the system. The garden contains a compost pile to make sure everything is as productive as possible, but the compost is created from the "waste" of the garden. Various biological controls are planted throughout the vegetable gardens so that external pesticides do not need to be added.

The garden also shows guilds, a key principle in permaculture. Appendix A is a good example of guilds (Mollison, 1988). This garden plans created guilds by growing species in close relation to, often directly underneath, one another. This special arrangement allows for the least amount of area possible as well as the sharing of resources between species. The guilds are created through intercropping which in turn creates greater diversity in the garden. These two factors are important because they allow species to provide each other with necessary nutrients, protection and enhanced productivity. Intercropping often change biotic conditions around the area, such as attracting pollinators, beneficial anthropoids or mammals. Intercropping creates more sustainable and energy efficient systems and reduces need for external inputs. (Gliessman, 2000). This is important to permaculture because all of the elements of the garden are working together, rather than against each other, as is done in nature.

A permaculture garden is an excellent way for the school to support the school lunch program they are hoping to start. The school currently does not offer the students lunch, but does have a "no trash lunch" policy (must have fruits and vegetables and no junk food) but does not provide food for the children. There are some children at the school who are undernourished. The school would like to grow as much food as possible for the school lunches. While this garden will focus mainly on fruits, it will also have organic vegetable and herb patches. The garden allows for the students to have a part in and learn about the process of growing the food they will then eat.

This garden is also important to have on school grounds because of the different mammals and insects that it attracts. The flowers of the various species in the garden attract hummingbirds, butterflies, moths, beetles, bees and other various small insects. The fruits attract arboreal animals such as monkeys, as well as a variety of birds. While

the school is located within the forest and it is likely that most of these animals already can be found on school grounds, the garden allows places for the students to sit an observe these species and their interactions. It allows the students to see and learn about the variety of biodiversity that lives in the forests around them. It is also an important teaching tool that allows for the students to learn the natural histories, behaviors, needs and threats of all the different species.

The first step in planting the garden is to prepare the soil. This process will take about a year according the Milton Brenes. First the grass will need to be covered with plastic to block the sun so that all of the shoots will die; a process that will take three months. Then two workers will need to work for three days cutting the grass down. It will then be recovered with the plastic and left for a month. After this it will take another two days of labor to pull up all of the roots. The area will then need to be left alone for another month. Finally it will take eight people two days to till the soil so that it is ready for planting. CFS-CEO would like to plant this garden at the beginning of the next rainy season (May 2007).

This garden will need some work required in the maintenance. The vegetable gardens will needed to be replanted each year as well as some time will need to be spent weeding. The gap area will also need to be maintained some, by keeping it clear so that the gap species will be the ones that continue to grow there. Some of this work will be done by the students, but the majority will be done by Milton and the volunteers that the school. The school has a large number of volunteers that rotate through the school for various periods of time. While this garden may require more manual labor that most permaculture gardens, the areas that need work are necessary for the production and educational values they provide.

The CFS-CEC currently has two staff members devoted to environmental programs. Karen Gordon, the overseer, and Milton Brenes, the land manager. Milton was hired because he previously was an organic farmer and a member of the local fare trade association. He is the expertise at the school in organic farming and will be crucial to getting the project started as well as working though any problems that may arise. Karen has been at the school for six years, and has taken on the creation of many environmental projects. However, neither knows much about permaculture, so this grant includes the money for one of them to take a permaculture class. They will both be crucial to insuring that the project continues to follow permaculture principles in the future and remains productive. However with their combined skills, it is ensured that a permaculture garden will be created and maintained by practices that are crucial to permaculture.

Permaculture practices are essential to support future generations. The Tropics are experiencing rapid population growth leading to increasing deforestation and pressure placed on ecosystems. Population growth is expected to grow from 1.8 billion people (2000) to 2 billion people by 2030 (Wright, 2005)). It is estimated that 300 million people in the Tropics now rely on deteriorating forests to live. The forests provide many services to these people such as timber, medicines and foods, which they may not otherwise be able to purchase (Lamb *et al*, 2005). It is crucial that we start changing out practices now in order to prevent further deforestation. Permaculture offers an excellent option that allows us to produce necessary food as well as protect forest.

Permaculture practices are especially important in the Tropics, because the human population tends to be malnourished and of low socio-economic status. It is imperative that the focus is put on nutrition and self-reliance for the people of the Tropics to make better lives for themselves and their children (Morison, 1988). By teaching the students the practices and ethics of permaculture they will then become the teachers to the greater community. They will create the change towards more sustainable living, which is imperative to the preservation of the environment.

Permaculture is also an excellent, healthier alternative to monoculture farming, which has negative environmental and socio-economic effects. Large monocultures generally depend heavily on pesticides to increase the production of crops (Morison, 1988). Current agriculture processes put more energy into producing the food than the food contains (Gliessman, 2000). Pesticides not only affect the health of the workers but also get into the rivers and local water, effecting local residents. When spraying the pesticides, the wind carries them to nearby farms, making any livestock there unmarketable (Morison, 1988). Permaculture incorporates intercropping so that pesticides are not needed. This offers a healthier lifestyle to those that wish to embrace the ethics of permaculture into their lives.

The species included in this proposal are ones that I found to be interesting and appropriate to include. However, as more people begin to embrace this garden it may be found that there are other species, which have been omitted from my plan that should be included. This plan can be easily adjusted to more adequately meet needs if the issue arises.

The Cloud Forest School is filled with students who are eager and interested in learning about ways to protect the environment and incorporating these strategies in everyday life. It is a community that is open to new ideas that are for the benefit of the individual, the community, and the environment. By creating a permaculture garden, it allows for a living classroom to teach students about the principles, benefits and ethics behind permaculture. The hope is that the students will then be motivated to create gardens at their own houses using permaculture practices. The students will become the teachers for future generations.

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