Reforest Concepcion Tutuapa:
Developing a Sustainable Society for the Future

Flowering Mexican Sunflower (*Tithonia*)

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"Reforest Concepcion Tutuapa"

"The world's forests are being cut and burnt at such a rapid rate that if action is not taken soon, we risk undermining their vital function in maintaining a habitable planet" (Salim and Ullsten, 1999). Virgin forests are being cut at an alarming rate to provide people with a multitude of products, some more critical than others. This problem is worse in countries that rely on timber resources to fuel their stoves for cooking and heat for their homes. In many places forested land is harvested for fuel-wood and construction materials, or export, and is then changed to pasture or fields to supply food. This trend is continued in many nations and has no positive end. In order to avoid the devastating losses of many lives in the future, we must change the methods in which we use the timber resources we have.

The purpose of the Reforest Concepcion Tutuapa project is to address the growing problem of deforestation in Guatemala, using a methodology that can be applied anywhere. Every year the country of Guatemala loses 2% of its 42000 km^2 of forested lands (Wilkie, 2001). This loss may not seem like a substantial amount, but when you take in to consideration the importance of the resource to the people of Guatemala for subsistence, the situation becomes serious. Few homes in Guatemala have access to electricity or fossil fuels to supply heat for their homes and stoves to cook on. The main source of fuel to meet these basic needs come from wood; therefore trees are in a sense the limiting factor for the people of Guatemala.

This project is not just about planting trees. The Reforest Concepcion Tutuapa project is about working with the people of Guatemala and educating them in land management techniques aimed at reducing their dependence on present forested lands, while rehabilitating lands already cleared. The rehabilitation will focus on improving agricultural lands by incorporating nitrogen fixing trees and shrubs with vegetable crops traditionally planted on the same plot. By using nitrogen fixing trees and shrubs the farmers will benefit in the form of better crop yields, reduced erosion, and enhances the uptake and utilization of nutrients (Hauxwell, 2002). The non-forest timber products used in the plots can also be used as an alternative source of income for the farmers.

If the problem was as simple as learning new agricultural techniques and planting trees, then the problem would have been solved long ago, but the situation goes well beyond that. The people of Guatemala are indigenous and have been living on the land for many years. Traditional methods used for heating and cooking have worked well in the past because the population size was smaller and resources were readily available. Today the population is increasing rapidly and resources, especially wood, are becoming harder to find. In order to decrease the rate at which wood is being extracted from their environment, more efficient means of using the wood must be adopted. Therefore, this project will need to design a stove that burns wood more efficiently, is economically feasible, and is accepted by the local people. Introducing new technology into the home can be more difficult than changing a farmer's planting technique because of the cultural connection to traditional stoves. The new stoves will decrease the amount of wood used per family and thereby increase the number of trees left standing.

The farmers and households who are willing to adopt new technologies and leave part of their tradition behind them will benefit the most from the Reforest Concepcion Tutuapa project. As the population of the region increases, farmers are being forced to use the same plot year after year, with diminishing yields. Without production levels sufficient to meet the needs of individual family's, the men are forced to leave their homes in search of work. Using the technologies that this project supports will allow for economic and subsistence stability; therefore families can remain together and continue their traditions. The goal of this project is to provide a model that when implemented will assist individual farmers or villages to become sustainable. Sustainability for Concepcion Tutuapa can be defined as providing the requirements for the subsistence of family's and villages without increasing the demands on local resources.

Region of Interest: Concepcion Tutuapa

The region this project is focusing on is near Concepcion Tutuapa del Departamento de San Marcos, Guatemala. The town of Concepcion Tutuapa lies at an elevation of 9000 ft (2700m). It is in an area of high volcanic and tectonic activity, making traveling difficult not only because of the poor road conditions, but also because of the mountainous terrain. Even though the area is located at a relatively high altitude, the climate can be fairly moderate. In Guatemala City, which is around 5000 ft., the average yearly temperature is 65°F (~18°C), with high temperatures usually coming in April or May and lows in January. Annually, the area receives almost 47 inches (~1200mm) of rain per year, with a majority of it falling between the months of May and October. Compared to Guatemala City, Concepcion Tutuapa is cooler in temperature and may receive around the same amount of rain. In the colder months frost can be a problem and snowfall is not likely (http://www.worldclimate.com/).

Approximately 1,200 people live in the town, with 55,000 people in the surrounding villages. Due to geography, twenty odd languages are spoken in the region, making communication for outsiders difficult, but not impossible. The area is wrought with poverty, and travel to the nearest city (San Marcos) is a 2.5-hour journey on unpaved roads, which at times are impassable.

Problem Statement

Reforestation of Guatemala is becoming increasingly important to the local people as forests disappear and the need for lumber, economic stability, and fuel to cook and heat their homes increases. This is an issue related to an inherent cultural tradition, increased population growth, poverty living conditions and adopting a new way of life.

According to Bandy et al (1993), the world has many problems to deal with in the near future. Two major issues, which need to be addressed in the next decade and are intimately tied together, are the increasing amounts of 'greenhouse gases', carbon dioxide, nitrous oxide, etc in the atmosphere and the ongoing reduction in the world's usable arable land.

Guatemala is a country that is both contributing to the problem as well as suffering from some of the immediate consequences. Guatemala's problems are similar to those of the third world and can be analyzed from the country's violent history that has disrupted the social framework of the people. As a result of Guatemala's social and political standing severe environmental degradation has occurred along with an uncertain future.

What does a sustainable society look like?

Sustainability can be loosely defined as, " meeting the needs of today without reducing the quality of life for future generations" (Mckinney and Schoch 1998). Using renewable resources, recycling, and modern technology, sustainability can be achieved.

The focus of the Reforest Guatemala Tutuapa Project will be to obtain sustainable harvesting of the natural resources of Concepcion Tutuapa. Specifically the project will address the depletion of wood. Using sustainable harvesting, wood can be extracted from the local environment without harming it. Therefore, success of this project can be measured based on the amount of trees standing before the project begins and several years after it has been implemented. If more or the same number of trees are standing, then the rate of wood removal is allowing for future generations to have the same quality of life, and no harm is being done to the environment. Thereby sustainability has been achieved.

Overcoming the Social and Economic Obstacles of Reforesting Guatemala

As the villagers of Consepcion Tutuapa struggle with a low quality of life and decreasing resources they have become a point of interest for the West. Foreigners from the West look to these developing countries as resource sinks where a bulk of the world's biodiversity and resources remain. Coming from an advantaged point of view, this puts westerners in a position to either: contribute to the removal of their resources or to stop or intercede the removal. If individuals choose to intercede and try to help not only the local villagers but also the future inhabitants of earth they must execute their attempts in a fashion that is effective, will continue over the long-term, and will be accepted by the local people. Doing so will require that social and economic problems are considered and that local populations are closely integrated into the project.

Two conditions that must be met in order for developing country's to adopt a project that promotes sustainability and resource conservation are a heightened local perception of environmental degradation and its negative impacts on human welfare, and a degree of political organization within the community to facilitate effective management. One of the issues that must be confronted initially is land ownership. In most of the areas where forest regeneration is occurring there is a land shortage and most individuals do not own the land that they toil. Therefore, if villagers participate in the reforestation program they view it only as temporary until they obtain their own property. Conflicts arise here because of the inherent quality of these projects to require long-term participation in order to see any results (Jordan et al 1992). One of the ways to overcome the problem of short-term interest in the project is to use community land. In this situation the entire village has a long-term vested interest in the success of the project.

The inherent longevity of reforestation projects poses a problem not only for the local villagers but also for the foreigners who execute the project. Many of the projects that have been started in Guatemala have failed due to the long-term commitments needed to complete the project successfully. Because of these failures one must address in developing a sustainability project how they can regain the local villagers trust and show them how the project will not be a futile effort (Clark, 2002).

A second problem that arises is a quality of life issue. When the villagers are surviving on a day-to-day basis it is difficult for them to see beyond today and into the future when their fuel resources are completely gone. In this instance they have a higher affinity for their food crops and see their labor to go grow trees as unnecessary and not important for them today. Competing demands for their labor is creating a "needs" conflict between meeting various subsistence needs and earning money to meet their other needs. In this case poverty and vulnerability must be appraised in order to determine their relative needs (Leach & Mearns 1988). To keep the villagers from ignoring the tree crops an incentive must be used because they may have other pressing needs, such as food security. This situation has been avoided in past projects if the trees are grown on private land owned by individual farmers or by local communities (Jordan et al).

The success of past projects is usually due to any of the following: widespread local involvement in the design and implementation, incorporation of the villagers to do as much as possible by themselves, and, finally, site-specific interventions. The last one is based upon the cultural diversity and complexity encountered in any undeveloped country. Many projects have used rapid rural appraisal to meet these demands by gaining an intimate understanding of the social and economic structure of individual villages and how a sustainability project will have to be designed in order to meet all their needs. Past sustainability projects that have failed all have unacceptability in common. These projects did not understand the fundamental needs of the villagers and therefore the villagers did not feel that the projects could meet their needs. Therefore, this deep understanding of the villagers themselves is the most important element in a successful project.

Political, Historical, and Social Concerns

Historical:

The historical background of Guatemala begins with the ancient Mayan civilization. Long before the Spanish conquistador Pedro de Alvarado defeated the Mayans in 1524, Mayan society had flourished. They constructed extensive cities with political and religious governing bodies. They developed calendars and complex mathematical calculations and their art was of the finest quality. The civilization still lives on in Guatemala's people, with more than half being descendants of the Mayan people.

According to the CIA Fact Book of the World-Guatemala (2001), Congress recently appointed Ramiro De Leon Carpio, the Human Rights Ombudsman, president of Guatemala. With the help of the United Nations, President Carpio began the tough road to win peace between the left-wing guerrilla group the Guatemalan National Revolutionary Unity (URNG) and the Guatemalan government. Together, these two groups signed agreements on human rights (March 1994), the resettlement of displaced persons (June 1994), historical clarification

(June 1994), and indigenous rights (March 1995), and made great strides on a socio-economic and agrarian agreement.

The next elections were held in November 1995 and included almost 20 different political parties. The final election round, on January 7, 1996, was won by Alvaro Arzu, by a margin of 2% of the votes. His opponent, Alfonso Portillo won all of the rural areas, while Arzu carried the majority of urban voters. In the most recent elections, held on in January of 2000, Alfonso Portillo returned to win the presidency. By the return of Portillo to power, rural areas of Guatemala should benefit due to his affinity for the impoverished rural communities (Anonymous, 2001).

Political

The present form of government leading Guatemala is a constitutional democratic republic. In many ways it mirrors our own government. There are three distinct and separate branches working together to form the leadership of Guatemala. The Executive branch is comprised of the President and Vice-President, and their appointed cabinet members. The president is elected by popular vote and serves a four-year term in office. The Legislative branch, the Congress of the Republic, is made up of the elected officials from the 22 districts within Guatemala. Each representative serves a four-year term in office. The Judicial branch has two different forms of judgeship. As mentioned above, each branch is separate and acts as in a check and balance system. The greatest problem mentioned is corruption among the three branches, though it seems the public has gained confidence over the last two elections (Anonymous, 2001).

The political atmosphere of Guatemala must be taken into consideration when undertaking a project that addresses the fragile resources of a developing country. The success of the "Reforest Concepcion Tutuapa" project will be determined by a thorough understanding of the political culture of Guatemala because the local villagers have little political representation.

Social and Economic

The founder of the non-profit organization AIR, Ann Hallum suggests that, "Things are better now, but when I started working there in 1991, the civil war was in its 30th year (between the military oligarchy and a few rebels, with indigenous Mayans caught in between, the majority neutral). Four hundred villages were burned and roughly 200,000+ killed. Now, the biggest problems are crime and poverty, especially in the large capital, Guatemala City (Hallum, 2002)." In this state of instability and nearing desperation Guatemalans takes projects such as reforestation very seriously. To ensure that these projects are not just another attempt to redefine who they are socially by making drastic changes in their way of life, they require a project that allows for flexibility and adoptability with a long-term commitment.

Rural poverty is extensive in Guatemala with 50% of the population engaged in some form of agriculture, often at the subsistence level. Illiteracy and low levels of education, inadequate and underdeveloped capital markets, and lack of infrastructure such as transportation, telecommunications, and electricity sectors are some of the main issues involved in resolving economic stagnancy. The wealthiest 10% of the population receives one half of all income, leaving 75% of the population in poverty. Indicators of this can be seen in Guatemala's rate of infant mortality at 79/1,000 and illiteracy, which are the worst in the hemisphere. Because the Mayan people are very close-knit and in such poor conditions they tend to help each other frequently, such as by trading the main local food source, corn. With an annual population growth of 2.68% their problems related to lack of food, shelter, and wood will continue to rise quickly. Alternatives to their current way of life and economic ventures will be necessary in the near future (US Department of State, ND).

The country has a GDP of $18.07 billion and a per capita GDP of $1,570. Some of Guatemala's natural resources include timber, oil and nickel. Agriculture makes up 23% of the GDP and includes the following export products: coffee, sugar, bananas, cardamom, vegetables, flowers and plants, timber, rice, and rubber. Manufacturing makes up 13% of the GDP and includes prepared foods, clothing and textiles, construction materials, tires, and pharmaceuticals. In 1999 they exported $2.5 billion worth of goods and imported $4.6 billion (US Department of State, ND).

The indigenous people living in the highlands of Guatemala are historically a self-sustaining society, but with the current transformation to large-scale agribusiness competing on the local level, they are faced with an increasing number of social and economic problems. The combination of population growth with decreased available resources has caused the local people to look for alternatives to their current lifestyle. Looking to the future, this lifestyle must include more efficient means of cooking, building, heating, and farming practices that require minimal amounts of destruction of forested lands. As wealthy landowners continue to dominate the majority of arable lands the indigenous people are forced to marginal lands where their current method of farming is "slash and burn". Knowing of no alternatives, the farmers clear the mountainous terrain of trees to produce corn and beans, the traditional crops. During the dry months these cleared lands are barren and stark. The wet season brings rain which batters the steep slopes and erodes the exposed soil into streams and rivers. Though the river valleys receive the benefits of this erosion, the families high in the mountains face a constant decrease in their land's productivity (US Department of State, ND). These techniques for survival have proved to be unsustainable for both the villagers and the environment that they live in.

Goals and Objectives

1.) Short term Goals and Objectives

Goal: Design a model and an appraisal method for a demonstration site in the proximity of Concepcion Tutuapa del departamento de San Marcos, Guatemala based on agroforestry principles that will meet the demands of the local villages while promoting environmental sustainability.

Objectives:

- Determine what a sustainable environment and culture looks like.
- Construct a format to be used when analyzing environmental conditions of the project site.
- Determine native woody, agricultural, and herbaceous species that will provide the most effective results, by comparing them with biomass yields produced by current species grown and species considered for the project.
- Determine possible fuel-efficient stove alternatives to be used during the implementation of the project.
- Design the methodology to be used during the rural appraisal analysis.
- Design a format to be used for monitoring and evaluating the project.

2.) Long-term Goals and Objectives:

Goal: Implement the model.

Objectives:

- Survey environmental conditions at the demonstration site and nursery.

- Determine the quantity of fuel used per household per day.
- Determine food crops grown by the local farmers that can be used to obtain economic stability.

Goal: Generate funding for research and development, implementation of the demonstration site, and to develop a website.

Objectives:

- Obtain money to cover the costs of implementing the model (Appendix D).

  Interim:

  1. Source funders
  2. Source partner agencies

Goal: Provide the local villagers with new fuel alternatives and more efficient means of cooking and heating to help reduce forest degradation in the area surrounding Concepcion Tutuapa.

Objectives:

- Provide additional sources of fuel and lumber using a fast-growing legume tree species.
- Reduce the amount of fuel used per family.
- Analyze the effectiveness of the demonstration site and nursery annually.

Selecting A Solution

Selecting a solution for a problem that is occurring on another continent with an entirely different ecosystem can be challenging at best. The problems associated with resource depletion and environmental degradation are complex and will require an interdisciplinary approach. For this reason the alternative solutions listed below (Table 1) will all have to be integrated into design of the project to ensure the success of the project. Weights were assigned to each solution from a scale of one to ten based on how well each solution met the criteria. The weighted totals were taken into consideration for the final solution, however it was decided that all of the alternative solutions would be used.

Table 1: This table shows four alternative solutions selected for the Reforest Concepcion Tutuapa project along with criteria used to weight how well each solution will meet the needs of the project. The solutions were weighted on a scale of 1-10, 1 being low. The sum of each solution total is listed in the table.

AITERNATIVE SOLUTIONS	CRITERIA				WEIGHTED TOTAL
	Adoptability by villagers	Amount of time required until villagers see or receive benefits	Success of similar projects implemented in the past	Economic and temporal feasibility	
Develop a technique for more efficient fuel wood use.	3	8	8	9	**28**
Develop a curriculum that works to enhance behavior modification in terms of current over-utilization of resources.	7	4	5	5	**21**
Identify obstacles that keep the local villagers from adopting sustainable alternatives.	7	7	7	6	**27**
Develop an agroforestry system that will maintain or enhance environmental conditions of Concepcion Tutuapa.	5	2	8	2	**17**

To identify the best solution to the complex problem of resource degradation it is important to analyze the Pro's and Con's associated with objectives for the project. Three main objectives were focused on to complete the process required to develop a model that will be applicable to reforesting Guatemala. By combining the alternative solutions listed above with the appropriate implementation strategy below, an economically feasible and socially acceptable project will be obtained. Table 2 lists three main objectives, alternatives to each objective, and the pro's and con's of implementing each one

Table 2: This table shows three main objectives used to complete the design process of the Reforest Concepcion Tutuapa project. Alternatives are listed for each objective along with the pro's and con's associated with each alternative.

Objective 1: Conduct site analysis and rural appraisals.

Alternative A: Site analysis and rural appraisal done by graduate student(s).	
Pro's	Con's
More direct, personal involvement with villagers.	Long- term commitment may not be possible or desired.
Increased funding opportunity with school involvement.	Student(s) may not be able to speak the local language.
Project available for professional/ faculty evaluation.	May not have required expertise to facilitate project.

Alternative B: Hire a professional to do site analysis and rural appraisal.	
Pro's	Con's
More experience and expertise.	Less direct, personal involvement.
Someone may already be in the area.	More costly.
	Not a long-term involvement.

Objective 2: Obtain money to cover the costs of implementing the model.

Alternative A: Write grant to federal, state, and private investors.	
Pro's	Con's
More money available.	Need partnership.
Fundamental research completed.	Not getting funded.
Development of partnership.	

Alternative B: Benefit event to raise money through donation or ticket sales.	
Pro's	Con's
Good press and public relations.	Lack of expertise in development.
Educate the public about situation.	One- time event.
Community networking and involvement.	
Possible naitonal converage.	

Objective 3: Reduce the amount of fuel being extracted from local resources and provide alternative fuel sources.

Alternative A: Use of fuel-efficient stoves and local nursery for seedlings.	
Pro's	Con's
Develops local sustainability.	Possibility of nursery failure.
Local source of seedlings.	Cost of wages for workers.
Hands on experience in nursery operations for villagers.	Initial start- up cost high.
Increase health benefits from reduced smoke.	Cultural acceptance by villagers.
Decrease in fuel usage.	

Alternative B: Purchase seedlings and fuel from local source.	
Pro's	Con's
More land available for crops.	Long-term costs to community.
Continual supply.	Lack of local species adaptation.
Present traditional way.	Introduction of pest.
	No local sustainability.

Final Solution: "Reforest Concepcion Tutuapa"

Due to time constraints, the preliminary tasks for the Reforest Concepcion Tutuapa project are summarized in this report (see Appendix E for timeline and hours spent). The next steps toward completing the project will be done after funds are obtained. Funds will be obtained by holding benefit events and by submitting a grant. Using agroforestry principals, fast growing woody species and the regions main food crops will be planted. A nursery will be required that will supply tree seedlings to those interested in adopting the project. The nursery will also provide funds necessary to further the project. A graduate student(s) will conduct a thorough appraisal of the region and its people in order to identify the target population, the environmental conditions, and potential obstacles to the project's success. Agroforestry techniques used in the project will be combined with efforts to design an efficient wood-burning stove to be distributed in the surrounding villages with educational seminars on the practices of sustainable living.

Appraisal Methods

The first step in finding a solution to the overriding problems associated with reforesting Concepcion Tutuapa relies on obtaining the necessary ecological and social information about the region. To accomplish this, an appraisal system must be implemented which includes a descriptive rural appraisal that addresses the physical, economic, social, and cultural characteristics of the region. Approximating and accessing the economic, biological and socio-cultural benefits is important for feasibility of the project's future. Past economic research on agroforestry systems has been geared towards financial analysis of market revenues and costs (Szymanski and Colletti, 1999), but this perspective fails to put a value on environmental and social benefits attained.

Szymanski and Colletti (1999) point out that ascertaining the value of non-market goods for indigenous cultures and their land-use systems can be a problem using Euro-American standards due to the socio-cultural discrepancies in values for goods, services, and resources. The Euro-American standards stress financial success and individuality, whereas many Native American societies place a greater emphasis on spirituality and family.

This program should entail a combination of Rapid Rural Appraisal (RRA), Participatory Appraisal (PRA) and Farming Systems Appraisal (FSA). These terms are defined below. The focus of rural appraisals is to gain information and knowledge about the needs of the people being affected by the project.

Tony Dunn (1994) describes RRA as a tool to be used in teaching and researching agroforestry projects. The RRA methodology should be applied to formulate possible problems to be addressed during research and development, as well as to ensure the full participation of the farmers. Data to be collected should be qualitative based on insights rather than numbers. Dunn stresses that this method is not a "recipe where each step has to be precisely followed, but a refined set of principals which requires knowledge and skill to apply."

"PRA techniques can facilitate the use of indigenous knowledge as an integral part of a land-use decision process (Szymanski et al, 1998)." This method tries to link cultural and spiritual values with environmental values and economic needs, driven by the community-driven decision-making process.

FSA is set up to design systems for their farms, utilizing the knowledge gained from the previous techniques. Participants should be innovators, those who are willing to take a risk. The following steps should be followed (Hauxwell, 2002):

Rapid rural appraisal

This process should take two weeks to complete. It includes interviews with the maximum number of people possible. An effort should be made to speak the language of the farmers. This is an opportunity to get a hold on what the farmers are doing in terms of soil management, cleared land, tilling, tenure, as well as gender structure issues. Spatial data should be mapped, and data gathered from plots should be synthesized (Appendix A). Data should include: farmer's objectives, including the question why farm? An approximation should be made for staple foods, as well as where the cash income comes from. Gender issues that should be addressed include; roles played in decision-making processes, allocation of farmland, decisions of food crops and trees to plant, and time allocation.

Participatory Rural Appraisal

This step requires a greater degree of input from local people. The time frame should last 2-6 months, with ongoing research required. Brainstorming sessions are encouraged to determine what information is needed and how it should be obtained (Szymanski et al, 1998).

Recommendations from people should be sought to suggest what might be done differently, and what obstacles might prevent them from producing change. The objectives for PRA should be to evaluate the land needs and to gather specific information for the agroforestry system. This should be done by visiting the farms in the area and conducting surveys that rank problems in order of importance.

Farming Systems Appraisal

This involves giving the individual farmer a chance to develop their needs through the actions taken by the participants of the project. A ranked list of farmers' problems should be complied, with the idea that the list will change over time. This process also involves setting up and designing systems for their farms. Again, participants should be the innovators and those who are willing to take a certain amount of risk.

To evaluate the Concepcion Tutuapa project, decision matrices based on a ranking system will be used to put a value on non-market benefits. The decision matrix format (Appendix B) comes from the Szymanski and Colletti (1999) study that was applied to the Winnebago Tribe of Nebraska: "Economic, socio-cultural, environmental, and risk decision criteria are evaluated simultaneously through the use of a scaled Z-statistic and then compared by using four weighting schemes."

Implementation

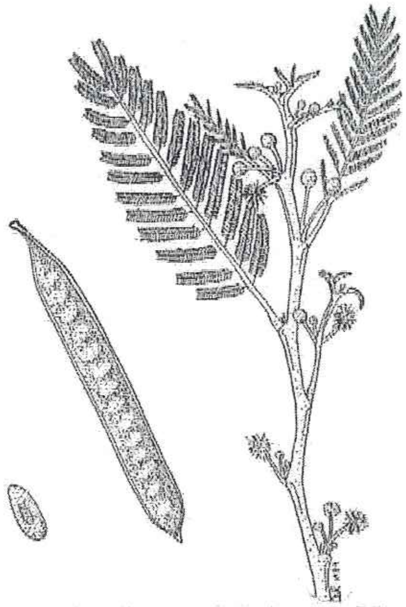
Nursery Design

Reforesting Concepcion Tutuapa requires a nursery that will provide a place to grow seedlings of several different varieties. The type of trees raised in the nursery will be multi-purpose trees that are used for more than one service or production function in an agroforestry system (Nair et al, 1993). The funding to build and maintain the nursery is included in the project. To minimize expenses of hauling materials, the building materials should come from a local source. A rainwater catchment system will be incorporated into the design, as the seedlings are to be placed in a greenhouse environment. The seedlings will be propagated using direct seeding ~~and~~ to run the nursery a local villager will be hired. This person will maintain the nursery and will be paid using funds from the project. By using local labor the project will provide a means to keep local influence incorporated into the project, and it will ensure that there is an incentive for the project to continue.

The primary multi-purpose trees to be grown in the nursery are *Leucaena diversifolia, Calliandra calothyrsus,* and *Tithonia diversifolia*. All of these trees are native to the region and have proved in trials to be beneficial in various ways. To ensure the longevity and health of the trees each one has to be properly inoculated with the rhizobium and mycohorrizae associated with that particular species. The appropriate microbial agents are typically available when obtaining the seeds (Appendix C).

Leucaena diversifolia

The genus *Leucaena* has been used in several agroforestry projects and has earned the reputation of the "miracle tree". This is due to the species ability to fix nitrogen as well as its rapid growth rates. "*Leucaena diversifolia* (Figure 1) is the second-best known species in the genus Leucaena. Through numerous international tree trials it has gained a reputation for aggressive growth at cool or high elevation sites where L. leucocephala performs poorly" (Bray and Sorensson 1992). It has multiple uses: fuelwood, posts, pulpwood, shade, reforestation, soil improvement, stabilization, pasture improvement, and forage. Juvenile growth rate is rapid if supplied with sufficient amounts of water. In some areas of the world *Leucaena diversifolia* is seeded as a cover crop.



Leucaena diversifolia ssp. *diversifolia* (Dr. Diane Ragone 1984). **Figure 1: Leucaena diversifolia**

Calliandra calothyrsus

"Calliandra is unusually promising as a firewood source because of its excellent coppicing ability and very quick growth" (Duke 1983). It is a shrubby species, growing up to 10 meters high. "Plantations are established by direct seeding or by seedlings, usually planted at the beginning of the wet season. Seedlings are transplanted from nurseries at about 4–6 months, spaced at 2m x 2m or 1m x 1m. Seeds are treated with hot water and then soaked in cold water for 24 hours. Because it grows so rapidly and densely, Calliandra supresses competing plants very quickly. There is little information on performance of this species on different sites. The plant is so hardy and reproduces so easily that it may become a weed of sorts, difficult to keep in check" (Duke 1983).

Tithonia diversifolia

Tithonia, also known as Mexican Sunflower, is a shrub species that is well adapted to many sites. The species is adapted to cycle large amounts of phosphorous through its leaves. It is an efficient forager for phosphorous in the soil, that is typically an element fixed in an unusable form in the soil. It is native to the region with a moderate resistance to drought, preferring 1000-2000 mm of rain annually (Hauxwell, 2002). Concepcion Tutuapa receives approximately 1200 mm of rain per year, making the Mexican Sunflower an ideal species for the region.

Agroforestry Plot Design

The plot design encompasses a number of variables that are difficult to predict, being so distant from the actual area of implementation. The final plot design may change dramatically upon arrival in Concepcion Tutuapa and with conditions found during the appraisal of both the plot and the village. For the purpose of demonstrating the agroforestry model, a number of assumptions have been made in order to show how the plot design and appraisal actually works.

A plot size of one hectare (10000 m^2) is assumed, which is similar to plot sizes found in villages surrounding the Concepcion region (Clark, 2002). Some additional assumptions are as follows: the land is predominately flat, with marginal soils, south facing aspect, and moderate drainage. From the cultural appraisal it was speculated that the main food crops grown by the village are corn, beans, and squash. These will be the crops that are grown on the plot.

Prior to planting the site the soil will be prepared using methods and tools identical to those used by the local farmers. The soil will be tilled, but no other additions, such as chemical fertilizers will be added. Because of the assumption of a flat plot, no terracing is required for this example, but is highly recommended on sites with substantial slopes (15-30%) to avoid erosion problems.

The planting schematic for the plot is broken into two sections (Appendix F). The first section will be the tree/crop section, and the second is the shrub/crop section. The tree/crop section will be planted with Leucaena seedlings and native corn species. The spacing for

Leucaena seedlings will be 3 meters, with a 5-meter separation from the corn alleys. The reasoning for planting these two together is that as the trees and corn grow the competition for sunlight will force the tree seedlings to increase their height. This strategy will work for the first 3-5 years of planting, but eventually the trees will dominate the area. This will cause a shift to a more shade-tolerant species for under-story planting.

One concern that must be addressed deals with the repercussions of forcing the seedlings to grow quickly. The possibility of wind damage to the seedlings once the corn is harvested is possible because of the changes in the microclimate of the forested area. With the presence of corn, the wind will travel differently through the plot compared to when the corn is removed. A solution for this problem would be to construct a windbreak. By planting the perimeter seedlings in closer proximity to each other on the windward side, the wind velocity entering the plot will be altered.

In the shrub/crop section the planting of Calliandra or Tithonia will be intermittent with beans and squash. Beans and squash make good growing partners because of the different areas they use to grow. Posts will be installed in order to train the beans to grow up in order to keep the ground open for the squash. The Calliandra or Tithonia seedlings will have 2 m spacing between each seedling, and a 5 m space between adjacent crop rows. The reason for the smaller spacing for the shrub seedlings compared to the Leucaena seedlings is that the shrubs will be harvested at a higher rate, thereby lowering the amount of competition between adjacent shrubs.

During the time that the site is productive, attention will need to be directed to the removal of any weedy species that may invade and compete with the planted species. This is essential since most weeds, once established, can outgrow planted species and compete for valuable nutrients in the soil. In addition, the farmers must look for signs of infestation from insect pests that can harm both crops and tree/shrubs.

Fava seedlings will be used to serve a dual purpose: as ground cover to avoid erosion problems, and as a winter crop capable of being harvested. Winter growing species are important to incorporate into crop rotations. These winter species are used to ensure that soil fertility is retained for the next growing season and they also help to reduce soil erosion. Prior to harvesting the summer crops the fava bean seedlings need to be ready to transplant. Throughout the site fava beans will be planted after the summer harvest.

During the summer harvest the crops will be removed from the site with the remaining biomass being reintroduced to the soil through direct mulching. A direct mulching process is used to minimize artificial inputs, as well as to return nutrients stored in the plant litter to the soil.

During years 1-3, the planting scheme will not change. The introduction of the shade-tolerant species is required in the tree/crop section once the tree component begins to shade the crops. Options for under-story crops should be determined from the list of species composed during the appraisal. In deciding which species to plant, attention should be paid to species that can produce a marketable product and is of importance to the community.

As the forest matures additional options may arise, such as fungi, which do better in established forests. Products like fungi are considered non-timber forest products and offer another source of income to the village. The best manner in which to educate the local farmers about this model is by demonstrating the principles of agroforestry using a plot inside the village. Putting sustainable techniques to use on a plot within the village allows interested parties to see first hand the methods used.

Hiring assistants from the village starts the educational process. Consultation from those experienced in the techniques can aid farmers attempting to adopt the model. Collaborating experienced workers with farmers will help to ensure future adoptability and continuation of the agroforestry principles used. Through successful collaboration, adoption of these techniques will become less of a game of chance for the individual family, and more of an investment in the future.

Fuel Efficient Stoves

The previous sections have been devoted to achieving reforestation of lands surrounding Concepcion Tutuapa. Planting trees in this area is only one aspect of the project. In order to achieve the greatest benefit from the reforestation efforts it is imperative to analyze how the wood is being used once it is harvested. In general, harvested wood falls into two use categories, construction and cooking/heating. Of the two, cooking/heating is the one with the greatest impacts on the success of the reforestation project due to continual demands for fuel.

Wood is the main source of fuel for cooking/ heating for much of the third world where alternatives such as fossil fuels or solar cookers are either too costly to construct or are not practical. In many households a fire is lit in the morning and maintained all day to cook and/or to heat the house. The stoves being used are based on a traditional model. The traditional design consists of three stones set in a circle with the cooking pot placed directly on the stones, or hung above it. This design suffers from poor fuel efficiency (estimated around 4- 7%, with an experienced user reaching ~11%) that results in heavy smoke production, the byproduct of incomplete combustion (Aprovecho, ND). In addition, a significant amount of heat that could have gone to cooking is lost to the atmosphere requiring more fuel to be used. In order to reduce the amount of fuel needed it is necessary to redesign the instrument used to burn the fuel: the stove.

There are two models that have been proven to be successful at reducing the amount of fuel consumed, while still meeting the needs of the cooks. The first is the "Rocket Stove" and the second is the "Estufa Justa." Both stoves are designed to increase fuel efficiency by concentrating more heat directly on the cooking surface, and reducing the amount of smoke produced though the combustion process by preheating entering air. The difference between the two designs is in the construction of the stove itself.

The "Rocket Stove" (Figure 2) is designed to concentrate the heat produced by the fuel directly to the surface of the pot, thereby decreasing the time needed to cook, which in turn reduces the amount of fuel required. Smoke production is reduced because the fuel is completely combusted (Aprovecho, ND).

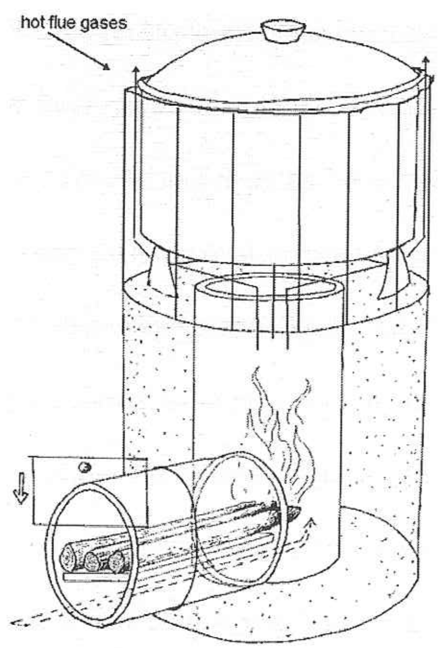


Figure 2: The Rocket Stove

The stove is constructed of three parts. The first is the section that contains the actual burning material, the elbow. The elbow is made up of the chimney (recommended length ~9 inches) and the fuel magazine (recommended length ~4 inches). This design allows only part of the fuel burning to be in contact with the flames, at the same time, preheating the remaining fuel in the elbow. Air enters the stove from beneath the fuel, allowing it to be preheated before reaching the flame too.

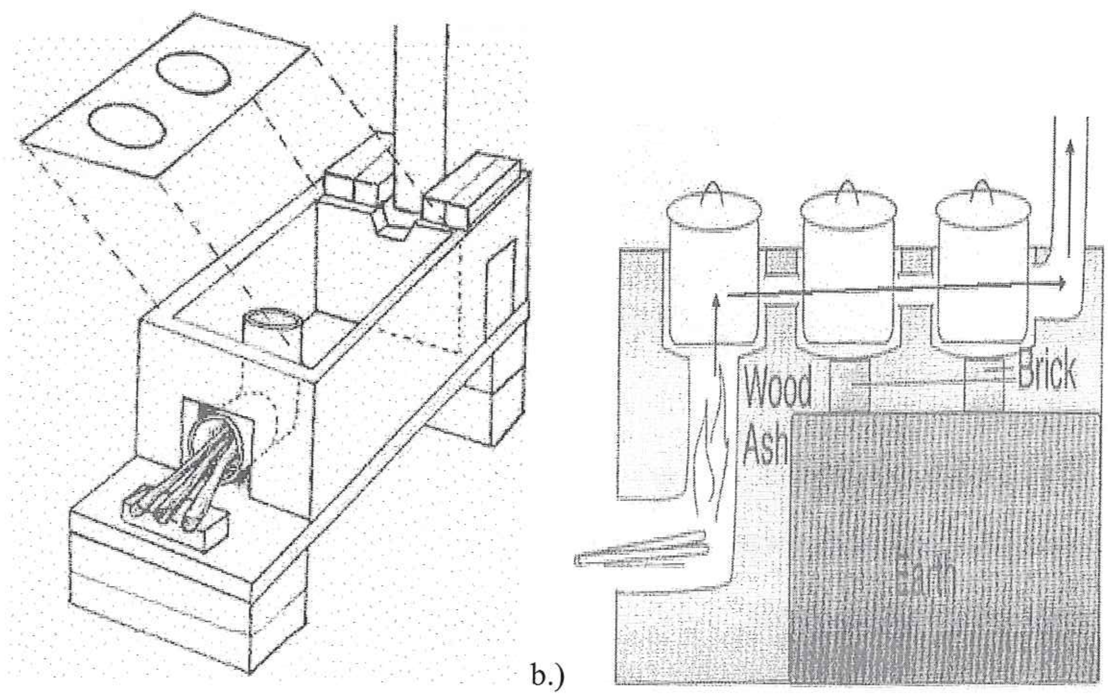
The second part of the stove is the insulating material surrounding the elbow. The elbow is placed inside a larger container and the space filled with an insulator. Good insulators are materials that allow for air spaces, such as wood ash. Air spaces take less energy to heat up than a solid insulator such as soil, which absorbs heat that should go to cooking (Aprovecho, ND).

The final part of the stove is the flume surrounding the cooking container. The purpose of the flume is to direct more of the heat produced by the flame to the cooking surface. According to Aprovecho (ND), the rocket stove has an efficiency of 12- 42% depending on the heat exchanger used. The elbows have been constructed out of a variety of material including clay/sand, steel pipes, or ceramics. Tin can and 5 gallon buckets have been used as the containers for the elbow. The average cost of construction of these stoves for Aprovecho was between $0- $20 American dollars, depending on material used and availability.

The "Estufa Justa" (Figure 3) is similar conceptually to the "Rocket Stove" but on a larger scale. The "Estufa Justa," design is to be built as part of the home, and therefore is less mobile than the "Rocket Stove". This design is more adapted to cooks who require more than one cooking pot on the flame at once. The chimney is incorporated into the stoves design as a method to pull the hot air passed the pots and out of the house.

The important features of the "Estufa Justa" stove design are the sunken pots and the insulated barrier between the stove and the earth that increases the efficiency. By cutting holes in the top of the stove surface for the pots, more of the cooking surface is in contact with the heat as it passes out of the stove. This is similar to the concept of the flume on the "Rocket Stove." When one of the openings is not being used or if it is needed as a griddle, the opening on the range top can be closed off, keeping the efficiency level high.

Figure 3 shows how the "Estufa Justa" is designed. Picture a.) shows the entire stove design. Raising the stove will eliminate any heat lost to the ground. Picture b.) describes the range top construction.



a.) b.)

Figure 3: The "Estufa Justa" Stove

The range is designed to limit the amount of space the heat must travel through in order to reach the pots. The space labeled "earth" in picture b.) is soil placed into the stove to take up space and support the cooking containers. The area labeled "wood ash" is similar to the container surrounding the elbow of the "Rocket Stove" and serves the same purpose.

As with the "Rocket Stove" the insulation between the section carrying the hot gases and the surrounding medium is extremely important to the efficiency of the "Estufa Justa". By insulating the space with material such as wood ash more of the heat produced by the flame goes to cooking rather than heating up the stove itself. Aprovecho (ND) stated that the "Estufa Justa" has at least twice the efficiency of the three stone fire ring design under testing conditions (see test protocol). The average cost of materials was around $25- $35 US, with the greatest cost accruing from the griddle cover.

Both of the stoves mentioned are great improvements over the traditional three stone fire ring and must be included in this plan. By providing more efficient stoves, the benefits gained from the reforestation efforts will be greatly increased, thereby allowing more of the trees planted to mature, instead of being harvested for cooking fuel. Below are the results of a test run by Aprovecho, that measured the efficiency of the two stoves mentioned above against the traditional three stone fire ring.

Test Protocol:

Use two pounds of dry wood. Fill pots 2/3 full, in this case each held 5 pounds of water. Assume that two pounds of dry wood contains 17,200 Btu's. Measure the effect of the burning by measuring both sensible and latent heat. Latent heat is measured by weighing water after the test and assuming it takes 1005 Btu's to evaporate a pound of water. The percentages shown below are the percent of total Btu's released from the wood that warmed and boiled the water in the pot(s).

Table 3: Stove Test Results done by Approvecho (ND) for three different models that shows stove efficiency for each model:

Three stone fire 1 pot	11%
Rocket stove	13%
Rocket Stove /Partial skirt	23%
Rocket stove full skirt	36%
Estufa Justa 1 pot	5%
Estufa Justa 3 pots	16%
Estufa 5 pots	20%

Construction, Education, and Dissemination:

To achieve the greatest benefits from the Reforest Concepcion Tutuapa project, it would be optimal for every household to be equipped with one of the two stove designs. In order to accomplish this an on-site "factory" must be constructed. Presently the people of Guatemala have the knowledge to produce mud bricks. With a little manipulation this technology can be used to construct the parts for the stoves. Using a cylinder mold, the elbows for both stoves could be constructed in a short time. Fill materials can be acquired from households by collecting ashes and saving them.

Determining what type of stove would suit each household best can be decided during the household appraisal or during subsequent interviews. It is very important that the cook is involved in the decision making in order to ease dissemination and ensure that the stove is practical.

A side-by-side comparison demonstration is the best way to educate the people about the advantages of the models over the three-stone ring stove. The test protocol provided above is a simple method to demonstrate the stove's performance. Allowing the people to test the stoves for themselves will help breakdown their inhibitions to accepting this new technology.

Monitoring and Evaluation

Evaluation of the reforestation project will be performed annually following the guidelines listed below.

1.) Site and Nursery Evaluation: Environmental conditions of the site will be measured initially for baseline data and then annually to measure the effects of the project implementation on the site. Baseline data and the evaluations will be done using survey forms found in Appendix A. Some of the conditions that will be measured include fertility, nutrient, and microbe content of the soil; erosion rates; crop yields and productivity; standing volume of crops and trees; nodulation; and an analysis of interspecific competition occurring. For a comparison, these measurements will be taken from neighboring plots that do not use similar techniques described in this project.

2.) Evaluate Farmer's Adoptability to the Project: Consultations with the farmer's will be done to address possible problems with the model and possible changes that need to be made.

3.) Evaluate Household Acceptabilty and Effects of Fuel Efficient Stoves: Using baseline data to compare how much wood households were using before the stoves per day and after the stoves were installed per day a quantifiable figure can be placed on the success of the stoves. An additional analysis will be conducted that compares fuel used by households with and without the fuel-efficient stoves. This will result in a deeper understanding of the effects of the new stoves on the community's fuel consumption. Through interviews with the household members any health benefits will be recorded including any problems or changes with the stoves.

4.) Evaluate Fund Allocations: The project will be evaluated also on how well funds obtained are being spent and if any changes to the budget is necessary. A record of how funds were spent will be kept to submit to the funders for additional funds to keep the project going.

5.) Evaluate the appraisal methods used during surveying: Conclusions made from the RRA, PRA and FSA will be evaluated based on how well they represent farmer's social, cultural, and economic requirements using follow-up interviews. Observing the farmer's will also help to decide whether the predictions made from the appraisals are actually occurring and embodying the farmer's day-to-day lives.

Final Thoughts

Attempting to change the way people use the land and resources can be an exigent endeavor. Subsistence farmers in Guatemala and all over the world are faced with a grave decision that can consist of two choices. The two choices they are faced with are; whether to continue farming in their traditional manner that has devastated their environment but has produced a livelihood for their families; or to choose a new method that has not passed the test of time. Traditional methods of farming cannot continue to meet the needs of the people into the future. "It is estimated that about 14 million hectares of tropical forest have been lost each year since 1980 as a result of changes in land use from forest to agriculture" (Salim and Ullsten, 1999). In many places without the input of artificial fertilizers the soil cannot grow food for the people. The Reforest Concepcion Tutuapa model is just one solution that can produce a number of benefits to those who are willing to break from tradition. Many times tradition is something worth holding onto, but just as with slavery and woman's suffrage, not every tradition is sustainable for civilization.

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Appendix A

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SOIL DESCRIPTION

Soil Type ______ Field Symbol ______ Photo No. ______ File No. ______

Area ______ Date ______ Stop No. ______

Location ______

Classification ______ Climate P. ______ T. ______ J. ______ J. ______

N. Veg. or Crop ______

Parent Material ______ Physiography ______

Relief ______ Slope ______ Aspect ______ Elevation ______

Drainage ______ Permeability ______ Runoff ______ Erosion ______

Moisture ______ Gr. Water ______ Salt or Alk. ______ Stoniness ______

Horizon	Depth	Color (including mottles)		Texture	Structure	Consistence			Roots	Pores	Clay films	pH & CO_3	Other features	Boundary
		Dry	Moist			Dry	Moist	Wet						

by ______

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Appendix B

Agroforestry Systems **44**: 227–239, 1999.

Combining the socio-economic-cultural implications of community owned agroforestry: The Winnebago Tribe of Nebraska

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Key words: decision matrices, Native American, nonmarket values, Participatory Rural Appraisal, social forestry

Abstract. Agroforestry systems usually are examined for their biological components and somewhat for economic feasibility but rarely for their sociocultural merits. A relatively young agroforestry system was examined in view of sociocultural, biological, and economic factors through the use of decision matrices. Decision criteria were used to evaluate an agroforestry system against two alternative landuse options, a corn-soybean rotation and renting the land to an agricultural producer. Economic, sociocultural, environmental, and risk criteria were considered simultaneously with a scaled *Z*-statistic and then compared by using four weighting schemes. When all criteria were weighted equally, the agroforestry system had the greatest *Z*-score (3.4), indicating the better alternative. Placing weights on economic criteria resulted with renting the land being the best alternative (*Z*-score 6.6). When sociocultural factors were weighted alone, or when greater weights were placed on sociocultural factors along with moderate weights on economic and risk factors, or when community weighted objectives were used, the introduced agroforestry system had the greatest *Z*-scores (11.5, 6.3, and 1.1, respectively). Use of weighted decision criteria allowed for sensitivity analysis between alternatives to be explored. This is especially important when using techniques that have a greater emphasis on economic parameters that are not equally important or appropriate cross-culturally. Use of decision matrices provides a more comprehensive method for comparing the multiple, interactive, and long-term benefits of the agroforestry system and competing land uses.

Introduction

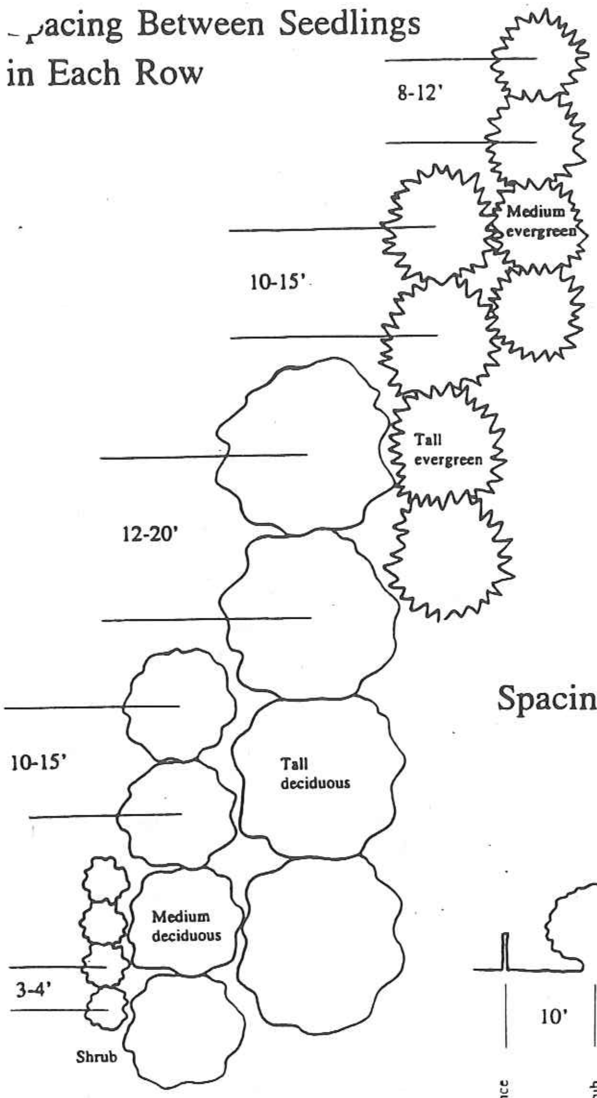
Valuation of agroforestry projects beyond bio-physical and economic inputs and outputs is required because of the flow of nonmarket conservation and ecosystem benefits expected from sustainable agricultural and agroforestry systems. Past economic research on agroforestry systems has focused mainly the on financial analysis of market revenues and costs (Campbell and Lottes, 1989; Swinkels et al., 1994) and somewhat on issues of risk and equity (Arnold, 1983). Price (1995) indicated that existing techniques used in forestry for valuing nonmarket effects also might be applied to agroforestry systems with possible corresponding and quantifiable values for sustainability. Environmental (nonmarket) goods such as existence values and soil improvement have been valued by using direct approaches that assign values for goods through a theoretical market (Contingent Valuation Method) or by using a value of a substitution good (numeriare) (Van Kooten, 1995; Winpenny, 1991).

How Far Apart Do I Plant?

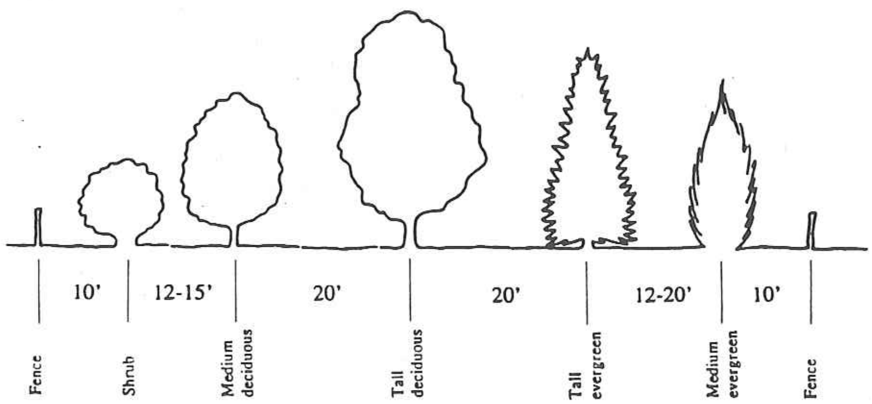
Adequate growing space assures a longer, more useful life for your windbreak. The recommended spacings look quite large when planting small seedlings, but the trees will grow rapidly to fill the areas (see figures to left and below for recommended spacings between rows, and between seedlings within the row).

Use wider spacings in areas with lower precipitation. Row spacing should be at least 4 feet wider than cultivation equipment. Tall deciduous trees should be at least 20 feet from shrubs and evergreen trees. Use close spacings in the windward row and in windbreaks with only two rows. Wider spacings will work better in the interior and lee rows of multi-row windbreaks.

Spacing Between Seedlings in Each Row



Spacing Between Rows



How Many Trees Do I Order?

For windbreaks and wildlife winter cover areas, divide the length of each row by the in-row spacing to calculate how many seedlings you'll need per row. For Christmas tree or timber planting, use the general guidelines shown to the right. Remember, the drier the site, the wider the spacing.

	Spacing in feet	Trees per acre
Christmas trees	5 x 5	1,742
	6 x 6	1,210
Timber	9 x 9	538
	10 x 10	436
	12 x 12	303

Problems arise in valuing nonmarket goods for indigenous cultures and their landuse systems by using Euro-American methods because of socio-cultural differences in values for goods, services, and resources (Adamowicz et al., 1994). Adamowicz et al. (1994), while cautioning about over-general-izations, point out that many indigenous people consider land as a means to sustain human society with the environment as an extension of themselves. What is viewed by Euro-American culture as 'indifference to land ownership' is in fact a difference in values. The predominant value of sharing among indigenous peoples results in an indifference to the accumulation of individual wealth and property. Smith (1994) indicated that the cultural aspects of a society define individual preference structures. Euro-American society empha-sizes individuality and financial success, whereas many Native American societies place emphasis on family and spiritual harmony (Smith, 1994). Additionally, problems occur in assigning nonmarket values for objects, practices, or places that have sacred or revered values, but have no monetary or substitution goods (Adamowicz et al., 1994). These defining elements make it difficult for the assignment of price valuation for natural resources and landuse decisions based on Euro-American constructs.

Techniques used in evaluation of agroforestry projects need to account for differences in economics and environmental issues and show how these may be combined to fit a particular culture. Incorporation of sociocultural values into an economic analysis requires recognition of the struggle between cultural integrity and economic development that exists among many Native American tribes (Smith, 1994). This means inclusion of benefits such as traditions, heritage, language, identity, and opportunities to practice culture. Additionally, there have been increasing ethical concerns about the need to recognizing indigenous technical knowledge and systems within the context of agroforestry development (Walker et al., 1995). To date, agroforestry systems have not been evaluated using sociocultural values. As an additional approach to considering nonmarket sociocultural factors and valuing indigenous knowl-edge, a decision matrix was used to examine an introduced agroforestry system on tribal lands of the Winnebago Tribe of Nebraska. A decision matrix allows for the summation of effects of mutually exclusive landuse alternatives measured with differing scales.

Sinden and Worrell (1979) gave a comprehensive treatment of using decision matrices for the incorporation and evaluation of unpriced values in project alternatives. He discussed the use of rankings to evaluate the effect of nonmarket benefits on project selection decisions. Canham (1990) further outlined the use of decision matrices for incorporating multiple environmental benefits into landuse projects. An extension to the use of decision criteria for natural resource project evaluation is the inclusion of sociocultural values associated with landuse.

The objective is to introduce the merit of incorporating sociocultural values in decision matrices and the use of decision matrices within the decision-making process for agroforestry projects with the assumption of individual

sociocultural values differing between communities. Economic, sociocultural, environmental, and risk decision criteria are evaluated simultaneously through the use of a scaled Z-statistic and then compared by using four weighting schemes. A general model containing the four decision criteria categories for evaluating agroforestry systems and other landuse systems on a holistic level is presented.

Materials and methods

Project site and design

The agroforestry system is located on 22.0 ha of tribally-owned bottomland near the Missouri River. The area was rented to a non-indian farmer until 1995 for a total yearly cash rent of $4125. Its landuse was a corn-soybean rotation. In 1994, a windbreak was planted in mixed shrubs (*Prunus* spp.), cotton-wood (*Populus* spp.), and Scots pine (*Pinus sylvestris* L.) on 1.0 ha of the site. In 1995, this planting and an additional 1.0 ha in the area were placed under the Conservation Reserve Program, which paid $220/ha over the a 10-year period. The remaining 20.0 ha was developed as an agroforestry demonstra-tion system consisting of an intercropping system with both temporal and spatial components. Started in the spring of 1995, 20 hectares of black walnut (*Juglans nigra* L.) are being planted at a 3.4 m × 20.0 m spacing over a 3-year period. Intercropped within the black walnut will be sweet clover (*Melilotus officinalis* Lam.), flint or Indian corn (*Zea mays* L.), and soybeans (*Glycine max* L. Merr.). In the fall of 1995 (first year), 20.0 ha was planted in clover. In the second year, 16.0 ha was left in clover, with flint corn interplanted within 2.8 ha of black walnut. For subsequent years until crown closure begins at age 15, the land will be intercropped in a rotation between the rows of black walnut. For purposes of this analysis, it is assumed that 18.4 ha will be cropped equally in a three-crop rotation of flint corn, soybeans, and clover. The Winnebago tribe is growing the black walnut for nut production, veneer, and wildlife habitat. Nut production is expected to begin in year 15 and continue until year 76 with selective harvests beginning in year 50. Another tribal objective for the agroforestry system is soil improvement and reduced use of agrochemicals. In 1995, the tribe banned all agrochemicals for the entire site. Although the area is in an agroforestry system, in this paper, it is compared with two alternatives: a rotation of field corn and soybeans and cash rent.

Decision matrices

The analysis considers four main categories of decision criteria: economic, sociocultural, environmental, and risk linked directly to tribal objectives for the demonstration (Table 1). To allow comparisons of alternatives, each

Table 1. Agroforestry demonstration objectives and their relationship to decision criteria chosen, Winnebago, Nebraska.

Agroforestry demonstration objectives	Decision criteria
To protect and aid in the further development of the natural resources of the tribe: wildlife and resource management purposes	Environmental/cultural
To involve the tribe as an owner-tenant	Risk
To integrate educational and employment opportunities for youth of the Winnebago Tribe	Cultural/economic
To remove the use of agricultural chemicals in the demonstration site: to eliminate surface and ground water contamination	Environmental
To have agricultural sites available to provide economic opportunities for tribal members	Economic

criterion was scaled or standardized by the construction of a Z-score (Canham, 1990; Rule et al., 1995) that facilitates a common measure across all decision criteria. A Z-score was calculated by using the following formula:

$$Z = (x_i - x_m)/S_x$$

where
x_i = individual decision criterion raw values for a particular alternative;
x_m = mean of all raw values for a given decision criterion;
S_x = standard deviation of the data for a given decision criterion.

Plums (*Prunus* spp.) produced in the windbreak planting are included in the benefits and costs of the agroforestry system and the corn-soybean rotation. Due to concerns about pesticide drift and use with the corn-soybean alternative and the land rent alternative, two wild food components (raspberries (*Rubus* spp.) and milkweed (*Asclepias syriaca* L.), eaten as food by Winnebagoes,) were included as secondary products only in the calculation for the agroforestry system.

Two economic decision criteria are considered: annual equivalent value (AEV) and benefit-cost ratio (B/C). Quick-Silver (Version 2.0 P.C., USDA Forest Service Southeastern Center for Economic Resources, Research Triangle Park, NC) is used to calculate AEV and B/C at a 6% real annual rate of return. Annual equivalent value is calculated to provide investment return for each system on an annual basis. A benefit-cost ratio is calculated as well because market and non-market values are included in the alternatives. Values for agroforestry products are based on 1995 prices paid in the Winnebago community. Because of differences in inputs and outputs, especially for labor-intensive crops such as flint corn, inputs and outputs are separated by species components for each of the three cropping systems. The evaluation assumes a common investment period of 76 years with landuse benefits changing over time for each individual alternative. The spatial dynamics of the agroforestry intercropping system are incorporated into the model by reducing areas under cultivation during the life cycle for black walnut. A total of 20.0 ha is considered available for cropping in year 1, 18.4 ha in year 2, 14.0 ha in years 11–14, and 13.2 ha in year 15.

Sociocultural factors are dependent on both a larger cultural context and the dynamics of a particular community. To obtain specific sociocultural factors for the Winnebago agroforestry system, information was obtained using Participatory Rural Appraisal methods (Messerschmidt, 1991; Scoones and McCracken, 1989). In 1996, a Participatory Rural Appraisal (informal surveys, focus groups, mapping, and preference matrices) took place over a $2^1/_2$ month period in Winnebago (Szymanski et al., 1998). Based on an informal questionnaire representing approximately one fourth to one fifth of the Winnebago community (69% were Winnebago Tribal members, 24% other tribes, and 7% were non-Indian; men (41%) and women (59%)) and secondary information, three types of sociocultural factors are considered: cultural, spiritual, and opportunities to teach youth. Measures for individual sociocultural factors are based on preference matrices obtained after the informal survey. The preference matrices were obtained during thirty informal interviews with the Winnebago Tribal Council and community members on main crop components (flint corn, soybeans, seed corn, clover, black walnut) and secondary crop components (berries, plums, milkweed). An assumption is made of the general representation of preference rankings for the Winnebago tribal values by the tribal council due to their status as elected decision makers within the tribe with preferences between individual tribal members and council members differing little in value. Each person ranked crop components on a scale of 1 (least value) to 10 (greatest value) separately for three types of criteria: cultural, spiritual, and opportunities to teach youth. Final values for each criterion are obtained by calculating an average value for each crop component, summing across crop components for each landuse, and then dividing by the number of crops in each system.

There are three environmental decision criteria: wildlife habitat index, soil impact, and pesticide risk. A wildlife habitat index is calculated as a function of food and cover made available by each cropping system by using the US Department of the Interior (DOI) Handbook for Habitat Evaluation Procedures for forest game, specifically white-tailed deer (*Odocoileus virginianus* Zimmermann) and wild turkey (*Meleagris gallopavo* L.) (US DOI, 1977). A soil impact index is measured by using a relative scale for bulk density and organic matter as a function of each cropping component in a given system and soil type. Bulk density is rated on a scale from one (most potential to reduce organic matter) to five (least). Organic matter is rated on a scale from one to five with one having the greatest negative effect on the amount of organic matter and five the lowest negative effect on soil organic matter. Because each crop type has different impacts on the soil, each scale is multiplied by the number of hectares in a crop type to obtain a weighted total. Final scores per alternative are divided by the total number of hectares. Pesticide risk is indicated as either a zero (no risk) or negative one (risk).

In this study, risk is a measure of the complexity associated with each land-use system. Two components are used to measure risk: the number of primary crops and the number of people involved annually for a given system. Risk increases as the number of primary crops and people involved increase, respectively. For accounting purposes, a –1.0 is multiplied with the risk measure for each alternative.

Four sets of weights are applied to the decision criteria to reflect the importance of criteria groups. Weight set one values economic criteria heavily and other criteria minimally. Weight set two values sociocultural criteria heavily. Weight set three values sociocultural criteria heavily and places a moderate emphasis on risk management and economic variables. Weight set four values sociocultural, environmental, and economic criteria based on project objectives. The weight for decision criteria is equal to the number of times decision criteria correspond to a project objective.

Results

Decision criteria

AEV and the maximum B/C ratio (18.3:1) indicate that the best alternative is renting the land (Table 2). The agroforestry system has the lowest B/C ratio. Over time most costs in the agroforestry system occur early in the project cycle, whereas benefits accrue much later, thus decreasing the B/C ratio (Figure 1). Preference rankings for sociocultural data shows that flint corn ranks highest (Table 3). Inclusion of flint corn as a primary cropping component in the agroforestry intercropping system heavily influences the final higher ranking this system receives for socioeconomic decision criteria (Table 2). The least risky alternative is renting the land (Table 2).

Decision matrices results

For the three alternatives considered, the agroforestry system provides the highest scaled Z-score (Table 2). When economic criteria are considered the primary or sole tribal concern, economic rent of the 22.0-ha area is the best choice. Scaled Z-scores for sociocultural decision criteria are positive for the agroforestry system and the corn-soybean alternatives. For the environmental decision criteria, only the agroforestry system has positive Z scores indicating positive environmental benefits (Table 2).

When economic criteria are weighted heavily, weight set 1 (see Table 4), rent of the land is best. When sociocultural criteria alone are weighted heavily (weight set 2) or when heavy emphasis is placed on sociocultural criteria with

Table 2. Decision matrix with raw values for each land use system and their corresponding standardized Z-score. Units shown under each decision criterion apply only to raw values, Winnebago, Nebraska.

Decision criteria	Raw values			Z scores		
	Agroforestry intercropping	Past cropping system		Agroforestry intercropping	Past cropping system	
		Corn-soybean rotation	Land rent		Corn-soybean rotation	Land rent
Economic (dollar per hectare)						
Annual equivalent value	–$41	$28	$175	–0.86	–0.24	1.1
Benefit-cost ratio	0.96	1.05	18.3	–0.58	–0.57	1.16
Socio-cultural (ranked scale 1–10)[a]						
Cultural importance	5.0	3.0	0.0	0.93	0.13	–1.06
Spiritual importance	2.6	1.3	0.0	1.00	0.00	–1.00
Opportunities to teach youth	3.7	3.0	0.0	0.74	0.39	–1.13
Environmental						
Wildlife habitat (HEP index)[b]	5.8	3.5	1.5	1.02	–0.05	–0.98
Soil impact (scale 1 to 5)[c]	4.9	3.3	1.7	1.15	–0.58	–0.58
Pesticide risk (0 or –1)[d]	0	–1	–1	1.14	–0.59	–0.59
Risk						
Complexity of management	–13	–2	–1	–1.14	0.43	0.71
Total Z score				3.41	–1.08	–2.37

[a] Values were obtained by calculating the average socio-cultural value for each crop component, summing across crop components for each land use, and then dividing by the number of crops in each system.
[b] Habitat Evaluation Procedures: US Fish and Wildlife Service Resource Pub. 132.
[c] One denotes lowest impact and five the greatest impact.
[d] Negative one denotes negative impacts.

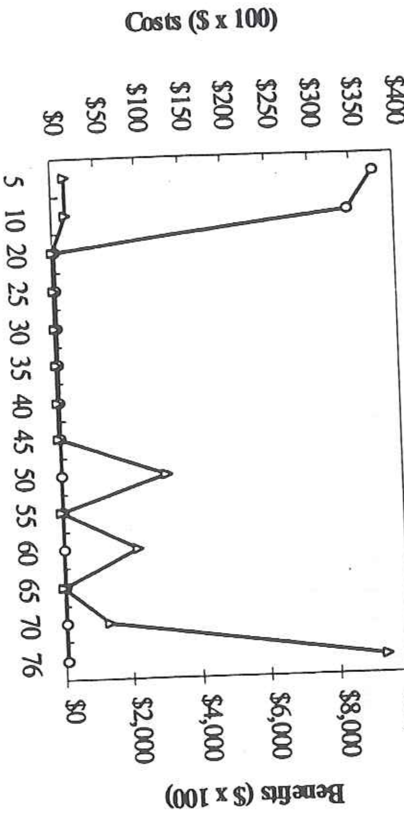


Figure 1. Trade-offs between costs (O) and benefits (Δ) over the 76-year project cycle for the agroforestry demonstration system, Winnebago, Nebraska.

economic and risk criteria weighted moderately (weight 3) the agroforestry system is best (Table 4). When weights are added corresponding to their importance in project objectives (weight set 4) the agroforestry system is best (Table 4).

Discussion

Consideration of nonmarket values is especially important in agroforestry systems because of their long project cycle. Due to differences in value systems between indigenous people and Euro-American cultures, problems can exist in using purely economic criteria with agroforestry projects. Decision matrices can be used to examine sociocultural aspects of system components that can influence project acceptance and ranking. Weighting of decision criteria will influence the best alternative by producing a greater overall Z-score for groups of criteria which have positive Z-score values. In this study, when decision criteria are weighted by using participant-generated objectives, the agroforestry system is the best alternative.

Market failure occurs with nonmarket goods because they have no price indicators. Contingent Valuation Methods usually are used to indicate environmental externalities or as a way to measure value for nonmarket goods. However, products have cultural values that also can be considered an externality affecting the social value of a good. Adamowicz et al. (1994) conclude that if aboriginal societies hold more values in the sacred realm than Euro-American societies, and taboo and revered resources remain external to

Table 3. Averaged rankings for socio-cultural values for primary and secondary cropping components for agroforestry intercopping and a rotation of corn and soybeans. Individual crop components were ranked by 30 Winnebago community members on a scale from 1 (lowest) to 10 (highest), Winnebago, Nebraska.

Crop component	Agroforestry intercropping system			Corn-soybean rotation		
	Cultural importance	Spiritual importance	Opportunities to teach youth	Cultural importance	Spiritual importance	Opportunities to teach youth
Flint corn	10	7	6	–	–	–
Black walnut	5	2	4	–	–	–
Soybeans	2	1	2	2	1	2
Clover	2	1	2	2	1	2
Secondary products	16	7	12	5	2	4
Berries[a]	4	2	3	5	2	4
Mixed shrubs	5	2	4	–	–	–
Milkweed	7	3	5	–	–	–
Totals	35	18	26	9	4	8

[a] Berries and milkweed were not considered as a secondary products in the corn-soybean rotation due to use of agrochemicals in immediate cropping area where secondary products grow.

Table 4. Weighted Z-scores for three land use systems with varying weights for decision criteria, Winnebago, Nebraska.

Criterion	Weight set 1	Weights × Z scores			Weight set 2	Weights × Z scores			Weight set 3	Weights × Z scores			Weight set 4	Weights × Z scores		
		AF[a]	C/S[b]	Rent[c]		AF	C/S	Rent		AF	C/S	Rent		AF	C/S	Rent
Economic	10								10				2			
AEV[d]	5	−4.31	−1.18	5.49	1	−0.86	−0.24	1.10	5	−4.31	−1.18	5.49	1	−0.86	−0.24	1.10
B/C[e]	5	−2.91	−2.87	5.78	1	−0.58	−0.57	1.16	5	−2.91	−2.87	5.78	1	−0.58	−0.57	1.16
Sociocultural													2			
Cultural	1	0.93	0.13	−1.06	6	5.56	0.79	−6.37	12	11.16	1.56	−12.72	0.67	0.62	0.09	−0.71
Spiritual	1	1.00	0.00	−1.00	3	3.00	0.00	−3.00	6	6.00	0.00	−6.00	0.67	0.67	0.00	−0.67
Opportunities to teach youth	1	0.74	0.39	−1.13	3	2.24	1.18	−3.40	6	4.44	2.34	−6.78	0.67	0.50	0.26	−0.75
Environmental													2			
Wildlife habitat	1	1.02	−0.05	−0.98	1	1.02	−0.05	−0.97	1	1.02	−0.04	−0.97	0.67	0.68	−0.03	−0.65
Soil impact	1	1.15	−0.58	−0.58	1	1.15	−0.58	−0.58	1	1.15	−0.58	−0.58	0.67	0.76	−0.39	−0.38
Pesticide risk	1	1.14	−0.59	−0.59	1	1.14	−0.59	−0.59	1	1.14	−0.59	−0.59	0.67	0.76	−0.39	−0.39
Risk	1	−1.14	0.43	0.71	1	−1.14	0.43	0.71	10	−11.42	4.29	7.14	1	−1.14	0.43	0.71
Total Z score		−2.37	−4.32	6.64		11.53	0.37	−11.95		6.27	2.92	−9.24		1.14	−0.84	−0.58

Weight set 1 places greater emphasis on economic return; weight set 2 places greater emphasis on socio-economic criteria; weight set 3 places greater emphasis on socio-cultural criteria and moderate emphasis on economic criteria and risk; and weight set 4 places weight in accordance to their importance in project objectives: sociocultural, economic, and environmental criteria were given a weight of 2 and a weight of 1 on risk.

[a] Agroforestry intercropping.
[b] Rotation of corn and soybeans.
[c] Rent of the land.
[d] Annual equivalent value.
[e] Benefit/cost ratio.

valuations, then nonmarket values will be underrepresented relative to Eu. American values. For example, for the Winnebagoes, flint/Indian corn is an important product in the agroforestry system, not just because of its economic value, but rather for its strong cultural and spiritual importance. Decision matrices allow these nonmarket values for a good to be considered.

For each alternative, the flow of products and corresponding benefits and costs occurs over time. Comparing the flow of benefits and costs between an agroforestry system in the 76-year project cycle and an annual corn-soybean rotation requires adjustment of preset values to an annualized basis by using AEV on a per acre basis. The woody component of the agroforestry system incurs most of its costs early in the cycle, whereas benefits occur much later (Figure 1). The later-obtained benefits and earlier costs adjusted through AEV diminish the economic returns from the agroforestry system. Returns are similar for nonmarket benefits of agroforestry systems that accrue through time, whereas systems, such as a corn-soybean rotation have negative non-market benefits that accrue over time (Nair, 1993). Exclusion of non-market benefits diminishes the real time effect of these benefits.

Decision matrices allow for sensitivity analysis to be conducted between alternatives and also allow examination of the trade-off effects nonmarket values have on an individual project. Ranking of alternatives differs according to weights chosen. By using objectives to determine criteria weights, the decision criteria are linked to the decision-making process. If the objectives for a project are equal in importance and only one decision criterion affects each objective, then use of equal weights for the four main criteria would be the best method to evaluate the three systems of landuse. However, some of the objectives are affected by multiple decision criteria. Weight set four places emphasis on criteria in relation to project objectives. For the Winnebagoes, sociocultural factors were linked with agroforestry components and environmental benefits so that emphasis placed on these components yielded greater Z-scores for the agroforestry system relative to the other landuse alternatives. If the model is examined without sociocultural factors with equal project weights, the agroforestry system and cash rent of the land yield equal Z-scores (0.73 and 0.72, respectively). This reflects the offsetting trade-offs of the two components of landuse: the greater environmental benefits from the agroforestry system with greater management risks due to complexity and the negative environmental benefits with the less risky cash rent of the land. When the project is examined without sociocultural factors but with weights added based on economic, risk, or project objectives, weights 1, 3, and 4, the best alternative is rent of the land. This reflects on the under-estimation of project benefits that occurs when socio-factors are not included.

Decision matrix models complement the usual purely economic evaluation performed for projects and allow for the examination of results and trade-offs. Incorporating sociocultural values into project evaluation allows for greater understanding of the decision-making process. The wider implications being inclusion of sociocultural values will allow for more realistic decision-making and evaluation of agroforestry projects connecting the benefits with beneficiaries. One of the major assumptions made when evaluating agroforestry systems is the evaluating 'yardstick' is the same regardless of culture. Under valuation of sociocultural factors devaluates the possible connection introduced agroforestry systems will have at the local level. This does not mean that project evaluation should be done solely on the basis of decision matrices, but rather that, decision matrices provide a methodology for incorporating into project evaluation those values not usually captured by economic evaluation. This is particularly important when using techniques that place a greater emphasis on a particular value system that cannot be cross-culturally translated. Use of decision matrices offers a more comprehensive method for comparing and combining the multiple, long-term benefits of agroforestry systems with other systems of landuse, especially when indigenous cultures with a differing value system are being considered.

Acknowledgements

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Appendix C

[home | services | trees | tree seed | training]

AgroForester Tropical Seeds

Seed Data and Prices

Selection Notes
Special selections noted. See Page 3 for further details. Seed lot data available on all seed.

Inoculant Group
Gives our rhizobia strain group. See also Rhizobium Inoculants.

Pregermination Treatment
Pregermination treatments are marked as follows:
N = Nick,
H(#) = Hot water (# of minutes),
S = Soak in water overnight.

Number of Seeds Per Kilo
Number of seeds per kilo data are provided as a general guide only. Actual numbers vary greatly depending on seed lot. Number of trees produced per kilo depends on germination and nursery or field conditions.

Price Information
Prices are in U.S. dollars FOB Holualoa, Hawaii. The price per kilo applies to quantities 500 gm or more, the price per 100 gm applies to quantities of 100 gm or more.

Ordering and Conditions of Sale

SPECIES NAME	Selection notes	Inoc. Group	Pregerm. treatment	# seeds per kilo	US$ 25 gm	US$ 100 gm	US$ 1 kg	US$/kg 5-20 kg	US$/kg 20+ kg
Acacia angustissima		K	N, H(1)	90000	$6.50	$17.60	$120.00	$110.00	$100.00
Acacia auriculiformis		C	N, H(1)	90000	$5.30	$13.70	$90.00	$80.00	$70.00
Acacia auriculiformis	select provs	C	N, H(1)	90000	request	request	request	request	request
Acacia confusa		-	N, H(1)	30000	$6.50	$17.60	$120.00	$110.00	$100.00
Acacia koa	routine collection	C	N, H(1)	8000	$35.00	$120.00	$1000.00	request	request
Acacia koa	forestry selections	C	N, H(1)	8000	request	request	request	request	request
Acacia mangium		A	N, H(0.5)	80000	$7.60	$21.50	$150.00	$135.00	$120.00
Acacia mangium	select provs	A	N, H(0.5)	80000	request	request	request	request	request

Acrocarpus fraxinifolius		none	N, H(2)	20000	$7.60	$21.50	$150.00	$135.00	$120.00
Albizia lebbeck		H	N, H(2)	10000	$6.50	$17.60	$120.00	$110.00	$100.00
Albizia saman		H	N, H(2)	6000	$6.50	$17.60	$120.00	$110.00	$100.00
Cajanus cajan		I	none	7000	$3.50	$6.00	$40.00	$36.00	$32.00
Cajanus cajan	agroforestry	I	none	7000	$4.30	$11.00	$75.00	$67.50	$60.00
Calliandra calothyrsus		G	N, H(1)	18000	$6.50	$17.60	$120.00	$110.00	$100.00
Desmodium rensonii		I	none	200000	$6.50	$17.60	$120.00	$110.00	$100.00
Enterolobium cyclocarpum		H	N	1000	$5.30	$13.70	$90.00	$80.00	$70.00
Erythrina berteroana		H	S	4000	$6.50	$17.60	$120.00	$110.00	$100.00
Erythrina poeppigiana		H	S	3000	$6.50	$17.60	$120.00	$110.00	$100.00
Flemingia macrophylla		H	H(1)	50000	$4.30	$11.00	$75.00	$67.50	$60.00
Gliricidia sepium	Retalhuleu	G	none	7000	$7.60	$21.50	$150.00	$135.00	$120.00
Gliricidia sepium	Other provs	G	none	7000	request	request	request	request	request
Leucaena diversifolia		G	N, H(2)	30000	$4.30	$11.00	$75.00	$67.50	$60.00
Leucaena diversifolia	K156	G	N, H(2)	30000	$6.50	$17.60	$120.00	$110.00	$100.00
Leucaena diversifolia	K784	G	N, H(2)	30000	$7.60	$21.50	$150.00	$135.00	$120.00
Leucaena hybrid	KX2	G	N, H(2)	15000	$17.50	$45.00	$350.00	$315.00	$280.00
Leucaena hybrid	LXL	G	N, H(2)	15000	$17.50	$45.00	$350.00	$315.00	$280.00
Leucaena leucocephala	K636	G	N, H(2)	15000	$5.30	$13.70	$90.00	$80.00	$70.00
Paraserianthes falcataria		H	N, H(2)	40000	$6.50	$17.60	$120.00	$110.00	$100.00
Pithecellobium dulce		G	N, H(2)	12000	$6.50	$17.60	$120.00	$110.00	$100.00
Sesbania grandiflora		E	N, S	20000	$6.50	$17.60	$120.00	$110.00	$100.00
Sesbania sesban	var sesban	E	N, H(1)	60000	$5.30	$13.70	$90.00	$80.00	$70.00
Sesbania sesban	var nubica	E	N, H(1)	80000	$6.50	$17.60	$120.00	$110.00	$100.00
Sesbania sesban	Mt. Cotton	E	N, H(1)	80000	$9.70	$26.50	$200.00	$180.00	$160.00
Sesbania sesban	AgFor select	E	N, H(1)	80000	$10/5 gm	$150.00	-	-	-

Appendix D

Possible Contact Organizations and Interested Parties:

FUNDAP (foundation for integrated development through socioeconomic programs) web mail address: fundap@guate.net. FUNDAP is located in Quetzltenango, Guatemala and Roberto Guitierez is the founder-chair. FUNDAP has a program called PRODAM which focuses on productive management, utilization and restoration of wood, water and soil resources. The direct contact for PRODAM is Efrain Monterroso at web mail address: prodamxela@yahoo.com.

AGROS at agros.org and Skip Li is the founder.

Ann Sloper at aslope@televar.com Global Partnerships

Cynthia Poten, grantwriter at web mail address: cepoten@pil.net

Dick Hansis at Humboldt State University, Arcata, California 95521.

Possible Funding Opportunities:

Agency for International Development

CARE

Danita Foundation(from Denmark)

Ford Foundation

Hellen Keller Foundation

Peace Corp

Appendix E

Tasks	4/15-4/21	4/22-4/28	4/49-5/5	5/6-5/12	5/13-5/17
1. Maintain Contacts	all	all	all	all	all
2. Provide background for past success/failure projects		Jenn			
3. Design format for a site analysis/plot design		Matt Jenn	Matt Jenn		
4. Design format for appraisals	Matt	Matt			
5. Determine list of species to be used for fuel alternatives, food, ect.		all			
6. Determine stoves to be used at site	Jason				
7. Design nursery plan and include materials needed		all	all		
8. Determine grant possibilities for project and write grant	Jason	Jason	Jason		

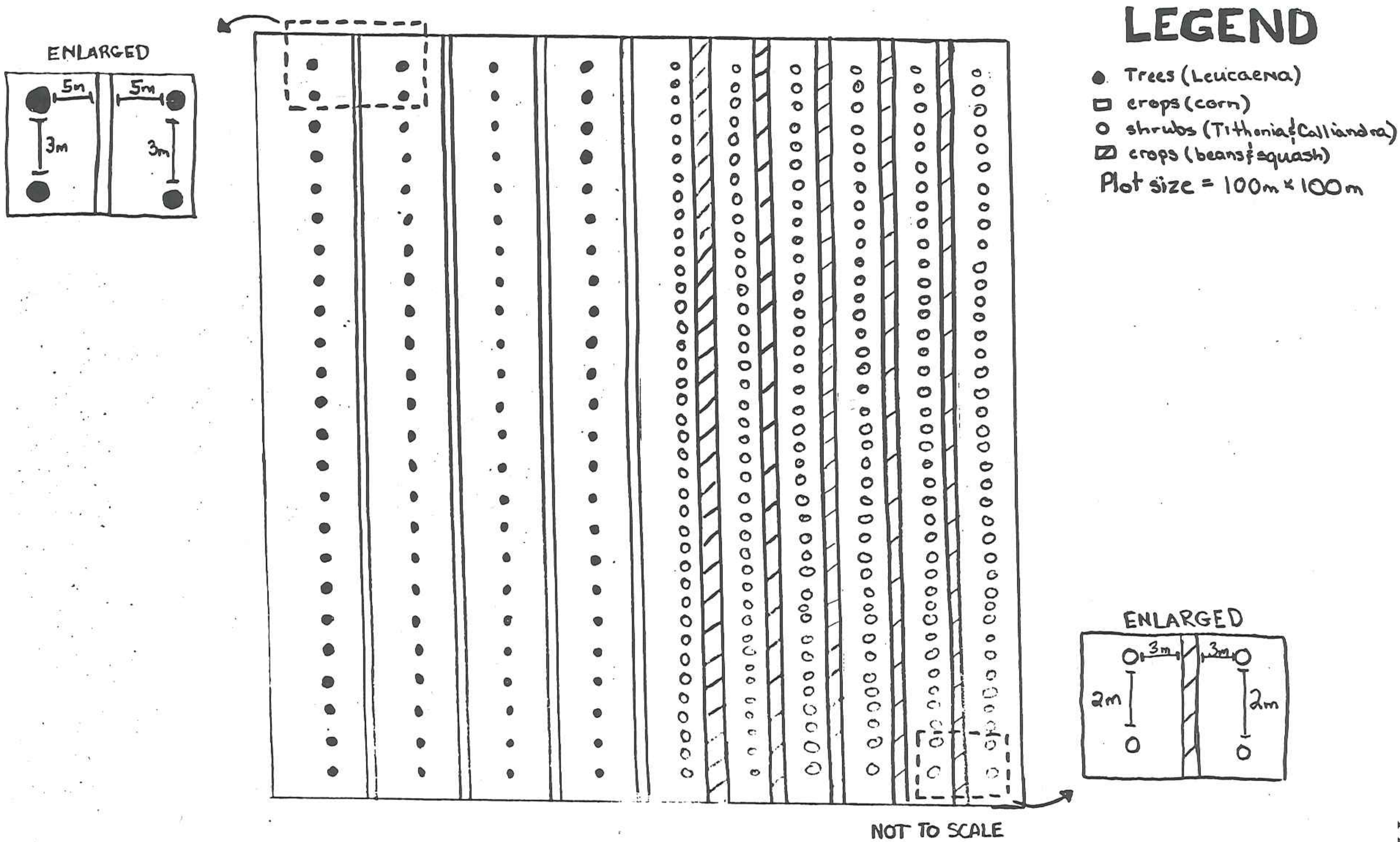
Hours spent on project and tasks assigned:

Jason Ball: Spent approximately 62 hours on project. Tasks included historical and political background, plot design, implementation timeline, stove research, and final paper.

Jennifer Cole: Spent approximately 63.5 hours on project. Tasks included economic background, Problem Statement, Monitoring and Evaluation, and final paper.

Matt Lider: Spent approximately 62.5 hours on project. Tasks included agroforestry data, environmental conditions, final paper, implementation timeline, and appraisal methods.

Appendix F



Plot Layout

Diagram of planting design for the Reforest Concepcion Tutuapa agroforestry plot.