ECUADOR

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NEED A WATER FILTRATION SECTION IN GREEN VOLUNTEER HOUSE SECTION

EXECUTIVE SUMMARY

In the summer of 2005, five students and one professor within Tufts Chapter of Engineers Without Borders (EWB) traveled to Ecuador to conduct an assessment trip for future work in the area. In collaboration with Federacion Brethren y Unida (FBU), the travel team was able to explore FBU's hacienda in Picalqui in Tabacundo and the remote town of Cristal in Intag. While there, they conducted health, education, and economic surveys, tested water for bacteria, made measurements on the volunteer house, initiated the building of a biogas unit, and developed a relationship with the non governmental organization (NGO). This trip was made with the intent to learn everything needed to return to Ecuador with new implementation ideas.

FBU is an NGO involved in agro-ecological research, environmental education, international volunteerism and community outreach. They host school groups from Quito as well as other organizations to teach and disseminate their research in agro ecology; EWB's audience for the Green Building would be to those groups. In addition, FBU is in contact with many community leaders and through international grants they have helped some of those communities develop small businesses, cultivate natural forests, and implement biogas systems.

While down there, the group helped install a biogas unit so as to learn this technology from an organization that has implemented it a number of times. The unit converts animal waste to methane gas and nitrogen rich biol, fertilizer, using an anaerobic process. The gas is then piped to a cooking stove and the biol is used on crops. This cycle is a prime example of the sustainable development FBU and EWB strive to accomplish.

The Ecuadorians FBU work with generally live an agricultural lifestyle in remote communities in the mountains. They make little money but live largely off the land they cultivate. Contaminated water is the commonly recognized source for ailments; diarrhea and upset stomachs are a normal occurrence. Education is minimal and the school systems are inconsistent. Also, gender roles are well defined in Ecuador, although there are a number of women's groups created to give women a more active role in society.

With FBU, EWB has decided to transform the volunteer house on the Hacienda Picalqui into an example of green building design. This renovation will be an educational example for the many school groups that stay at the hacienda and a testing site for the feasibility of our designs in the climate and culture of Ecuador. Primary design ideas include rainwater collection, water filtration, passive water heating, natural lighting, and incorporation of the biogas unit.

In future years, we hope to extend those designs which are successful on the hacienda. FBU has contacts in numerous communities in the mountainous regions of Ecuador that we could work with; next year's implementation trip would include more site assessment in a specific community.

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DEFINITIONS

Biodiesel	A fuel derived from animal fats, plant oils, or restaurant grease.
Distillation	A purification process where liquids are evaporated then condensed and collected.
Greenhouse Gas	An atmospheric gas that contributes to the greenhouse effect, or the warming of the planet by atmospheric gases.
Life-cycle Assessment	A process used to evaluate the environmental impacts of a process, product, or activity across its entire life span. The life span of a product, process or activity includes extraction and processing of raw materials, manufacturing, distribution, use, re-use, maintenance, recycling, and disposal.
Methyl Ester Process	The process used to convert fats and oils to glycerin and methyl ester (biodiesel). The process is also known as base catalyzed transestrification.

LIST OF INITIALISMS AND ANACHRONISMS

FBU	Fundaction Brethren y Unida
NGO	Non Governmental Organization
CEA	Coordinadora Ecuador de Agro-ecologia
MAELA	Movemiento Agro-ecologico Latino America

INNFA

1.0 INTRODUCTION

Our purpose in traveling to Ecuador in June 2006 was to establish a relationship with Fundación Brethren y Unida (FBU) as well as to assess the possibilities of implementing a green building design for future trips. During our stay at the Hacienda Picalqui, FBU's headquarters we helpe FBU to install a biogas unit. We also visited Intag, a county that FBU works in where we made observations in El Cristal and Apuela so that we could better understand the needs of the people. For the green building we took the dimensions of the house that we plan to remodel. We also mapped out the structural make-up and water supply systems at Hacienda. We also tested water quality at the Hacienda and in the community we visited. We visited an elementary school in Picalqui to better understand their curriculum with the hope of eventually working our project into it.

This report serves to inform readers of our trip, both in its purposes and what we learned. We will discuss the structure of FBU, the biogas unit, regional backgrounds, Intag, water, the volunteer house, and out goals and recommendations for the future.

2.0 FUNDACION BRETHREN Y UNIDA

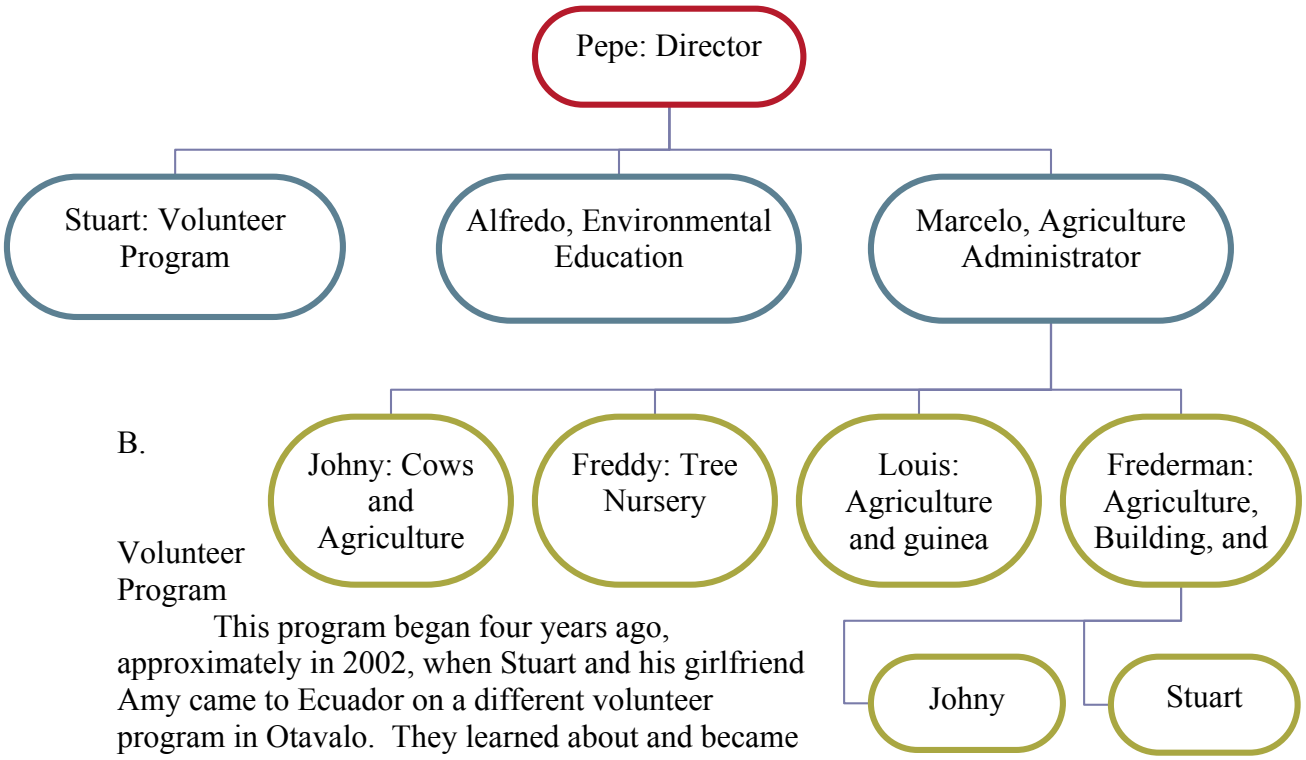
A. Overview

In Ecuador, we worked with an NGO named FBU. They were founded about 100 years ago by Catholic missionaries, although they are no longer religiously affiliated. **FBU is committed to promotion of agro-ecology, sustainable agriculture, environmentally friendly sustainable development, and environmental education. (go find their mission statement instead?)**

The central location of FBU is at the Hacienda Picalqui, which is 1 ½ - 2 hours north of Quito on the PanAmerican Highway, and a few miles south of the town of Tabacundo. The farm is about 20 hectars now, which does not qualify it as a hacienda, rather as a **lafinca or granja**, but the name stuck. They also have an office in Quito, and connections in the Intag, Columbe, and Pedro Moncayo regions.

FBU is run by a director named Pepe Rivadeniera. He comes about once a month and is not paid for his position; instead he is just passionate about the mission of FBU and runs the program voluntarily. Pepe is also a busy man. He works on the grassroots level with FBU, the national level as the director of Coordinadora Ecuador de Agroecologia (CEA), and on the international level with Movemiento Agroecologico Latino America (MAELA).

FBU has four main work areas: international volunteerism, environmental education, agricultural research, and community outreach. While a lot of the organization of FBU is cooperative and mixed, the structure, as we understood it, is shown below.



B.

Volunteer Program

This program began four years ago, approximately in 2002, when Stuart and his girlfriend Amy came to Ecuador on a different volunteer program in Otavalo. They learned about and became interested in FBU from a friend who's cousin was working on the hacienda. FBU wanted a program for volunteers designed by volunteers, so Stuart made a proposal and was hired.

The volunteer program is very flexible. Volunteers are Spanish speakers who come from all over the world to help FBU in any aspect they'd like. They can be general helpers, or have a focus in areas such as education, veterinarianism, agriculture, sustainable development, or anything else that FBU is involved with. They used to come for a week or so, but more recently they have been coming for about a month each. The money they pay goes to their food and lodging, to pay Stuart, and to FBU as an organization. **Percentages?**

On average, a volunteer begins with a week long orientation at the hacienda with Stuart. They live in the volunteer house and eat with either Stuart or one of the families on the hacienda. While getting an introduction to FBU and the organization's acitivities, the volunteer will also provide manual labor for various projects like the tree nurseries, whuertas (vegetable beds), compost pile, biogas unit, etc. Then, if the stay is a month or more, most volunteers will do a homestay with a family in one of FBU's partner communities: Pedro Moncayo, Intag, or Columbe. The homestay is done so both the volunteer and the local family can learn about each other's cultures. Also, the volunteer brings some knowledge of FBU's research and practices to the family and communities they stay with.

FBU also has a credit program with University of Vermont, Burlington. The students who came took Spanish classes, did community work, and had specific reading lists related to fields they were interested in. For example, the students who came focused on sustainable development, education, and ecology. This program is very flexible, however, and could be investigated at Tufts.

We know four volunteers, and a brief description of their volunteer experience is listed below:

1. Heidi Hauenstein, the Tufts EWB Ecuador Head in 2006 from Colorado, was 20 when she volunteered for 1 month in 2004 with FBU. She completed orientation at the hacienda for one week where she helped out with the tree nursery. Then, she did a 3 week homestay with a family in Barcelona, Intag, where she helped the women of the family with daily chores.
2. Ronan, a 26 yr old from London, volunteered for three months in the spring of 2006. He did a 1 month homestay with another family in Intag. Then, he left to try another volunteer program in South America, found it was a scam involving a school principle hoarding money and building cheap schools for children, then came back to the Hacienda Picalqui to continue help there. At the hacienda, he volunteers at the school in Picalqui which is down the road where he works with the three 7th graders at the school. In the afternoons, he helps Stuart and Frederman tend to the whuerta behind the stable.
3. Helen, 19, and Louise, 23, are sisters from New York City. They were recommended to volunteer at FBU by Nikki, a member of the Tufts EWB group. They stayed at the hacienda for about a week and worked in the school in Picalqui with various age groups. In the afternoons, they helped us work on the biogas unit. They have been eating with Esperanza and her family and staying with us, but soon they will move to live with a family closer to the school. They will continue working at the school and helping out at the hacienda in the afternoons until they leave in early July.

C. Agricultural Research

Marcelo is the director of the hacienda, and deals largely with agricultural research and the basic farm operations that make money to employ the workers like Freddy, Johny, Frederman and Louis.

The Hacienda Picalqui is an organic farm that operates on and does research for the principles of agro-ecology. Rather than using chemicals, they use natural ecological systems to solve farm problems. On our tours, we learned about a number of ecological systems used on Carlos's farm in Intag and the Hacienda Picalqui. These systems help provide shade, protection from cows and other animals, insect repellants, protection from soil erosion on steep slopes, wind shelter, direction for vine plants, and nitrogen fixation in soil. A few examples of these sustainable systems are listed below:

1. At Carlos's farm, the sugar cane they plant is more than just a case crop; it has five uses on the farm. It is planted in sections below other crops to prevent soil runoff on the steep Andean slopes. It is tall, providing shade and wind protection for the shorter plants it surrounds. The top part of the plant feeds animals on the farm, while the bottom part is processed through a heating and molding system to be sold as sugar. Finally, the seeds from the plant can be used to start the next crop.
2. Pigs in a biogas system have three uses on a farm. First, they provide meat when they are slaughtered. Second, their waste makes gas for cooking and heating. Finally, the boil from the biogas system makes excellent fertilizer, which can be used to complete the system and feed the pigs. (See the Biogas section for more information.)
3. In vegetable gardens at the hacienda and certain parts of Carlos's farm, multiple crops are planted together in one plot of land rather than separately. For example, five different species could be found in one square meter of land. This is an attempt to simulate nature's intrinsic variety. As a result, all sorts of natural relationships occur

at once. Also, fewer insects are attracted to the area because there is no single plant type in abundance. A large crop of one species serves as a breeding ground for the one type of insect that likes that crop and plant diversity eliminates that problem.

4. Elevated beds, which are mounds of dirt in rows, are used in some areas for multiple reasons. First, in replanting, so the soil does not need to be overturned. Instead, the elevated bed is opened slightly and seeds are dropped in. This way, micro ecological systems can develop in the top 10 cm of the soil and eventually produce beneficial bacteria. Also, the soil is loose, so water can seep down to the roots easily. Finally, elevated beds are good for temperamental soil that needs lots of fertilizer because they are above ground and easily accessible.
5. Often, corn and beans will grow next to each other in a symbiotic relationship. The corn provides direction for the climbing beans while the leguminous beans fix nitrogen into the soil for the corn.

These systems are based on the principle that the most effective systems are found in nature. They take a lot of start up money and patience, however, because the ecological balances take time to grow and evolve correctly. It is often difficult for local farmers to start these practices because their food and money depends on every season's crop being economically fruitful. Organic farming often will produce a few bad crops before sustainable systems can evolve. As a result, many farmers will resort to using harmful chemicals to ensure the safety of their crops.

Another large component of the agricultural system at the Hacienda Picalqui is the tree farming. FBU has a number of semilleros, or seed source centers. For example, we saw a second-generation forest on the path from Carlo's house to Cristal in Intag. FBU finds or plants forests of native tree species, then cuts down the undesirable trees, depending on the future use of the tree. The remaining good trees will cross-pollinate to produce a genetically stronger batch of seeds, and the process is continued. FBU harvests the good seeds and maintains a tree nursery where they grow baby trees to sell. They also have a native forest where buyers can see what their baby trees will look like in the future years, and to serve as a seed source for the nurseries.

Many tree nurseries in the area sell strong, resilient exotic species, such as eucalyptus, Cyprus and pine. These species, however, are damaging to the soil because they use too much water for this area and they kill off neighboring plants. Most buyers like these species because they are quick and easy to grow, and they provide excellent sources of lumber. FBU sells these exotic trees simply to attract buyers, then proceeds to advertise and educate the buyers about native alternatives. In this way, more people will hopefully understand and desire native forests.

D. Environmental Education

Alfredo runs environmental education programs at hacienda. FBU hopes to expand these programs and use them as the main source of income for the foundation. There are many different ways they make money off of teaching people their agro-ecological practices: receiving school groups from Quito for the day, hosting other groups for longer periods of time, and running summer camps at the hacienda.

We saw three school groups while we were here, all from middle to high-income schools in Quito. They get tours of the hacienda and are taught about the agro-ecology and other environmentally friendly practices that FBU supports. Usually, they will plant some trees or vegetables in the pseudo-garden behind the main building. Those plant beds are not maintained,

and are assumed to be only a learning center because the kids manhandle the plants too much to produce a fruitful crop anyway.

Large groups varying in size and purpose will also come stay at the hacienda for longer periods and stay in the main building or above Stuart's house. They usually do more of the same stuff the daily groups do.

In addition, the hacienda hosts kids' camps in the summer. FBU hires part time counselors to teach games, outdoor skills, arts and crafts, etc. just like an average camp in the states.

Recently Alfredo has been contacted by a number of groups that he never advertised to. Word of mouth is increasing FBU's popularity such that about 600 people are scheduled to come this summer. This is good news for FBU because it will help them spread their ideas and make money to improve the hacienda, conduct more research, and help the communities they work with.

E. Community Based Projects

FBU has influence in three main areas: Intag, Columbe, and Pedro Moncayo. These are counties in Ecuador, and FBU has contacts in various communities within these counties. For example, Cristal, Pucara, Barcelona, and Apuela are in Intag, while Tabacundo, Cayambe, and Picalqui are in Pedro Moncayo. Their biggest presence, however, is in Intag.

The foundation usually applies for international grants to fund their community projects. They help the communities with things such as installing biogas units, teaching about agro-ecology, helping farmers initiate those systems, running workshops to help with small business initiatives, and maintaining native forests and seed sources. Usually when FBU comes into a community with a new project, the locals are skeptical. However, once the project proves useful and economically beneficial, Ecuadorian jealousy drives everyone to want to have one.

We visited Intag and saw some of FBU's initiatives in practice there. They installed some biogas units, and had a native tree source near Cristal where they buy the seeds from the community that owns the forest. Also, FBU helped Carlos, in cooperation with other families in Intag, start a small sugar making business. We are unsure whether FBU provided start-up capital, but they do run workshops on how to choose a name and how to manage the business. For more information about FBU's work in Intag, see the Intag section.

F. Financial Situation

FBU makes money through a number of sources, but still lacks the financial and time resources to improve and advance their organization the way they'd like to. The workers, such as Marcelo, Frederman, etc. view working at the hacienda as simply a job, and their incomes come directly from the agriculture on the farm. They sell crops, milk, pig meat, etc. to pay for that. Money comes from the tree nursery and volunteer programs as well. The main source of income for the foundation, however, is from the environmental education programs. For projects, they apply for grants, although they only had one project this year. They welcome any help they can get so they can initiate more projects.

G. Future Possible Projects

When discussing the future of EWB's relationship with FBU, we jointly came up with a number of options for projects. If we return next year, we have committed to improving the volunteer house using green building technology. (For more details on the possibilities there, see

the Volunteer House section.) Listed below, however, are possible paths for years to come. Some are more feasible, practical, and useful than others, so keep in mind that this is a brainstorming list.

1. Confedec is a Catholic organization that provides school buildings for rural areas in the Jungle. They are working with 21 schools in 35 communities. Alfredo is working with them, so we could apply some of our designs to their school buildings.
2. FBU recently got money from a German organization called GTZ to start a 5-year program in Paramo and Zuleta, two communities on the other side of Otavalo, where they will help design the infrastructure of the communities from scratch. When they make more secure contacts with those communities, we may be able to help that project.
3. FBU would like to create an interpretation center where all of the educational aspects of FBU's agro-ecology and our green building techniques can be presented in an organized manner to incoming school children and other groups.
4. Cristal has no water treatment system, and health surveys make us think it would be greatly appreciated to have one. Improving the quality of their water is a possible project.
5. Cristal is also planning on constructing a new community center for group meetings and/or as a classroom. We could help by installing rainwater collection and filtration systems (or whatever green technology we think is appropriate) on that building.
6. FBU would like to improve their compost heap. Currently it is in one location, but it has no aeration system and no roof to protect it from the rain.
7. They would also like to install a greenhouse chicken coop at some point. In this symbiotic relationship, the chicken waste can be used as fertilizer for the plants; the plants can feed the chickens, and both the chickens and the plants like the warmth from the greenhouse roof.
8. **school education?**
9. FBU is always looking for agriculture design ideas. Watering systems were suggested to us because it would link with our engineering backgrounds, but if we have connections to other groups or programs that have agro-ecological ideas, we could help the two parties work together.

Together, FBU and EWB would like to work together to benefit each other. FBU always needs financial help and hacienda improvements, while EWB requires an educational component for its student members. Both organizations, however, are committed to helping the people of Ecuador improve their living standards in an environmentally friendly way. Together, we hope to achieve these goals in the years to come.

H. Financial Cooperation

The following are ideas that have been presented as joint fundraising ideas for our project.

1. The women's groups in Intag are incredible artisans who sell products such as bags woven from cabuya in the cloud forest and hand made soap. Stuart has given us a cd with product descriptions, so we can order some products and have them shipped to us in the states. EWB can sell them at booths in the campus center to make a profit

dedicated to the Ecuador project. That way, almost all of the money goes to the Ecuadorian people.
2. EWB can also advertise FBU's volunteer program at the study abroad office or other schools. A percentage of the volunteers we get could possibly go towards our project, although details would need to be worked out with Stuart.
3. FBU and EWB can jointly apply for grants. With cooperation from each other, receiving these grants is more likely.

2.? Animals

The Hacienda Picalqui is a working farm with many animals. During our trip there were six female cows, and one male cow was born. Three of the cows were mature enough to be used for milking. One of the milking cows was pregnant and expected to give birth in July 2006. The cows are milked twice a day, once in the morning and again in the afternoon. The morning milk gets sold outside of FBU for profit and the afternoon milk is sold to families on the Hacienda. The other three cows are all pregnant, and the foundation hopes for female calves to provide for more milking cows. Females also can be sold for more of a profit than males. These three cows will be used for milking too once they are ready.

Another form of profit for FBU are guinea pigs (cuy) and rabbits. Guinea pig is a delicacy in Ecuador and can be bred rather easily as can rabbit. Guinea pigs are sold by the foundation for $4 a piece.

There are at least eight pigs living on the Hacienda. Some belong to FBU and others belong to the families living on the property. Once the biogas unit is completed the pigs' waste will be used to create gas. Pigs are also used for meat.

Also living on the Hacienda, but belonging to families rather than FBU, are a number of chickens that the families use for meat and eggs. There are also dogs and puppies which people primarily use for protection, though occasionally as pets too.

There are at least six ducks in reservoir #2, which will eventually be used for meat. FBU also owns three llamas whose main purpose is so the school groups can see what a llama looks like.

3.0 BIOGAS

3.1 Biogas Overview

Biogas is a form of methane gas created using animal waste in an anaerobic (without air) process. The biogas unit installed in the hacienda at FBU, uses pig waste to create both gas and biol, a high quality fertilizer. The gas will be used for a cooking stove in a nearby house and the biol will be used to fertilize plants and trees around the hacienda.

The biogas unit consists of a pig pen, a square holding hole that the waste is washed into, a longer digester hole where the methane is produced, another square holding hole for the boil, and a run off tank which collects the excess biol. The waste flows from the pig pen stalls down a channel into the first holding hole. Water is used to wash away the waste and help the digestion

process. Sometimes it is necessary to add extra water to the holding hole to reach the correct consistency. Once the waste and water mixture reaches a certain level it flows through a tube into the plastic in the center digester hole. In the plastic, the methane is produced. The mixture is stirred once a week with a rope and paddle contraption to help stimulate the methane production. As methane is created it fills and inflates the plastic. The methane is then piped out of the top of the plastic to the in-house stove for cooking. Along the pipeline, there is a filter and an overflow valve. The filter is made out of steel wool and is used to filter out impurities such as sulfur. The overflow valve simply allows gas to escape when the pressure reaches a certain threshold; this may occur when the gas hasn't been used for a few days. After the amount of waste builds up to a certain level in the digester it flows through another tube into the second holding tank. After the aforementioned digestion process, the waste has become biol fertilizer. The fertilizer is naturally rich in nitrogen and potassium, but lacks phosphorus. Once in the holding tank, phosphorus and other additives can be added as needed to fully enrich the biol. Other additives include natural insect repellents such as garlic or chili pepper and can be added depending on where and what the fertilizer will be used for.

The biogas unit should last just as built for about seven years, and is limited by the life of the plastic. After seven years the plastic may need to be replaced, but the rest of biogas unit should still be fully functional. Certain factors may greatly shorten the life of the plastic and must be considered. Any small animals that fall into the digester hole may chew holes in the plastic. A roof may be built over the hole to prevent this from happening. Also, any roots, sticks or rocks in the hole could puncture the plastic. All of these must be removed or trimmed to ensure the longest possible life of the plastic.

3.2 Biogas Drawings

3.3 Materials Needed for the Biogas Unit

All of the materials for the biogas unit have either been bought locally at the nearby town of Cayambe or found on the hacienda. The only material that has not yet been obtained to finish the biogas unit is the plastic for the center hole. The plastic is difficult to find due to its unique tubular shape.

Cement, sand, gravel, and ash based soil – All were used to make the concrete walls of the holding holes and the foundation and walls of the pig pen. The cement was purchased and the sand was collected from various spots on the hacienda. Because the first batches of cement for the holding holes did not need to be very strong, small, light volcanic rock called cascajo was used for gravel. In the latter batches, bags of ripio, or small stones, were purchased.

Blocks – Both existing adobe blocks from a demolished latrine and new, purchased breeze blocks were used. Breeze blocks are light-weight concrete blocks similar in shape to cinderblocks but closed on one side and measuring 15.5 inches by 8 inches by 6 inches. They were used in the construction of the walls in the holding holes. The existing blocks were used in the foundation for the floor and the walls of the pig pen and measure 36 cm by 17 cm by 8 cm.

Concrete tubes – Two 20 cm inner diameter concrete tubes were bought. The outer diameter of the tubes are 26 cm, but this is not a critical dimension. These tubes were used on either end of the digester hole to connect to the two holding holes. They allow the pig waste to flow into the plastic and later allow the biol to flow out of the plastic.

PVC tubes – A length of 2 cm diameter PVC tubing is needed for the pipeline that pipes gas from the plastic to the stove inside the house. Various PVC connectors may be needed depending on the path of the tubing and whether or not it goes to more than one house. Another, small length of 7 cm diameter PVC tube is also needed to pipe the excess biol from the biol holding hole to the plastic holding tank.

Rubber hose – A roll of ¾ inch diameter rubber hose will form most of the pipeline used to transfer gas from the biogas unit to the house. The length needed will vary based on the distance from the digester to the house.

Plastic tank – A large 200 litre plastic tank was bought to store the excess biol. It is barrel shaped and came with a lid.

Inner tubes – Old inner tubes from car and truck tires were obtained. Three discarded inner tubes were obtained for free from a nearby gas station. Two large truck inner tubes were purchased from a mechanic on the side of the road. The inner tubes are going to be cut into strips and tied around all of the connections, such as around the plastic and the concrete tubes. The elasticity of the inner tube rubber is crucial because as the tube streatches it makes an airtight seal.

Plastic – A long sheet of plastic, already sealed at both sides to form a tube is needed to go in the digester. The plastic needs to be Grade 8 thickness and for the specific biogas unit on the hacienda, 26 to 28 metres of plastic is required. The plastic, however, may only be able to be purchased as a 75 metre long.

3.4 Tools Used While Building the Biogas Unit

Shovel – for collecting and moving sand, gravel and cement and removing dirt from the holes

Pick-axe – for digging holes, removing dirt from around tree roots and removing plants, roots and debris from the area

Hoe – for moving loose dirt, leveling the area, and removing debris

Tamping bar – a long, heavy iron rod with a point at one end and a flat, square-shaped piece at the other end used for breaking up heavy soil and shaving down and squaring off the sides of the holes

Compactor – a large, heavy stump with two sticks, one nailed on each side for handles, used for compacting loose dirt

Machete – for general cutting, shaving out smaller holes, chopping compacted dirt off the bottom of the compactors, breaking blocks into smaller pieces and cutting roots

Level – to make sure the ground and holes are at the correct level

String and pegs – any type of string or twine and pegs shaved out of sticks with a machete for marking off areas and showing the proper level for an area

Measuring tape – for accurately measuring distances

Cement trowels – for making sure the cement doesn't have any air pockets in it and is smoothed evenly on top

Wood boards – to provide a wall to contain the wet cement while it dries and to level the cement

Chainsaw – to cut away large roots and remove trees and tree stumps

Hammer and mallet – for breaking apart blocks and block walls and fixing other equipment

Gloves – for minimizing the number of blisters on the workers' hands

Nikki – for comic relief, finding puppies and milking cows

2.1 Biogas Construction Process

The first step in construction was to dig the three main holes for the biogas unit. The majority of the digging for the three holes was finished upon the arrival of the travel team. The next step was to clear the area for the pig pen and continue with the holes until they were exactly the right dimensions. A lot of brush was cleared from the pig pen area and dirt was cleared from around the roots of three tree stumps. The roots needed to be completely exposed so that they could then be cut with a chainsaw and the stumps could be removed. There was also an old latrine that needed to be demolished and removed. The roof tiles were taken off and the walls were broken apart with the mallet, trying to keep as many bricks in tact as possible for reuse. Refuse and waste surrounding the latrine was collected, bagged and removed from the site.

A lot of work was still needed to make the holes the exact necessary size. Mostly the tamping bars and pick-axes were used to shave the sides down to make the hole the correct width and to dig out the floor of the hole to the correct depth. Shovels were used to remove all the loosened soil. This task proved to be difficult and time-consuming due to the extremely hard soil, called cangagua, that begins just a few inches beneath the surface. On occasion, heavy rain also slowed the work on the holes. Then two horizontal, circular holes were dug through the walls between the digester hole and the two holding holes. These holes were to allow the two concrete tubes through which would allow the waste and biol to pass from hole to hole. The holes were both 26 cm in diameter and the one to the waste hole was 57 cm from ground to center and the one to the biol hole was 43 cm from ground to center. The difference in height is to make sure that the waste and biol flow in the correct direction.

Another, smaller hole for the plastic biol tank also needed to be dug. The hole was approximately 70 cm deep to ensure that the top of the tank was lower than the top of the biol holding hole. The tank was settled down into the hole and the extra space was filled in with loose dirt. Then a channel was dug from the biol hole down to the tank. A hole was cut in the side of the tank near the top and a PVC pipe was placed in the channel, running from the biol holding hole into the tank to allow overflow biol to be stored.

Then the ground for the pig pen area needed to be leveled. Obstacles included the holes left by the tree stumps, the concrete base of the latrine and a slow-growing native tree that was to be left in place. It was decided to build up the area with all of the dirt from the holes to make it level with the top of the concrete base. The holes from the tree stumps were filled in and compacted with the tree stump compactors. Because this was the ground underneath the pig pen and needed to support the weight of the pig pen and the pigs, it was crucial that only dry soil was used and that the dirt was thoroughly compacted. If the area was not sufficiently compacted, the foundation of the pig pen might crack under the weight. To ensure good compaction, from ½" to 2" of soil were laid down at a time and were passed over with the 20 lb compactor between 2 and 4 times until the soil was stable. Then the next layer of soil would be laid down and the compaction repeated.

The desired level was marked with string and pegs. The area was not completely level, but had a slight downgrade in both directions towards the corner nearest the holding hole for the waste. This way when the pig pen stalls are hosed out the waste will naturally flow into the corner of each stall and out a hole into a channel where it will naturally flow down into the holding hole.

After the ground was completely compacted and leveled, the work for the foundation began. Trenches that were 10 cm deep were dug around the perimeter of each pig pen stall. The trenches dug in this case were approximately 17 cm wide. They were then filled with medium sized stones, stacked tightly. These were the foundation for the walls of the pig pen. The smaller, broken portions of the existing blocks from the latrine were then used as the beginning of the foundation for the floor of the pig pen. They were fitted together to cover the floor area of each stall. One center stall was left without blocks so that the cement could be mixed there. Having the cement in a central location allowed it to be spread over the entire foundation easily.

The cement was mixed in proportions of approximately 3 parts sand, 2 parts gravel and 1 part cement. This cement was laid over the stones in the trenches. It was mixed in the center of the stall without blocks with four people with shovels and water added from the hose as needed. It was shoved into the open cracks and spaces with the trowel and then smoothed out and leveled with a board. Boards were also used on sloped edges to create a solid wall to contain the wet cement until it dried. The cement in the trenches served as the foundation for the walls and was allowed to dry for a day before anything was built on top of it. More cement was then mixed but with only the very fine cascajo for gravel. Any large bits of rock were thrown aside. This cement mixture was used to start laying blocks for the wall of the pig pen. The full, unbroken blocks recovered from the latrine were used to start the wall. The blocks were soaked in a bucket of water for at least a minute before they were laid so that they would not absorb any moisture from the cement once they were put in place. This cement was also used to begin the floor of the pig pen stalls, covering the broken blocks that had been laid as a foundation.

Another batch of cement was mixed with the proportions of 4 parts sand, 2 parts cascajo and 1 part cement. This was used in building the walls inside the holding holes. First, large stones were placed in the bottom of the hole and covered with cement and leveled. Then the walls were built with breeze blocks. The walls were one block deep and went around the inside perimeter of the holes. The top layer of the wall was the existing adobe blocks that are thinner than breeze blocks and made the wall the right height to be even with ground level. After the wall dried, fine cement was used to smooth out the top and create a concrete surface that went all the way to the edge of the digester hole.

There is still a fair amount of construction that is yet to be done on the biogas unit. The pig pen will be completed by a builder in a way similar to how it has been started. Eucalyptus trees will be cut down from a sustainable forest on the hacienda to be used as support beams and roofing. A channel will be built along one side of the pig pen to carry the waste from the stalls down into the first holding hole. Once the plastic is found, it will be cut to the correct length and laid in the hole. The ends will be placed around the concrete tubes and tied in place with the strips of tire inner tubes. It is very important to make sure that the plastic is air tight. Sometimes a fan is used to test this. A roof system may also be built over the digester hole to keep out small animals such as mice that might fall into the hole and tear the plastic. Then a length of rope will be fed through all three holes. A wooden board will be attached to the rope as a paddle inside the plastic section. This arrangement is used for stirring the mixture. Next, a pipeline from the plastic to the stove will be built. The PVC piping will be attached to a hole in the top of the plastic. The connection will be well sealed. The filtering section and overflow valve will be built into the pipeline. Then the rubber hose and PVC piping will carry the gas up to the house where it will be connected to the stove. It was important to make the hole the correct depth so that the stove is above it and the gas will naturally rise up the pipe instead of being pumped. The last step is to commission a new stove to be built. The current stove is not set up to accept the biogas. The new stove will be built by a welder and be installed in place of the old stove.

2.2 Benefits of Biogas

There are two main benefits to the biogas system. First, it provides a constant source of methane gas that can be used for cooking or heating. Second, it provides a source of very high quality fertilizer for the farm. Using the biogas system not only saves money by providing free gas as an alternative to buying gas from the gas company, but it is also environmentally friendly by containing and utilizing the otherwise harmful greenhouse gases that are produced by animal waste. The biol fertilizer is also an extremely valuable byproduct of the biogas system. The biol is naturally extremely high in nitrogen and potassium and after a few additives such as phosphorus and sometimes some natural insect repellants, it becomes a very high quality fertilizer and a significant asset to a farm. Other fertilizer is often costly and not nearly as good.

2.3 Photos of the Biogas Unit

4. Regional Background

1. Culture

When traveling to Ecuador it is advisable to be aware of some of the cultural differences and norms in order to fit in as best as possible and to better understand the people, providing for a firmer ground upon which to build relationships. Below is a broad outline of Ecuadorian culture.

Presentation: Presentation is very important in selling a product. People judge based on appearance, so an item must look good in order to sell.

Submissiveness: In the workplace authority is everything. What the boss says will always go without argument. An example of this occurred on the Hacienda when one of the workers, Frederman, who is very knowledgeable about agriculture and knows that crop diversity is important for successful harvests will plant a field with only one crop if his boss, who does not have as much farming experience as he does, tells him to.

Jealousy: People are generally hesitant of new initiative. Biogas for example takes quite a long time to pay for itself, and people are cautious about investing in something that they do not know works. The key however is to convince one person to involve themselves in the new idea because people have a tendency to be jealous of their neighbors. If one person gets a new product and their neighbors see that it works, they to will want it.

Modesty: Because jealousy is a cultural norm, people tend to be modest about certain topics, especially when it comes to how much money they make. While in El Cristal, we asked a farmer what his income was, he said he made $3 daily, when in reality he made between $5-7.

Political Awareness:: People are very politically aware, and apathy is uncommon. In Quito most of the graffiti had political messages. It is probably wise to read current news articles and be somewhat up-to-date on politics because the people care about it.

Male-Female Relations: Males and females both children and adults seem to maintain friendships mainly with people of the same sex. It is rare to see men and women who are not married socializing with each other. Among children, only those under the age of seven seem to

play with members of the opposite sex. Family size is decreasing, and three or four kids is average. Most people get married between the ages of 16 19.

Food: Breakfast and lunch are usually the biggest meals of the day. Lunch is the main meal, and therefore the bigger of the two. It usually consists of soup, followed by a plate piled high with rice, potatoes, and some type of protein, either meat or beans. Vegetarianism is understood in terms of visitors, but is not practiced. Dinner is generally light, consisting of bread and tea or coffee. Coffee is not consumed regularly. Most places serve Nescafe (instant coffee). It is rude to not finish the food on your plate, however organic waste is not an issue, as whatever is not eaten will be fed to pigs, dogs, etc. People generally have enough to eat to fill themselves, but it is not always the most nutritious food, and it is normal for families to load up on carbohydrates and starches.

Religion: Catholicism is the most widely practiced religion. Because of this there is much more pro-life media than would be seen in the US. This also gives some explanation to the large family size.

Animals: People keep dogs mainly as guards and for protection. Pets are rare.

Ecuadorian Time: Ecuador is a very relaxed country. People generally lead simple, uncluttered lives. Though you should always be punctual, it is not unusual for Ecuadorians to be late or not show up at all because of a change of plans that was not communicated. Though we never experienced this to its full extent, it sometimes happens and is good to be aware of.

2. **Health**

Surveys were conducted to assess the health, general economics, and education systems in the communities that FBU works with. There were two different surveys, one for key informants and one for individuals. The key informants discussed Peñaherrera, El Cristal, and Pucara, all communities in Intag. Picalqui, in the Pedro Moncayo region was also discussed. Both individuals were interviewed on their hometown of El Cristal. With the exception of key informants being more knowledgeable on the causes and backgrounds of specific health issues, general concerns among people were similar.

Our interviews showed two common health problems. The first was la gripa. La gripa comes with the changing of seasons and has flu-like symptoms including headache and coughing. 20-50% of both children and adults are estimated to come down with la gripa annually. People thought that their drinking water as well as the increase of dust during season changes caused la gripa.

Parasites were the second major health issue in the areas where we conducted interviews. Parasites are so common that they have become a way of life, and hence were not the first things that came to mind when asked about common illnesses or injuries. Parasites were estimated by one of our key informants to affect 90% of children under eighteen, 80% of adults eighteen-fifty, and 60% of adults over fifty. People know that their parasites come from water, but of the communities we interviewed water remains largely untreated. We learned that every six months or so people take medication to rid themselves of the parasites. In El Cristal the medication was a laxative which flushes the body of everything.

Another illness which we discovered to be common among women in Picalqui was Gastritis. A key informant that we interviewed said that half the women in a women's group he visited claimed to be affected by the disease. Gastritis requires an operation to resolve. Other, broader concerns were an increase in cancer and in kidney problems.

Hygiene is also a major issue. Though there are proper bathrooms, men and children especially, along with some women will go to the bathroom in the fields in the countryside. It is common for people to wash their hands before meals, but not as common for to wash them after using the bathroom. From visual observations, oral hygiene also appeared to be a problem as children and adults alike had rotting or we missing teeth.

Key informants discussed issues of water contamination. A councilman of Cotacachi told us that in 2005 a horse had died and was decomposing by the water source. We were also told of cows being left to graze around water sources, thus causing contamination, and of an event where a man who owned the land surrounding the water source was disposing of waste (exactly what type of waste is unclear), causing the water to become contaminated and calling for court action. There are also water shortages in the summer and water management seems to be an issue. People rarely drink water as a form of hydration. Soda, fruit juices, and drink limonada (water, limon, and sugar) instead. Children for the most part get vaccinations and doctors are generally available, though money and transportation are sometimes barriers. Home remedies also exist. In the interviews we learned a variety of herbal teas are used, especially in treating kidney

problems. There are some public health initiatives in communities, but these are limited, and there is no formal health education in schools.

To ensure that people fully benefit from our work, it would be useful to further research the health benefits of green building and see how they can be applied to the needs of the community. Furthermore, to help ensure the sustainability of our projects it would be beneficial to incorporate green building and how it positively corresponds to health in both the FBU and school curriculums.

3. **Economics**

Our interviews also served to gather information on general economics from the key informants and individuals. The questions asked included whether people earned cash for working and how much, as well as how they earned it. We also asked what their money was usually spent on and whether or not they paid taxes. Finally we asked if people would be willing to pay for water.

The individuals we interviews averaged at making between $36 and $50 a month. The key informants from Intag estimated higher, saying people made between $80 and $120 a month. Picalqui is a more educated community, where a relative number of people hold degrees. With this education come higher salaries for the people in the Pedro Moncayo region. Rather than working in agriculture or farming many people in Picalqui have began to work in the flower industry where they might make as much as $140 a month. People also work for larger companies or organizations such as INNFA a child protection program where they can make between $300 and $400 a month. In both areas women's groups also bring in revenue.

Primarily, unless people harvest their own food, their income goes to feeding their family. Almost everyone in Picalqui owns a TV. After buying necessities though, people tend to save their money for larger investments.

Paying taxes is rare. There are sometimes land taxes and people may pay for health benefits, but neither of the individuals interviewed paid for either of these. People pay for electricity and telephone when applicable.

In some communities people currently pay for water. In Picalqui families pay $1.50 a month for 15 meters cubed of water. The key informants said people in Intag would be willing to pay

between $.5 and $2 for water. Everyone seemed to be in agreement that they would pay for water if it were guaranteed to be potable.

4. **Education**

4.4.1 Overview

There are two schedules for the education system depending on the region in which the school is found. On the coast school starts in April and goes through February. In the Sierra, or mountain region, schools are in session from September to July. A typical school day is supposed to begin at 7:30 am and go until 11:30 in the afternoon. School is held Monday through Friday, with vacation periods that correspond to Easter and Christmas. Additionally, teachers attend meetings, thus canceling school, about two to four times a month. Many additional unexpected school day cancellations may happen throughout the year.

Most teachers are not perceived to be passionate about their work, but rather see it as a job with regular pay. This is held in high regard due to the stress in Ecuador's economy.

4.4.2 Case Study School: *Escuela Picalqui*

Escuela Picalqui is located just beyond the FBU Hacienda, at approximately a ten-minute walk. School starts at 8 am (ish) and ends at 11:30 am, although it is supposed to begin at 7:30. Some students remain for lunch and pay $0.50 per week for this service.

The school is from first to sixth grade (approximately 6 to 11 years of age). There is one official teacher for the entire school. The number of children attending this school has increased within the past fifteen years from about twelve to fifty. This increase is attributed to a general population migration to this region for steady work in businesses such as flower factories. Despite this increase, the number of children per family is decreasing.

According to the teacher of this school, general family structures have also been changing. In many cases parents are now more heavily tied to their work and have longer workdays. For this reason, many of the children have only grandparents or each other to watch over in the time

when they are not in school. In many cases, younger children of the family will also come to school with their older siblings merely to sit in the corner during the lessons of the day.

School Infrastructure

- Two buildings, each of which is a single classroom
- "Comedor," or cafeteria which is a wooden skeleton covered in translucent plastic sheeting
- Two external bathroom sites, the first of which is two latrines that are lacking doors and used predominantly by the male students for urination. The second facility is also two stalls both of which are in disrepair.

Materials

There are a variety of books in the classroom, but most are outdated. The government recently promised to provide textbooks for rural schools and supplied them for some coastal schools but they have not yet followed through for the schools of the sierra. Funding for school materials is provided for by the money charged for attendance to school or from donations by NGOs or volunteers.

The school has one computer which was provided by the regional council and operates Windows XP. The programs on this computer are mostly provided by NGOs or volunteers and include educational programs pertaining to Ecuador, the environment, math, and language. The computer is kept locked up and appears to be used rarely. The use of it is promoted for older levels as a preparation for high school years where technology becomes more important.

Costs

The school's budget is provided by fees assessed for attending school. Each student pays three dollars per year. There are additional expenses that do not go towards school materials. These include the optional school lunches and costumes for special occasions run by the school. The total money collected by the school for materials per year is approximately $150.

Curriculum

The teacher stressed the importance of teaching the value system and the ability of students to interact and develop responsibility and social skills. This is believed to be of high importance because once these student leave school for the day they are mainly on their own because their parents work until around 5pm. The partial restructuring of families has also been attributed to this as now grandparent and grandchildren are both seen to be responsible for each other in the absence of parents. This could partially explain the children's enthusiasm for attending school, as it is perceived to be a place of play with peers in many cases.

Some homework is given, but this is minimal because after the students have left school not much is/would be done in terms of education. This creates difficulties because children will forget all that they have learnt in a single day over the course of the afternoon. This is even more extreme over weekends and can be frustrating for teachers when progress is made much slower.

For further information on the national curriculum used within this school refer to Appendix C.

Furthering Education

Most of the students who attend this school will proceed to *colegio*, or high school, in Tabacundo. The tuition for this school is around $25 in addition to paying for uniforms. The government has recently set forth a goal to provide subsidies for children and families who cannot afford to further education to this level with the goal of covering all tuition costs in most cases so that student will only have to provide money for their uniforms.

The high rate of continuation of study at this school is believed to be due to the unique nature of the town of Picalqui. This community has a larger number of residents who have pursued higher education even to the level of a bachelors' degree, and for this reason education is highly valued.

4.4.3 Student Learning Qualities in Picalqui with Respect to Other Communities

Students are reported to be strong in mathematics in this school. This seems to contradict the "EWB Community and Health Survey" which showed a general perception that math was one of the most difficult subjects in the interviewees' respective communities. This could be due to the influence of volunteers that pass through this school and their personal strengths in teaching.

The most common way of teaching is through memorization. Because of this many students feel uncomfortable with creative work. The pressure of being "wrong" and the more social infrastructure of schools may be an indicator of the potential for group work.

4.4.4 Recommendations

Most rural schools resources are stretched very thin. There is much potential for the introduction of activity ideas to teachers if it is accompanied with the human and material resources to carry them out. Open-ended design (or "engineering") problems may be difficult for students to apply memorized knowledge to, but could provide for the opportunity to work in groups. This may cut out some of the fear of individual failure.

3.0 INTAG

3.1 Natural features and Climate of Intag

Intag is located in the northern sierra region of Ecuador in the county of Cotichachi. It is located in a tropical section of the Andes mountain range. Tropical mountain ranges are distinctive because they are not common and they support exceptional biodiversity. The tropical section of the Andes spans from Panama to Peru. Intag borders a nature reserve called _____ , which protects a cloud forest and is the home of about thirty species of endangered birds and thousands of plant species. In addition to supporting native plant species, people have successfully grown many exotic crops in the area.

The climate in Intag is moderate. The rainy season is between generally between November and March. The temperature range is about 8^{o}C to 28^{o}C and the temperature never drops below freezing point. Elevation effects temperature. At higher elevations the temperature is lower. The elevation range is approximately 1000 meters to 2000 meters. Intag is unique because the variations in temperature, elevation, and the angle that the sun hits the mountain slopes results in localized weather patterns, and distinct microclimates. For this reason both crops that are typical of both the coastal lowlands and the high sierra are grown in Intag. For instance, a person that lives at the bottom of the valley can grow bananas, which are typical of the coast, and a farmer that lives closer to the top of the mountain can grow potatoes, which are typical of the high sierra.

3.2 Societal History of Intag

The Intag region of Ecuador was first settled about 150 years ago. The first people that settled in the region could buy large 80 hectare plots of land, which they called haciendas. In time the haciendas were divided up into smaller plots of land called _____ and even smaller plots called fincas. Currently, people that live in Intag own plots of land that are approximately the size of fincas, but the amount of land a person owns depends on the individual's economic status.

3.3 Women's Groups in Intag

Traditionally, women do not have control over family finances, but Intag has women's groups that are dedicated to empowering women both financially and socially. The women's group collective in Intag is called the Coordinadora de Mujeres de Intag, and it composed of groups from 12 locations in Intag. The collective womens group has six strategies for exercising their rights and responsibilities with the intention of diminishing the inequalities between men and women. The six strategies are: (1) earning money, (2) promoting individual and family health, (3) protecting the environment, (4) participating in community forums, (5) looking for opportunities for educating women, and (6) trying to stop and prevent violence against women. The women's group has an artisans store in Apuela where they sell products like bags, hats, soap, and shampoo that women make from natural materials (see Appendix __ for the Coordinadors de Mujeres de Intag brochure).

5.4 Communities in Intag (Cristal)

There are many communities in the Intag region. The communities are relatively small (around 1000 people), and most of them have a central meeting area, or community centers. The community that we visited was named Cristal.

About 100 families live in Cristal, and the average family has six people. The average family size is decreasing as a result of fertility issues, which are mentioned in the health survey section, and family planning workshops. Like most communities in Intag, Cristal has a town center where people from the area gather for meetings and social interactions. The town center is not a town in the traditional sense. Like most town centers, Cristal has a school, a general store, a Catholic church, a karaoke bar, and a playing field. The families that run the general store and the karaoke bar live in the town center, but not many other families live there. People gather in the community center on Sundays to attend church, play sports, restock supplies at the general store, and socialize. Ecuadorian volleyball, which is like American volleyball but the net is higher and three people play on each side, and soccer are the most popular sports.

In the winter or spring of 2006, the community of Cristal purchased a building that they intend to use as a community center. Each family in Cristal contributed money to buy and remodel the building. Eventually the community center will be used to hold meetings and workshops. The community is considering using the building as a daycare center for children that are too young to attend school. They are also hoping that they can rent the community center out to outside groups (like ngo's or school groups?).

5.5 Economics in Intag

5.5.1 Agriculture

Agriculture is the primary source of income for most people that live in Intag. As mentioned above, Intag has an ideal climate for agriculture because a large variety of crops thrive in the area. Some of the crops that farmers from in Intag grow and sell include: yucca, potatoes, bananas, plantains, corn, beans, tomato de arbol, lemons, oranges, avocadoes, sugar cane, blackberries, carrots, and coffee. Farmers from Intag have a difficult time making money from selling their crops because it is difficult to transport crops to the major markets in Ecuador, the soil is becoming depleted of nutrients, and the weather is less predictable than it used to be.

Transportation to and within Intag is difficult. The closest substantial market is in Otavalo, which is about two and half hours away from the town of Apuela, which is the hub of the Intag region. None of the roads leading into Apuela are paved, and since Intag is a mountainous region all of the roads are curvy and steep. Many families in the Intag region live over an hour's drive away from Apuela, and very few families own their own vehicle. It is very difficult for farmers to get their crops to Otavalo themselves, so they sell their crops to intermediaries at prices that are far below market price. The intermediaries take the crops to the markets in Otavalo and sell them for a lot more than they purchased them for in Intag. FBU is trying to help farmers in Intag find ways to eliminate the intermediaries. Without intermediaries, farmers from Intag would earn more money from selling their crops.

Soil depletion is a major concern in Intag. Crops are sown on mountainous terrain. When the loose top soil erodes it quickly slips down the mountain and is lost forever. Crops do not grow as well if the soil is low in nutrients and organic material. The people that farm in Intag do not know how to prevent soil erosion. The most common method of farming is: find a plot of land to farm, burn the native forest down, till the soil, and plant a single crop on the land. This method does not incorporate any soil conservation mechanism, so the soil quality is rapidly decreasing. FBU has made efforts to educate farmers in Intag about the effects of soil erosion and nutrient depletion. FBU also tries to show farmers methods for preserving the soil. Two ways to preserve soil are to plant on terraces and to limit the water erosion.

Terraces are effective because the potential for soil to slide or wash down the mountain is decreased because the soil is contained on a flat surface. When somebody installs terraces on a mountain side the silhouette of the mountain changes from a constant grade to a step-like grade. Soil that is contained on the flat surface of the step will stay on the step like surface unless the terrace collapses or it migrates too latterly across the slope.

A majority of soil erosion is caused by flowing water. If water is not well managed, water can quickly wash soil downstream. One ways to limit the effects of erosion from water are to install drainage systems that direct water away from the loose topsoil in the fields. Another way to prevent soil erosion due to water is to plant vegetation that stabilizes and strengthens the soil. Plants that have intricate root systems are ideal for soil stabilization.

Farmers depend on good weather for the crops to grow. If it rains too much, or too little, the crop yield will be less than ideal. Weather patterns are becoming more turbulent and unpredictable than they used to be, so farmers are having a difficult time producing crops. Although Intag is a lush region where a huge variety of plants are produced, people are not earning a lot of money farming and their income is not reliable. As a result of unpredictable and overall low income, people are leaving Intag to find more profitable jobs in larger towns.

5.5.2 Café Río Intag

Café Rio Intag is an association centered around coffee production in Intag. About ___ years ago a group of Japanese people came to Intag to start a mining company. The citizens of Intag were opposed to mining because of the adverse environmental effects of mining. The citizens of Intag protested the mining and successfully prevented further mining explorations in the region. After mining was banned, the Japanese looked for other business options in the region. The Japanese

suggested that they would purchase any coffee that was grown in Intag for a premium price. Before the Japanese introduced coffee to the region nobody grew coffee, but now coffee is becoming a popular cash crop. About 115 families are part of the Café Rio Intag coffee association. Each member contributes coffee to the association, and the members share the income. In 2005, Café Rio Intag sold 2800 pounds of unroasted coffee to the Japanese. There are no written contracts between Café Rio Intag and the Japanese that purchase the coffee. All of their agreements are based on trust. In 2006, the Japanese would like purchase two times as much coffee from Café Rio Intag as they purchased in 2005.

In addition to selling unroasted coffee to Japan, Café Rio Intag has a small business where they roast coffee and sell the final-ready-to-brew coffee. The business started when the association realized the profit potential for selling processed coffee. The association asked the Council of Coticachi for the money to purchase a machine that peals the coffee beans, a roasting machine, and a grinding machine. The Council of Coticachi gave the association the money they asked for, and the business started. As time passed, the association perfected their coffee processing skills, and they started to earn money from selling the coffee. They have invested some of their income to purchasing better machinery and expanding their business. Café Rio Intag supports local women's groups by selling the processed coffee in bags that are woven by local women. The bags are made from a natural plant – Cabulla – fiber and Café Rio Intag purchase each bag for fifty cents.

5.5.3 Dolce Panela

Carlos is a member of an association in Cristal called Dolce Panela. The association is trying to start a business where they produce and sell a sugar cane derived product called piel. There are 14 members of the association. Each member contributes sugar cane and helps with the production process. The members share the income from selling the piel. FBU helped Dolce Panela organize themselves and develop a business and marketing plan. Currently the business is small, but they are hoping to expand.

4.0 WATER IN PEDRO MONCAYO AND INTAG

4.1 Water at the FBU Hacienda and in Pedro Moncayo

4.1.1 Water sources and availability

The source of water that is used at the FBU Hacienda and in Pedro Moncayo is about forty miles north of the Hacienda high in the mountains. Water that flows down from the mountains to Pedro Moncayo is separated into two different uses, namely, irrigation and tap water. Everybody has to pay for both irrigation water and for tap water. FBU uses irrigation and tap water from the Pedro Moncayo municipalities, and they have a well on the Hacienda. We were not able to look at the well on our trip.

In general, water is readily available during the wet season, which is from October to May, but Pedro Moncayo, like all counties in the high sierra region of Ecuador, suffer water shortages during the dry season. The dry season is from June to September.

4.1.2 Water Quality

Irrigation water is not treated and it flows through fields where animals graze, so it is not safe to drink. Many people use pesticides on their corps, so there is a good chance that irrigation water in some parts of Pedro Moncayo is contaminated with pesticides. The water down stream from flower plantations is likely to be contaminated with pesticides because flower producers use a lot of pesticides. We tested the water on the Hacienda for pesticides and the test results were negative. FBU pays the council of Pedro Moncayo about $10 a month for irrigation water.

Tap water in Pedro Moncayo is not necessarily potable. The water treatment facility is a non-profit organization that is operated as a small collective. Only a portion of the tap water that is delivered to Pedro Moncayo is treated. The water that is treated is treated with chlorine. The name of the water company is EMASA (European Municipal de Agua Potable). The average family pays $0.10 / m^3, the minimum of 15 m^3 available equals $1.50 / month. When we tested the tap water on the Hacieda for bacteria, we found that there is more than one bacterium in 100 mL of water.[1]

Tap water is used on the FBU Hacienda for drinking, bathing, washing clothes and washing dishes. FBU also uses tap water wash down animal stalls and for dinking water for the animals. FBU pays $120 per month for tap water; they use about 500 m^3 of tap water per month.
Management

4.1.3 Water Management

Water has to be managed well because many people depend on water to grow crops. Most water management projects in Pedro Moncayo aim to improve irrigation during the dry season. For example, the town of Picalqui recently installed a large resevore that will serve the families that need water for irrigation. Before the reservoir was installed, each family was allotted access to water for one 24-hours period once a month. The water that they received came through an irrigation ditch that is about one foot wide and six inches deep. This irrigation system did not work because crops would not get watered enough for most of the time, and one time a month the crops would be too wet. Now that the new system is in place any family can ask the Council of Picalqui for water to irrigate their fields and the families receive water when they have a demand for it.

FBU manages the water they use for irrigation. To ensure adequate water supply during the dry season, FBU recently invested in repairing one of the reservoirs on the Hacienda. Unfortunately, even after the repairs, the reservoir leaks. FBU has a second reservoir that is currently covered with a red algae called Azola. In addition to the two reservoirs, FBU has a rainwater collection system. They fill five large underground storage tanks – all of them hold at least 700 m^3 of water – during the rainy season so they know they have a reserve of water in case they run out of water in the dry season.

4.2 Water in Crisatal

[1] The US EPA requires the concentration of bacteria in drinking water to be less than 1 bacterium per 100 mL of water.

4.2.1 Water sources and availability

There are two major sources of water in Cristal. One source supposedly comes from below ground, or is a spring, and it serves 30 families in Cristal. The name of the spring is Ojo del Agua and it is located in a forest that FBU uses for a seed source. The second source is from the mountains above Cristal and it serves both Cristal and another community that is located at a lower elevation.

4.2.2 Water Quality

Water quality is a prominent concern in Cristal. When we tested the drinking water in Cristal we found that the pH was lower than normal (pH 5), and the water contained more than one bacterium per 100 mL. All of the citizens of Cristal that we interviewed said the water causes illnesses and they would be willing to pay (50 cents to two dollars per month) for water if they knew the water would not cause illnesses.

4.2.3 Water Management

The "jefe del agua" (or the boss of water) is in charge of the water in Cristal. He makes sure the water distribution system operates correctly, and the community pays him five dollars a month for his services. His job entails cleaning leaves and gunk from irrigation ditches and repairing leaks in the distribution system.

The tap water in Cristal used to be treated with chlorine, but it is not treated at the moment. The most likely reason that people stopped treating water in Cristal is: treating water costs money and in general people in Cristal do not have a lot of money.

5.0 GREEN VOLUNTEER HOUSE

5.1 Introduction to the Green Volunteer House

One of the objectives for our June 2006 trip to Ecuador was to gather information about the house on the FBU hacienda that we are planning to renovate on our next trip to Ecuador. We will use environmentally responsible design principles to improve the livability while using natural resources more effectively than they are currently being used. Below are a few concepts we came to Ecuador to investigate, as well as ideas that were mentioned by the people living at the hacienda. All are viable ideas to work with in the upcoming year.

5.2 Benefits of the Green Volunteer House

The benefits of installing a green volunteer house are five fold. First, and most apparent, FBU and the people that volunteer for FBU will benefit from the renovation because volunteers will have a nice place to stay at the Hacienda. FBU hopes that more volunteers will come if they improve the volunteer facilities., Indirecely the communities that FBU works with will benefit if more volunteers visit the Hacienda because EWB uses the money they earn from volunteer visits to pay for community projects.

Second, building the volunteer house provides us, Tufts EWB, with the opportunity to use the skills that we are learning in school in a real design process.

Third, the volunteer house will be used as a teaching tool for children that come to the FBU Hacienda to learn about the environment. Thousands of kids from schools in Quito and from schools around the Pedro Moncaeo area visit the Hacienda each year. If many children learn about using resources effectively, we hope that at least some of those children will practice environmental responsibility in the future. Because education is an integral part of community growth, each child that learns from the green volunteer house is in some way helping the community to which they belong.

The fourth benefit of the green volunteer house it that we can perfect the different components of the green building and assesses how applicable the different components of the green building will be for buildings in communities throughout Ecuador. While we are designing the building we will do everything that we can to consider the social and economical constraints that might prevent Education from adopting the green building principles and installing some of the components in their own homes or in buildings that they may build.

Last, designing and building the volunteer house will help us develop our relationship with FBU. Eventually, we hope to work on projects that are more specific to the communities that FBU works with in Ecuador. We hope to prove that our designs are socially and economically appropriate so that FBU trusts us to work on projects in communities in the future.

5.3 Natural Lighting

7.3.1 Overview of Natural Lighting

Electricity wastes energy, is expensive, and in some cases is not accessible. In order to have a more environmentally sound building, techniques of natural lighting could be used. In some cases, white sheets or reflective materials can be extended from the tops of windows to help the light flow more into the room. Also, one story buildings could be made with transparent or semi-transparent roofs so that light can come in from above. This all reduces the amount of electricity needed during the day.

7.3.2 Applicability of Natural Lighting

The volunteer house is a one story building that has a triangular top and a lot of space between it and a pseudo roof. In some places the pseudo roof is knocked out and the space above is visible. Sun seems to shine through a semi-transparent section of the roof, which helps light up the middle portions of the building. It is very dark in the middle, and this roof idea would be very beneficial. The laundry drying idea could be coupled with this as well.

7.4 Water Filtration

7.5 Solar Electricity

7.5.1 Overview of Solar Power

Solar panels are an environmentally friendly way of transferring solar energy from sunlight into electrical energy to power outlets in a house. Solar energy is much cleaner than most other kinds of power plants that are used today. They would be mounted on the roof of the house, facing the sun so that they receive the most amount of sunlight. Depending on the size and rating of the

solar panels they could be used as the sole source of power for the house or they could be used in conjunction with conventional power sources. Solar panels would reduce the reliance on conventional power and save money spent on electricity.

5.3.1 Current State of Power

Currently, the volunteer house has electricity that is brought in by power lines that are fueled by an unknown type of power plant. The voltage of the outlets is supposed to be 110 volts, but seems to be much lower. If you are running one appliance, you may want to turn off other appliances. There are often brown-outs, showing a lack of voltage and adequate electricity.

In the communities, electricity is similarly brought in from power lines from an unknown type of power plant. However, we are not sure if communities experience the same low voltage problems that are experienced in the volunteer house.

5.3.2 Applicability of Solar Power

Solar panels could be effectively integrated into the volunteer house. The roof should be able to support them and the wiring could be done to accept the new power source. Solar panels would also be a great educational tool to teach the school children that visit the hacienda about solar energy. However, both for the volunteer house and the communities, solar panels are extremely expensive.

5.3.3 Materials

5.3.4 Recommendations

Although solar panels would be very educational and environmentally friendly, every kind that has been found so far would be far too costly to for the FBU volunteer house or for the communities. The high prices mean that the solar panels are not a cost-effective solution to the energy problem. More research may need to be done into cheaper alternatives or the possibility of the donation of a solar panel.

7.5 Rainwater Collection

7.5.1 Overview of Rainwater Collection

In rainwater collection systems, rainwater that falls on the roofs of buildings will flow into catchment systems, which are often gutters around the house. Gravity then directs the water through piping or the gutters into a storage tank. The water that is collected in the storage tank can be pumped through filters to faucets, through passive water heaters to a shower, or through any sort of irrigation system for crops or gardens.

7.5.2 Current State of the Rainwater Collection System on the Volunteer House

Currently, there is a large underground storage tank on the west side of the volunteer house. Water from Frederman's house and the water that falls on the northwest side of the volunteer house drain into the tank, but the water that collects in the tanks have not been pumped out in at least five years. When the rainwater collection system was completely functional, the water was pumped from the underground storage tank to three smaller tanks on an elevated platform and the water was delivered to the houses via gravity. There was an automatic shut-off valve inside the small, elevated storage tanks, so when the water reached a certain level the pump would turn

off. The shut-off valve was similar to the valve that is used in toilets. The elevated platform and the tanks still exist, but the tank system is in disrepair. The tanks are filthy and the pipes that lead to the houses are missing (see appendix __).

7.5.3 Applicability of Rainwater Collection

Rainwater collection is important because the summers are long and dry, and without proper irrigation the crops will not survive. Also, since water is scarce and not necessarily safe to drink, it would be beneficial if the rainwater could be filtered and used as a source of potable water in the volunteer house, Frederman's house, and Louis' house. Water in Ecuador is becoming increasingly expensive, and some homes do not even have running water. Therefore, we think that the rainwater collection aspect of the green building has a high potential to greatly increase the quality of life for the Ecuadorians in a natural, environmentally friendly way.

7.5.4 Materials

The materials that would be used in a water collection system include:

- Gutters
- Pipes
- Large underground storage tank
- Smaller storage tanks
- Pump
- Non-toxic roof materials

7.5.5 Feasibility and Recommendations for the Rainwater Collection System

Rainwater collection would be useful both on the Hacienda and in communities throughout Ecuador. We suggest Tufts EWB peruse repairing the rainwater collection system on the volunteer house because it is applicable both on and off the hacienda.

If we want all of the water that falls on the roof of the volunteer house to reach the underground storage tank, we will have to find a way for the gutters on the north, east, and south side of the house to drain into the underground storage tank. To use the water that is collected, we will need to find a way to pump the water out of the underground storage tank and into either the irrigation system or the elevated tanks for use in the houses later. If we want to use the rainwater in the houses, we will have to clean and find lids for the three smaller storage tanks that are on the elevated platform. In addition, we will have to purchase and install pipes from the elevated storage tanks to the houses and fix the automatic water shut-off system.

Ronan, who lives in the volunteer house currently, also suggested that we reuse grey water. A system that reuses shower or sink water to flush toilets might be beneficial and cost efficient for the house.

7.6 Passive Solar Water Heating

7.6.1 Overview of Passive Solar Water Heating

Passive solar water heating is a process of heating water with sunlight. The solar water heater consists of a solar collector that faces the sun and absorbs the heat energy from the sun. Water is

piped through the solar collector, where it absorbs the heat and then hot water can be piped into a storage tank and held until it is needed.

To make the passive solar water heater, start by building a shallow box that will most likely be mounted on the roof of the house. The bottom of this box needs to be a dark absorber plate to soak up the heat and the top of the box needs to be a material like glass or plastic that will allow the sunlight through. The bottom also needs to be very well insulated to retain the heat. Then, either tubing or piping should be laid inside the enclosure. There should also be an inlet for cold water and an outlet to the storage tank.

Passive solar water heating is both environmentally friendly and economical. After the initial cost of the installation, the only cost is upkeep. With solar heating, the sun does all of the work and the fuel is free. Solar energy is also much cleaner than any other kind of power source. There are no air pollutants associated with solar power like there are with most of today's power plants. Also, passive solar heating is much more reliable, easier to maintain, and cheaper than active solar heating which has pumps and controls.

7.6.2 Applicability of Passive Solar Water Heating

Passive solar water heating would be a useful addition to the volunteer house. It could be used alone or in addition to the current electric water heater. The main issue concerning the passive water heater is that it needs to get enough sun to produce adequate heat. The sunlight in the summer months should be more than sufficient, but there may not be enough sunlight in the winter months to fully heat enough water. This could be one reason to use the passive solar water heater in parallel with the electric water heater. Another consideration is the availability of materials. When looking around local area stores and suppliers, all of the necessary materials were found. Further deliberation and design may be necessary to ensure that the most efficient and cost-effective materials are used. Also, looking at the volunteer house, it seems to have an appropriate roof and layout for passive solar water heating.

We are currently unsure how well passive solar water heating will be accepted into communities. People are used to using only cold water and may not immediately, if ever, see the benefits of using hot water. Ideally, the passive water heater could be used to heat water for all household uses. However, even if hot water were not seen as a comfort issue with people, i.e. they would prefer to keep taking cold showers and baths, it could be seen as beneficial for its superior cleaning ability. Therefore passive solar water heating may be accepted and used at least for washing dishes and clothes. It could also work in the opposite way. One woman on the hacienda currently has an electric water heater for showering but still does all of her washing in cold water. It is a cultural habit that she has no desire to change.

7.6.3 Current State of Water Heating

Currently, the volunteer house has an electric water heater. However, the voltage in the house is very low, limiting the ability of the water heater. The result of someone is taking a hot shower is that the lights are dim and there is shaking in the rest of the house.

In the communities, there are no water heaters. If hot water is desired, it is heated up in a pot on the gas stove and then used.

7.6.4 Materials for Passive Solar Water Heating

There are many ways to construct a passive solar water heater. Materials that are cheap and easy to get near the hacienda could be used for this project. The box can be built out of wood and you can use any material that retains heat well for the base. Black paint can be used to make it even more heat absorbent. Any type of insulation that is available can also be used to retain the heat and either glass or a plastic material like Plexiglas or flexible plastic sheeting can be used for the top. For the piping, a conductive metal piping such as copper pipe is good or a rubber hose could be an alternative. You will also need a few small additional items like nails, solder and silicon glue or caulk. For equipment, you need hand tools such as a hammer and a saw to build the box and a hacksaw and propane torch for the pipes.

7.6.5 Feasibility and Recommendations

After assessing the needs and resources of both the FBU volunteer house and the local communities, it has been determined that passive water heating would be both feasible and beneficial. A passive solar water heating system could be designed and implemented on the volunteer house for both educational purposes and benefit to FBU and then, based on the results and interest, more passive water-heating systems could be designed and installed in the community.

7.7 New Ideas

After we finished dimensioning the house, we had a discussion with Ronan, a volunteer currently living in the volunteer house. He had lived there for 3 months, and had a number of suggestions to improve the usability of the space. Below are the ideas that we brainstormed together.

7.7.1 Green Roof

We considered planting a vegetable or herb garden on top of the roof to make it a green roof. In theory, a green roof like that helps decrease noise pollution, serves as insulation, decreases the effect of urban microclimates, and provides green space for gardens to grow.

This would be applicable to the volunteer house because currently the rain on the aluminum roof is very loud. A green roof would decrease that noise pollution, as well as add an interesting component to our green building model.

This concept is more applicable to urban areas, however, because there are plenty of green spaces for gardens on the hacienda and in rural areas of Ecuador. This green roof would be more applicable to people in Picalqui or Quito, the more urban areas. People in Picalqui often sell their land to large flower plantation owners, and Quito is a compact city, so green space is sparse. A green roof there would be a great space for a vegetable or herb garden, which would cut down on costs of food for those families. Since most school groups come here from Quito for educational purposes, it might be beneficial for them to see and learn about the green roof.

7.7.2 Soundproof the Roof and the Walls

The volunteer house is connected to Louis and Esperanza's house by a thin wall; similarly, Stuart's house is connected to the living space for summer camps and large groups. Both Ronan and Stuart complained of poor noise insulation. If a simple solution to the thin Ecuadorian walls could be found, it would be beneficial.

7.7.3 Find a Way to Manage Mud from People's Shoes

When a volunteer comes home, he or she walks inside, into the hallway, and around the corner before they take their boots off. The mud that falls off the volunteer's boots, especially the mud in the hallway, gets tracked all over the house because the hallway connects the kitchen, the bathroom and the bathroom. The mud problem may be solved by putting a grate on the ground in front of the door, or by building a place to store boots closer to the front door.

7.7.4 Vegetable Wash

The sink in the volunteer house often gets clogged. This is most likely due to the washing of muddy vegetables. On the hacienda, and in most of rural Ecuador, people eat vegetables straight out of the ground. They are usually caked with mud, so that mud can clog the pipes when the vegetables are washed. One idea would be installing a separate vegetable wash system where the grey water goes directly outside.

7.7.5 Improve the Ventilation in the House

Many Ecuadorian buildings have poor ventilation and are stuffy. Also, the adobe homes can get very damp from heavy Ecuadorian rains. Therefore, a proper ventilation system could be helpful.

7.7.6 Provide a System for Drying Laundry

While there seems to be little issue with hanging clothes outside to dry, the possibility of hanging clothes to dry in the space over the false roof was addressed. There is plenty of space up there that is currently useless, and if natural lighting was employed, the space could get warm and be a nice place to hang clothes. We envisioned a system with a rack tied to a string attached to pulley systems on the roof to raise and lower the drying clothes. This would be similar to the drying rack at the Tufts Mountain Club Loj. A drying area might also be helpful in the winter months when it is very rainy.

7.7.7 Change the Floor Plan

The volunteer house is laid out in a very odd, maze-like manner. Also, a lot of the rooms are currently unused. If we knocked down a couple walls, it might be better use of some of the space. A number of the walls are connected by a thin board, like the back of a cabinet. See the floor plan for more details.

7.7.8 Fix the Fireplace

There is an unused fireplace in the back of the volunteer house. Fixing and cleaning it might be nice for the volunteers who live there because it can get quite cold at night.

7.7.9 Make the Power Supply More Reliable

The power source in the house should be 110V, but it is not. Usually, one needs to turn off one thing in order to use another. Also, when the volunteer shower is used, the lights in both the

volunteer section and Louis and Esperanza's house flicker. Using energy efficient light bulbs might be a simple solution.

6.0 WHERE DO WE GO FROM HERE

Tables

Figures

Appendices

APPENDIX A: TRAVEL TIPS

As we explored Ecuador, we picked up a number of travel tips to pass on to the next travel team. Listed below is general information we gathered, and suggestions for next year's group.

1. Meals / food

- Breakfast is usually miniscule: a roll, instant coffee, and juice.
- Lunch is huge. Usually you can get a bowl of soup, juice, heaps of rice and potatoes, a vegetable salad, and some meat all for $1-$2 at any place that serves almuerzo. Also, store up an appetite if you are eating with a family because it is rude to leave food on your plate.
- Dinner is a less important meal. It is usually much smaller than lunch.
- Each meal has tons of carbs: heaps of rice, potatoes, and yucca.
- Marshmellows are gross and fruity.
- Jugo is just juice. It has no water in it, so it is ok to drink it. Refresco is different however; it is juice watered down and should be avoided.

2. Communication

A. - Internet cafes

- They are prevalent in most towns like Quito, Tabacundo, Cayambe, etc. On average, it is $0.70 per hour, but you can pay for less than an hour too.
- You can make international phone calls there; to the US is usually about $0.10 per hour.
- There are usually copy machines there. Printing is expensive, like $0.20 per page, but copying is only $0.03 per page.

B. - Cell phones

- You can get a SIM card at any Porta shop.
- A card costs $8, but you need to unlock your phone first. This should be done in the country, and takes a couple hours.
- Next, you need to buy a phone card and transfer that to the phone. We bought $10 worth, but the number of minutes depends on where you are calling (in or out of country, etc).
- Nikki's Nokia tri-band works because it is on an international plan. We assume it is probably quite expensive though.

3. Living arrangements at the Hacienda

- There are hot showers, running water, and flushing toilets with toilet paper. Water and gas are expensive and unreliable though, so be conscious of usage.
- There is a large kitchen with gas stoves, plenty of pots and pans and dishes, a fridge, etc. that the women on the hacienda use to feed school groups. We were allowed to set up in there, but make sure not to disrupt their organization. Also, you are expected to bring your own dish soap.
- We cooked all our own meals, but when there are school groups we just eat lunch made by Lucia and Esperanza and pay $2 a head.
- There are beds with sheets and warm blankets, but a sleeping bag might be useful because it gets cold at night.

- You can do laundry on cement washboards outside. Buy your own laundry detergent though; bars of detergent are recommended. ATTACH PIC OF LAUNDRY
- There is a fireplace in the main building, and firewood behind the stable.

4. Clothing / Weather
   - Bring boots, preferably "wellies", rubber boots, for working around the hacienda.
   - Work gloves are also good to have; everybody got blisters.
   - Even though the sun can get pretty strong during the day, it is dry heat so it is not overwhelming. Most Ecuadorians wear long pants and sometimes long sleeve shirts. Shorts are useless here, and your legs will get bitten.
   - Bring sunblock.
   - Bring lots of warm layers because it gets cold at night. Even in the buildings it can get cold during the day because the walls are well insulated; it stays cool all day long.
   - This year was a la nina year, so it has been exceptionally dry in the winter and rainy in the summer so far. Usually you don't see a drop of rain in June; however there have been some downpours and it was cloudy most of the time. Bring a rain jacket.
   - Weather is also unpredictable. Most of the time it was sunny in the morning and rainy in the afternoon, but it varied.

5. Transportation
   - It takes about 15 minutes to walk to the PanAmerican from the Hacienda. We caught all buses from the side of the road there.
   - The Quito bus station, Terminal Terrestre, is very hectic. There used to be huge pickpocket issues, so now there are guards all over the terminal. It is easiest to just ask a guard where to go.
   - On the weekend, buses from Otavalo to Apuela get booked very quickly. We took a bus to Otovalo and arrived at 7am, but tickets for the 8am bus had been sold out the day before. We ended up standing the whole 2 hour bus ride, but there are a few unsold extra seats in the front by the engine that you can take if you show up early. Jen sat there because of her bad knee, but those seats are usually given to deserving people like old ladies and women with babies.

Trip	Price	Length
Quito – Picalqui	$2 per person	2 hours
Picalqui – Tabacundo	$0.15 per person	10 minutes
Picalqui – Otavalo	$0.75 per person	45 minutes
Otavalo – Apuela	$2 per person	2 hours
Apuela – Carlos's house	$10 each way (back of a hired truck)	30 minutes
Picalqui – Cayambe	$0.22 per person	?
Airport – Hotel in Quito	$12 taxi-van ride	15 minutes

6. Lodging
   - We stayed at Hotel Viena Internacional the first 2 nights in Quito. It was in Old Town, so while it wasn't very touristy, it was much quieter than New Town. Free breakfast included, but very small. Noisy dog. Make sure you confirm 5 times. Stuffy rooms. Overall good rating though. Address: Calle Flores 600 y Chile; Centro Historico, Quito . Phone: (593)- 2- 295 –

4860. Fax: (593) – 2 – 295 – 4860. Email: vienaint@interactive.net.ec . Price: $11 / night/ person.

- The Cabanas we stayed at near Apuela in Intag (>4km from Apuela, 1 ½ hour walk) were really nice. Stuart arranged them. There were hot springs with a water slide to play on. Heidi had bed bugs though, and was bitten all over. 3 cabins with 3 bed each plus 8 dinners was $63 total.

- On June 13th we stayed at Hotel San Fransisco de Quito. Address: Sucre Oe3-17 y Guayaquil, Quito. Phone: (593) 2 – 295 – 1241 / 228 – 7758. Website: www.uio-guided.com/hsfquito . email: hotel@sanfranciscodequito.com.ec . Price: $90 for 6 people.

7. Shopping and Money

- The supermarket is expensive. The local market is much cheaper; we recommend you buy food at the Markato Central in Quito or the markets in Tabacundo and Cayambe. Also, imported foods are very expensive. For example, a box of granola bars was more expensive than it would be in the states, which is absurd for Ecuador. Any American comfort food should be bought before the trip.

- Ecuadorians will overcharge foreigners in everything from fruit at the market to biogas supplies. If at all possible, buy materials with a local.

- Almost all prices are negotiable. Bargaining is expected.

- Shop with small bills because making change is very difficult. Getting change for a $20 bill is almost impossible in a food market, and making change is an issue everywhere, from restaurants to bus rides etc. Bring lots of $1, $5, and change. Quarters are also good to have for using the Quito trolly.

- Ecuador is a cash economy, so it is impossible to get a receipt in markets and buses, for example. Writing that into any future grants might make reimbursement easier.

- Material shopping is “haphazard and random”

8. Other

- Don’t trust Ecuadorian time. Our bus was not there to pick us up when we first flew into Quito, even though we arranged it before hand. It is also common for Ecuadorians to operate on their own schedules. See the culture section for more information.

- Altitude wasn’t that bad, but we tripped a lot the first day. The altitude may have been a factor, so make sure to drink lots of water and eat plenty of carbs.

-Bring speakers. Preferable ones that do not need an outlet, but if someone brings a computer, computer speakers are good for using inside.

APPENDIX B: BUDGET

Expenses Chart

Expense	**Total Cost**
Accommodation	
Food	
Travel	
Biogas	
Miscellaneous	
Total Cost of Trip	

Financial Tips

Get a receipt for absolutely everything. Nothing can be reimbursed without a receipt. This can be difficult in Ecuador where prices are relatively low and everything is paid for in cash, but generally if you ask, someone will write one for you. Even if the vendor doesn't have a receipt book, you can ask them to hand write a receipt on a piece of paper. Always write the purchaser's name and social security number or student ID number on the back of the receipt. Elect a trip treasurer and who will keep all of the receipts and a log of all expenses in a notebook.

Bring small bills and change. Because prices are lower here, most places will not be able change large bills such as twenties and sometimes even tens. Fives and ones will be the easiest to spend. Also, change is very useful for bus fare as well as any smaller purchases.

Do not waste too much money at the grocery store. Much cheaper food can be found at local markets instead of large grocery stores. American brand names cost a lot more money than the local alternatives. Comfort foods such as granola bars and peanut butter that can't be found anywhere else and have no local alternative can be packed and brought from home.

Go shopping for materials with someone from the hacienda who is familiar with the prices and stores. There is not just one large hardware store, but instead many smaller places that may specialize in different things. You may also want to limit the number of team members that go because often when a number of foreigners all come in, the prices may raise significantly.

Look into writing a certain amount of cash spending into your grant. Sometimes it is possible to write a grant in a way that sets aside a certain amount of travel money that is preimbursed and does not need to be reimbursed with receipts. This could be very useful because Ecuador is a largely cash-based economy with few receipts.

APPENDIX C: NATIONAL CURRICULUM OF ECUADOR (1987 VERSION)

The four major areas of study include Spanish, Math, Social Studies, and Natural Sciences.

The specific curriculum as issued by the Ministry of Education in 1987 is as follows:

1st Grade:
Castellano
- Pronunciation

Matimaticas
- Measurement-
  - length- m, dm, cm
  - volume- liter, quarter liter
  - time and clocks
  - money
- Shapes, circumference, open and closed lines
- Counting

Estudios Sociales
- Holidays
- Family
- Dress, Classes, Origin, "History of Living"
- Transportation, methods and history of

Ciencias Naturales
- Nature, living and non-living
- Living - humans, necessities of life, body parts, the senses
  - plants, cycle of life, air and water, dirt
  - places of life
  - movement in animals
  - sun light and heat
- Day vs Night- moon and stars
  - Matter, energy, electricity and sound

2nd Grade:
Castellano
- Consonants vs vowels
- Simple vs double consonants
- Upper and lower case letters in script and print
- Syllables
- Accents
- Nouns (sustantivos) – personal, number, gender,
- Definite and indefinite articles
- Personal pronouns

Action verbs
Punctuation
Verb tenses

Matimaticas
Lines and positioning- horizontal, vertical, etc.
Addition and addition properties (associative, commutative, and modulativa)
Prime Numbers
Measurement- more and less than a meter
Line segments
Subtraction
Rational numbers
Quadrolaterals- perimeters
Weight measurement
Multiplication- commutative property
Angles- obtuse, acute, and right
Time and dates
Review of other shapes
Division
Four operations

Estudios Sociales
Vacations
School
- location, buildings, obligations of the students, parent duties for school
- the neighborhood, its limits, and its traditions/customs

Founding of Quito
Public services of the community and proper behavior of children
Repetition of transport, dress, holidays and history of some national holidays
Communications
Ecuador's regions
The seasons

Ciencias Naturales
Review of nature, living vs non-living, humans and body parts, senses
Hygiene and care of the senses
Needs of life- specifically air, water, and food
Classification of food and the production of calories and energy
Plants, parts of the plant and their functions, classification as food, medicine, industrial use, decoration, etc.
Classification of food plants- cereals, tubers, fruits, legumes, etc.
Where food is grown
Domestic vs wild animals
Mammals, birds, reptiles, and fish
Minerals, valuable minerals (gold, silver, and petrol) and where they are found
Water, states of water, material, energy, light and heat, soil and its movement

3rd Grade:

Castellano

- Oral, written, and mimicking language
- Subject and predicates
- Accents and tildes
- Noun classification
- Composition
- Definite and indefinite articles
- Proper names
- Adjectives
- Personal pronoun
- Verbs
- Punctuation

Matimaticas

- Length measurement and conversion
- Geometric elements- point, line, segment, plain, body
- Volume measurement and conversion
- Angles
- Mass measurement and conversion
- Quadrilaterals- perimeter and area- derive formulae
- Time
- Triangles- perimeter and area
- Money
- Circles- circumference, lines, diameter, radius

Estudios Sociales

- Marine vs terrestrial
- Solar system
- Earth processes (movement)
- Cardinal points, methods of orienting direction, the compass
- Neighborhood of school- streets, buildings, civil holidays
- Parochial classes- rural and urban
- Authority and obligations, public service, duties of a child in a family
- Political chief and organization of the municipality, duties of a child in society
- History of the region, dates, cultures, resources, transportation, communication, population and socio-economic levels
- History of the province- location, limits, organization and administration, history, natural resources, climate, civic holidays
- Commerce (provincial and inter-provincial)
- Sites of tourism, recreation, historic/ cultural, danger
- *Hoya* of Guayllabamba- location, relief, geographic features, hydrology, animal, vegetable, and mineral production; regulations in public and private acts
- Ecuador- natural regions, political divisions, location and boundaries, patriotic symbols

Ciencias Naturales

Inorganic Elements:
Air – components, properties, movement
Importance of vegetation to produce oxygen and the need for green space
Water-
physical states, water cycle, chemical composition
visit a treatment plant for potable water- characterization of potable water
dangers of drinking contaminated water
The ground/soil-
classification of sandy, *arcilloso, calcareo, humifero*
enmiendas, the effect of human activities, erosion

Living Things:
Plants: regions where they are found; conservation; classification by utility
Classes of alimentation and their origins
Hygiene
Parts of the plant
Animals classified by region
Humans-
body parts, principal organs of the head, upper and lower extremities, internal organs of the thorax and abdomen
stages of life and importance of alimentation in infancy, childhood, and puberty

Material and Energy:
Material and physical properties
Light and heat
Opaque, transparent, and translucent
Good and bad heat conductors (insulators vs conductors)
Electricity- use and dangers; good and bad conductors
Sound- classes of, echoes, noise
Simple machines- inclined planes, *palanca*, applications

4th Grade:
Castellano
Stress placed on conversation, narration, and recitation
Prepositions
Upper and lower case letters and when they are used
Punctuation
Sustantivos
Different types
Common errors in usage- gender and number
Adjectives
Different types
Use/formation of formal address and questions
Pronouns
Verbs- parts, use, conjugation, and common errors

Matimaticas

Conjuntos- union, intersection, and *complementacion*,
Length measurement and the S.I. system
Basic geometry- lines (direction and position), areas, and planes
Measuring area in metric and agricultural (hectare, *centiarea*) and conversion
10s and decimals
Absolute vs relative value
Quadrilaterals- squares, rectangles, rhombus, trapezoid, *trapecio, deltoide, rombo, romboide*
Mass
Weight- first non metric then relation to metric
Capacity and Volume- units
Multiplication
Angles
Division of decimals
Time units, international time, and age
Triangle- properties, perimeter, and area
Circles

Estudios Sociales

Climate zones, longitude, latitude, rotation, orbit,
Prehistoric times; indigenous towns and location; Incas
Responsibility: duties vs rights
Reading maps
Social organization of "primitive tribes," cultures of Ecuador
Three major regions of Ecuador (*costa*/ coast, *sierra*/mountains, and *oriental*/ Amazon and *insular*/ islands) and two major watersheds (Amazon and Pacific)
Quito
Economic relations between regions
Colonial times, Christopher Columbus, Spanish Conquest (Pizarro), Indigenous heroes
Moral qualities: truthfulness, punctuality, honor, etc
Ecuador's exports

Ciencias Naturales

Inorganic Elements

Green space and cleaning of air
Combustion
Water- classification of water bodies, as oxidizing agent
Soil- makeup, modifiers (internal and external)
Erosion and prevention

Living things

Plants- parts, functions, *fanerogamas vs criptogamas*, angiosperms vs gymnosperms
Vertebrates and invertebrates
Vertebrates: mammals, birds, reptiles, fish, and amphibians

Humans: tendons, cells, organs, systems
Vitamin, alimentation

Matter and energy
Particles, molecules, atoms, and their structures
Light, heat, velocity, propagation of light (reflection and refraction)
Thermometers, temperature, health
Electricity- *frotamiento* and induction
Iman
Sound and propagation

Power, work, and movement
Simple machines, types, balances, inclined planes, system of *poleas*,

5th Grade:
Castellano
Subject and predicate
Upper and lower case
Composition
Debate
Synonyms, antonyms

Matimaticas
S.I. System
Conjuntos
Cartesian coordinates
Geometry
Absolute value
Systems of counting
Polygons
Factoring numbers
Max common divisor and minimum common multiple
Areas (same as previous year)
Application of concepts into problems
Volume
Fractions, reduction, operations, mixed numbers
Capacity, Mass, Time

Estudios Sociales
Solar system, climate zones, bodies of land and water
Aztec, Maya, Chipcha, and Inca Cultures
Spanish conquest
Americas, geography, ocean currents
Patriotism, loyalty, solidarity, cooperation
Lake regions

Major rebellions; independence, emancipation
Different forms of living in America

Ciencias Naturales
Inorganic
Air- weight, volume, pressure
Water- states, potable
Soil- cultivated, erosion, contamination
Abonos

Living things
Cells, structure, types
Raiz (race) and function
Invertebrates and their characteristics- arthropods, mollusks, *analidos, nematelmintos*
Respiratory, circulatory system
Tallo
Leaves- *platelmintos, equinodrmos*
Blood
Invertebrates perjudiciales to humans- octoparasito
Alcohol, drugs, and tobacco

Matter and energy
Physical study of matter
States of matter and change
Heat and its effects on matter
Light- reflection, refraction
Electricity
Magnets and earth's magnetism

Power, Work, and Movement
Definition of fuerza, trabajo, and movimiento
Gravity
Machines

6th Grade:
Castellano
History o f the language
Writing
Public speaking
Predicates

Matimaticas
Geometry- parallel, perpendicular
Measurements- S.I. system
Angles- degrees and radians
Pythagorean theorem

Positive and negative numbers
Proportions, percents, and probability
Polygons
Poiedros, cubes, prisms, cylinders, cones, speres, etc.
Currencies, temperatures (C and F)
Statistics- mean, median, and mode
Commercial documents?

Estudios Sociales

Solar system, periods of history, etc.
Regions of Ecuador
Different forms of government
Division of Ecuadorian politics
Europe, Asia, Africa, Antarctica, Oceana (economics, politics, physical, peoples, and compare with Ecuador)
Sufragio
Capitalism vs Socialism

Ciencias Naturales

Inorganic

Air- components, hurricanes and cyclones, weather measuring tools, industry applications, contamination, control
Water- composition, types, surface tension, applications, Archimedes principle, capillarity, Pascal's principle, hydropower
Soil- geologic structures, "subsuelo fuente de riqueza"
Petroleum- origin, exploration, extraction, refining, derivatives, applications, importance to the economy of Ecuador, non-renewable resource

Living things

Plants, animals, humans- classification, properties, components
More detail- ie covering protozoa, bones, algae, etc.

Matter and Energy

Bodies and classification
Metal and non-metal
Mixing and combining
Light, lenses, heat, electricity and magnetism, electromagnetic, sound

Force, Work, and Movement

Define terms
Simple machines- all previous plus *torno*
Gravity

Comments:
* Memorization is built explicitly into the curriculum where problem solving and open ended problems in general are not. Many terms are vague.
* A couple of oddities are the attention paid to the Rio Protocol (Jan 29) and petroleum.

*Castellano curriculum is divided between: Locucion y Audicion; Lectura; Escritura, analisis, y sintesis; Escritura conf. y creative
*Matimaticas curriculum divided between: Aritmetica; Medida; Forma
*As of 4th grade social studies is divided between: geography, history, and civics

APPENDIX D: INUTES ROUGH DRAFT OF COLLABORATION AGREEMENT BETWEEN TUFTS UNIVERSITY AND ESCUELA POLITECNICA NACIONAL

APPENDIX E: MEETING MINUTES

I. MEETING WITH ESCUELA POLITÉCNICA NACIONAL
MAY 31ST 2006

Attendees:
2 faculty from Politécnica:
Dr. – Civil and Environmental engineering Dept; Jefe of Hydrology Dept
??? – specializes in irrigation and seemed to be very aware of specific student projects in the *campo* (field)
Tufts:
Chris Swan
Nicole Lane
Sarah Freeman

*Best overlap to include students and faculty with would be the "**Titulares**"*
-Capstone/ Thesis which includes research, field work, and lab work
-Many are based on four major categories of rural work
1. Alcantarillado (Residual water and sewage)
2. Riego (Irrigation)
   - Site: Cotapaxi
3. Agua Potable (Potable Water)
   - Treatment for towns- ozone or chlorine
   - At altitude usually only use bacteria removal systems
   - Site: Cotapaxi
   - Have also been involved in discussion on minimum quality regulations
4. Hidroeléctrica (Hydropower)
   - Mostly small scale for towns
   - Site: Paramo

Other work being done at Politécnica:
-Water management
-Effects of melting tropical glaciers in Machachi (?)
-Professor who researches this will be at the meeting on the June 13th (and speaks English)

*The university also has **other collaborations** with:*

-German schools (working on hydropower)
-Clemson

Resources at Politécnica:

-All major faculties of engineering
-Small sociology department
-Small public health program (both of these are accustomed to working in the field on teams with engineers)
-Water Lab
-Materials Lab

In order to engage other faculties they must be approached separately

FOLLOWING UP TO BE HELD: JUNE 13TH, 3PM

Documents for the Meeting

1. For the 13th they will have an outline of Titulares projects
2. Borrador for future work collaboration: Spanish and English version (us?)

II. MEETING WITH FBU AND TUFTS EWB

Thursday June 8, 2006

Attendees:

FBU:

Frediman , Stuart (Volunteers), Alfredo (School Groups, Summer Camps, Environmental Education Program, Mng w/ CONFEDEC Catholic Education Schools, Haciendo Programs, FBU's Lawyer (ie legalized El Cristal), Vice Jefe), Marcelo (Research and Reforestry)

Tufts:

Chris, Heidi, Sarah, Jen, Nikki, Kat

Introductions

What is Tufts EWB

Alfredo

- Thanks
- Technical and Technological exchange based on understanding of both FBU and Tufts EWB
- International funding is not there therefore partnering with us might be beneficial

Presenting our idea of "Green Building"

- potable water and filtration
    - irrigation water
    - drinking water

        - COMPANY???
        - Ceramic filter idea
- canal system for rain water
    - use as irrigation or potable- still up in the air
- 3 house system for water
- volunteer house fix up

Alfredo
- the issue for them is the lack of funding for the fix up of buildings, etc.
- environmental education is the new push in the interest of generating money

Cristal
- issue of potable water
- parasites in water effect especially children

Passive solar water heating

Alfredo
- CONFEDEC rural schooling- 21 schools connected to 35 communities
- Small business ideas

Major pushes at FBU:
- Infrastructure and water
- Interpretation center- where all information about FBU's work

Alfredo
- Follow up methodology filtration and dissemination
- FBU's Neccessities:
    - Paramo starting- Paramo and Zuleta other side of Otovalo to work with communities to help develop countries
        - Designing a community from scratch
        - Funded by GTZ from Germany
    - Development of Andean communities

Of ideas what are their preferences?

Alfredo

-different areas and community links

-although they need to develop the infrastructure of the Hacienda it is all with the final obligation to serve communities in need.

Catholic rural schools

-Contamination of water due to oil pipelines common

- general

Three Principle regions where work:

1. Pedro Moncayo
2. Columbia
3. Intag

Frediman
- Is there an interest in agricultural systems?
- Irrigation systems

Marcelo
- Center of capacitation
- Need for money- management of system
- Need means to make this an education center and the importance of presentation of the Hacienda- *Image*
- Wells that are not used (5) not maintained- 2 used when run out of water
- 2nd reservoir dry up during summer
    - built last year for $1000 but now doesn't work
    - reservoir leaks
- Semilleros- seed centers maintained by Marcelo
- tree nursery and seed sources
- constant word

Communications
- send meeting minutes to get the input of FBU along the way

OUR MAJOR POINTS MADE:
→Student group cannot promise money and funding, although

→Representative group of a larger team
-want to bring back ideas and let it take its form

→Identify ideas of mutually beneficial ideas

→Our requirements:
Work at school
Design
Multidisciplinary

III. MEETING WITH ESCUELA POLITÉCNICA NACIONAL – FOLLOW UP

IV. MEETING WITH PEPE, PRESIDENT FBU
Quito, Ecuador

Attendees: Jennifer Crawford, Nicole Lane, Sarah Freeman, Pepe

REFERENCES:

EWB Community and Health Survey for Individuals and Key Informants, administered June, 2006.

Personal Interview with teacher (Maria Suilar) at Escuela Picalqui, June 9, 2006.

Montenegro E., Lcdo. Marcelo, "Seleccion de Contenidos por Unidades Didacticas: Coleccion Ayda Docente Nivel Primario, No. 1." Distribuidor Exclusico Para Todo el Pais, Etecmo S.A. Pasaje Farget 155 y Ante. Telefono 570-757. Quito, Ecuador, 1987.

APPENDIX F: MATERIALS AND COST

Stuart asked Marcelo, and gave us some rough cost estimates of materials we suspected we would need to use in the future.

Glass	0.48cm x 0.38 cm	$1.10
PVC Pipe	3"	$1.80 / m
Black Tubing	½" ¾" 1"	$17 / 100m $20 / 100m $38 / 100m
Metal Gutters		$1.20-$3 /m (depending on thickness)
Asbestos Roofing		$4-$9 (depending on thickness)
Aluminum Roofing	2 x 0.80 cm 3.2 x 0.80 cm	$5 $8
Clay Tiles	40 x 24 cm, 17cm taper	$150 / 1000 tiles
Labor	Lowest Builder Carlos	$7 / day $13 / day $15 / day
Clear Plastic		$6 / m^2
Black Paint		$12-$20 / gallon
Copper Piping	½"	$1.50 – 2.00 / m
Adhesive		$3 - $10 (depends on size of pot)