Introduction Engineers Without Borders (EWB) is a humanitarian organization capable of implementing sustainable engineering projects that will improve the quality of life for people in developing countries. Each chapter under EWB-USA makes a minimum five-year commitment to a partnering community. The chapter works alongside this community in order to design and implement low-cost, small scale, and sustainable engineering solutions. Here at the University of Florida, Engineers without Borders has joined efforts with Engineers in Action (EIA), a non-governmental organization, to launch a project in Cachitambo, Bolivia to enhance the welfare of 60 families for generations to come. Our Cachitambo team is composed of 13 undergraduate students from electrical, mechanical, chemical, civil and environmental engineering disciplines, including three United World College students. Our connections with local Potosi engineering students aid in making the project even more plausible and sustainable. We also maintain close contact with several graduate student advisors from many backgrounds. Thus far we have undertaken two trips to Bolivia to assess the needs of the community and successfully tested prototypes for our designs. With the help of local residents, we will provide rainwater collection systems and personal greenhouses for the majority of the community. The success of the prototypes has ensured that our project will flourish. In August 2012, we plan on travelling to Cachitambo to implement these projects.

Background The village of Cachitambo rests in the mountains of Cerro Rico above the city of Potosí, the highest city in the world. In this mountainous landscape, the average annual temperatures range from 26 to 65 degrees Fahrenheit, and there is no more than twelve inches of rainfall expected each year. The little water that does collect in streams is frozen for most of the year and likely contaminated from vast silver mining in the underground water community's past. This climate, coupled with nutrient-poor soils and insufficient water supply, makes for less than ideal agricultural conditions. Currently, the little income these families collect derives from dangerous local silver mines that have long since been stripped of valuable ore. They also practice small-scale sheep and llama farming. Of the many needs this community has, two that our team wishes to address are their need for a sustainable food source and a stable supply of water.

In May 2010, the team embarked on our first assessment trip. This was a very enlightening experience for us. When we were first assigned this project, the sole focus was to build greenhouses. During the assessment trip it was determined that there are several things that must be evaluated and conquered before this is possible. Upon arrival, the team discovered the village's water sources, or lack thereof. There was a dry well that had not been used in years and a second well put in place by Chinese developers that only provided limited amounts of water. Though ample water discharges from the nearby mine it is very likely contaminated with mining by-products and unsuitable for consumption or irrigation purposes. The town was also fairly abandoned. Most villagers have been forced to relocate to nearby cities Potosi and La Paz where jobs, food, and water are more readily available. That being said, we now have to change focus a little and first bring potable water to the village of Cachitambo.

In August 2011, the team took part in a second assessment trip. We utilized some of our resources to implement the prototype of our rainwater collection system and our greenhouse. We also discussed with the community their involvement with the project and determined their willingness to build gutters along their houses to aid in water collection. Their enthusiasm to participate verified that many of them desired personal rainwater collection systems. On this assessment trip we also discovered an accessible, clean water source in the form of a small stream that we hope to channel to a reservoir in Cachitambo via a water dam system.

Concept After analyzing the water situation, we initially considered drilling another well. Seeing that wells had worked in the past, this seemed like a viable option. However, after further examination we concluded that drilling would be too costly and would not meet the highest standards of sustainability embodied by the EWB chapter. Not only are wells costly, but their construction is outside the scope of students' abilities, and require long term community maintenance. Therefore we are considering an alternative solution that is small scale, low-tech, inexpensive and easily maintained by the community: rain-water collection systems. We have designed roof-top rainwater collection systems that gather and

store rainfall from each house, making water accessible year round for drinking and irrigating localized gardens. Since our design depends upon maximizing surface area for collection sites, we will install other roofed structures in the communal areas that can double as storage sheds. Our most recent trip verified the efficiency of our design. We plan on installing 30 water collection tanks this upcoming trip, one per family. In the future, if we discover that these tanks have been successful, we will continue this project and install the remaining 30 tanks for the rest of the families in the community. A second alterative we are considering is installing a dam system as previously mentioned. This system will provide a centralized water basin for the community to use collectively, especially during the dry season when wells dry out by the early afternoon. This option requires further research and will be assessed on our upcoming trip. Both of these options are easier for the community to understand and maintain. Once our water collection issue is resolved, we can then move on to implementing the greenhouses.

Our greenhouse designs are simple and creative, lending to the ease of use and maintenance the community requires. The concept of individual greenhouses came about as a means to prevent conflict over control of the greenhouses. This will also foster a sense of responsibility and ownership for each family. In the years following the construction of these greenhouses, we hope to see enhanced trade between families and with nearby communities. These greenhouses will be the first of many projects that EWB-UF will provide to Cachitambo to insure a long lasting resolution. EWB-UF members will train local community members and nearby NGO's to successfully monitor and maintain the projects.

In order to make the greenhouse construction and maintenance sustainable and inexpensive, we are forgoing the traditional design in favor of a Pankar-Huyu. Pankar-Huyus (Aymaran word for “garden bed”) are earth-dug greenhouses that require very few common materials that can be purchased in nearby Potosi. A Pankar-Huyu is a partially-dug plot 4 ft wide, 10 ft long and 2.5 ft deep. The bottom is covered with gravel for drainage, and then soil and manure are placed on top. A clear cover is made of a sturdy plastic sheet and wooden frame and can be opened or closed to control temperature. A sketch of this device can be seen below in figures 1 and 2. Because llama and sheep farming is already integrated in the community, manure will be constantly available at no cost. Additionally, composting of organic waste will be taught to enhance soil health. The simple design and cost-effectiveness outweigh the possible benefits of a typical greenhouse design and do not require technical education within the community. The selection of such basic materials ensures they can be bought in Potosi, thus relieving the community of expensive transportation costs. During construction of the initial Pankar-Huyus, villagers will be taught the building techniques so that they can continue building their own while we are back in the United States.

The people of Cachitambo have exhausted their efforts to make an income from the resources in the region. Coupled with the lack of water and inability to grow food, much of the community structure has disintegrated. The local school has closed its doors to the few local children that remain. Upon our “town-hall” meeting with the village members, we heard adamant interest in the reopening of their school house. By providing potable water and greenhouses for nourishment, our project will indirectly aid in the reopening of the school.

Instead of just handing these communities food, money, and water, we hope to teach them to be self-sustaining and capable of producing goods for trade. Since our designs are inexpensive and effective, we hope that our project may be a model for communities in other water-starved parts of the world. We thank you for your time and consideration of this project.

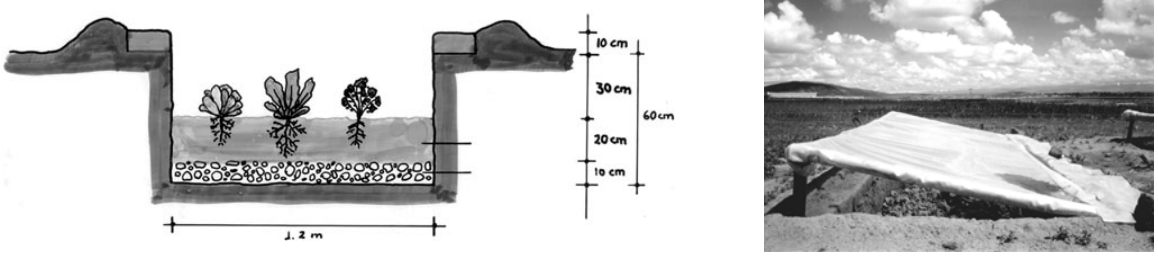

Fig. 1- Pictured are a sketch (left) and photograph (right) of a typical Pankar-Huyu, Courtesy of the Benson Agricultural & Food Institute & Corporation