Appendix G: Sanitation Project

Objective:

Provide sustainable and affordable human waste sanitation in the village of La Fortuna and Tule to reduce the precedence of diseases like diarrhea and dengue. Look into the possibility of new technological development and aim to win the EPA P3 competition. This group project will be combined with other projects which provide clean water supply to the community. Together the projects will improve the health, benefit the economy, improve the education and increase the living standard of people in La Fortuna and Tule in general.

Relevance of the project to P3:

People – The community usually disposes of its excreta on the ground or into the river where there are bushes for privacy. The sanitation system will reduce the amount of excreta lying randomly on the ground and prevent flies from surrounding human wastes. This improves the hygiene of the community by preventing diarrhea and other gastrointestinal diseases. Having a proper excreta disposal system also reduces the possible breeding sites of mosquitoes and helps reduce the transmission of diseases. It will provide sanitary convenience especially at night, and for women, it helps prevent sexual harassment.

Prosperity - The health improvement resulting from the sanitation system will enable people to be more productive. It will boost the attendance in school as there are fewer students getting sick each day, thus helping the community develop their young for the future.

Planet - By having a system to dispose of human waste, there will be less pressure on the flora and fauna in the region. A cleaner environment will result from the more organized system.

1. Introduction

La Fortuna and Tule are villages in Honduras with dispersed community distribution. One takes an average of 10 minutes to walk from one house to the other. There are no wells in the community and there is a stream which, on average, is 10 minutes walking distance from the houses. The stream is located at a lower elevation than most houses. There is also a spring at a higher elevation than most houses. The community currently does not have a sanitation system. Human waste is usually disposed on the ground where there are bushes for privacy, or into the river. Laterites, which is strong but rather impermeable, is the typical soil found there. There are altogether 29 households in the community. The family size ranges from 1 to 9. The average family size is 5. Refer to Attachment G-7 for details of each household.
2 Latrine Designs for La Fortuna and Tule

We consider two types of latrines for La Fortuna and Tule. They are pit latrines and composting latrines. For the two latrine designs, we also have different materials to choose from—brick, concrete, ferro-cement or wood. A pit latrine is basically a hole dug in the ground with a slab cover and a shelter. A few improvements we include are adding pour-flush toilet, water seal, offset pit (pit not directly below the toilet hole) and twin pits. A composting latrine has a waste storage vault above the ground. One adds sawdust, woodchips and ashes into the pit to facilitate the reduction of wastes into compost, which can then be used for fertilizer. The two designs are chosen over a few other designs because they are comparatively easier to empty. Other designs such as an aqua privy require the use of higher technology like hand pumps which are neither readily available, nor affordable in the community. These two designs are also more sustainable compared to a primitive pit latrine where an entirely new pit needs to be set up after the old one is filled up. See Attachment G-1 for diagrams of a primitive pit latrine and an improved pit latrine (our design) and Attachment G-2 for diagrams of a composting toilet.

The pit latrine is designed with water seal to prevent odor from escaping through the hole in the slab. A pour flush system uses water to flush down excreta into the offset pit and adds more water into the pit. The water and liquid part of human waste will soak through the ground in the pit. The problem with this design is that since the soil is impermeable, water may fill up in the pit quicker than expected. An overflow pipe from the pit that leads to a seepage area is therefore included. Both offset pit and twin pits facilitate emptying, which will be done manually with shovels. The offset pit allows the user easy access to the content of the pit just by removing the cover. Each pit in the twin pits is designed for three-year use before getting filled up. Once one pit is full, the channel leading to this pit is blocked and excreta are led to the other pit. The first pit is emptied when the second one is full. By then, it will be at least three years since the excreta are first deposited, so the wastes would have decomposed to reduce odor and increase safety when handling.

The composting latrine requires high maintenance on the part of the users. One advantage it has over pit latrine is having a storage vault above the ground, which means it is not dependant on the impermeable soil. This storage vault is divided into two, much like the twin pits of the pit latrine. Users rotate from using one pit to another every one or two year. The latrine cannot be designed to take longer to fill up due to the space constraint above the ground. It should be noted that conveniences like water seal or pour flush are not applicable for a composting latrine since there is a strict moisture content requirement for the waste to turn into compost. Emptying for the composting latrine is simpler than pit latrine and is done through the back doors of the storage vault. See Attachment G-3 for a summary of pros and cons of the pit latrine and composting toilet.
3 Detailed Design of Pit Latrine

3.1 Pit

The pit should be at least 20 m from the nearest stream, 6 m from the nearest dwelling, 6 m from any drinking water pipelines and pila\(^1\) for hand washing, 3 m from the nearest property line, no farther than 30 m from the building to be served (for convenience) and it should be on fairly level ground. The bottom of the pit should be at least 1 m above the groundwater level and the impervious layers (creviced rock, hardpan, shale or clay). Refer to Attachment G-11 for the Site Layout. The size of the pit depends on the volume of discharge. The pit dimensions we are using are 1.5 m long x 1.5 m wide x 1.1 m deep. This is designed for the largest family size (9 members). Refer to Attachment G-4 for the exact pit calculation. The pits are designed not to be too deep for ease of emptying. Each will last three years. Assuming strong soil properties, there will only be minimal lining/wall support consisting of a few crossing poles/wooden blocks.

The pit cover is made of ferro-cement. Its dimension is (1.49 m long) * (1.49 m wide) * (0.06 m thick)

3.2 Slab

The slab is where the toilet hole lies. It is the base supporting the shelter/the user. It can be made out of a few different materials- concrete, ferro-cement, or wood. Concrete is a mixture of cement, sand and gravel. It lasts long and is the strongest among all, but these come with high cost. Ferro-cement is a mixture of cement and sand spread on frames of chicken wire, which adds to the ferro-cement tensile strength. It also lasts long and it is not as bulky as concrete. Slabs made out of wood are the most economical option. However it is also the least sustainable and it does not confer mechanical strength as much as the other two. Refer to Attachment G-6 for comparison between different materials.

The slab dimension is designed to be (1.2 m long) and (1.0 m wide). Its thickness varies according to the material used. The toilet seat is constructed on the slab. It is a seated toilet for convenience. The toilet seat can either be pre-fabricated, or constructed on site.

3.3 Shelter

Shelter can also be made out of different materials like wood, ferro-cement, bricks or concrete. The dimension of the shelter is exactly like that of slab: 1.2 m long and 1.0 m wide. The height of the shelter is 1.8 m. This number suits the height of the average people in La Fortuna and Tule. The roof is made out of corrugated zinc and it is tilted at 30 degree to allow rainwater to flow down. Netting is attached from the walls to the roof to provide ventilation. The material for the door is wood, since it is the lightest of all. We ruled out the use of bamboo due to its scarcity in La Fortuna and Tule.

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\(^1\) Pila is a wash basin
4. Detailed Design of Composting Latrine

4.1 Vault

The vault is either made of concrete, brick or ferro-cement. It is 1.10 m long * 1.60 m wide * 0.70 m high and this volume is divided into two equal parts, equivalent to the twin pits system in the pit latrine. Two rectangular openings are made for the doors and two holes of 100 mm diameter each are left for ventilation, which is crucial for decomposition of wastes into compost. Refer to Attachment G-5 for calculations of the dimension of the vault.

4.2 Slab

Much like the pit latrine, the slab for composting latrine can be made out of concrete, ferro-cement, or wood. However the slab for composting latrine needs to be stronger since it is directly above the vault, unlike the pit latrine where the slab is a distance away from the pit. The slab dimension is 1.85 m long * 1.25 m wide. For the composting toilet, pour-flush is not included so as to control the amount of water getting into the vault. For this reason a squatting toilet is preferable than seated toilet since wastes will drop right into the vault and not make much of a mess.

4.3 Shelter

The shelter for the composting toilet is designed very much the same as the pit latrine.

5. Budget

Refer to Attachment G-8 for materials cost and detailed cost calculations for pit latrine and composting latrine

The cost to construct one pit latrine is $ 140. For 29 families, the cost of the entire project is $ 140 * 29 = $ 4060

The cost of one composting latrine is $ 544.2. For 29 families, the cost of the entire project is $ 544.2 * 29 = $ 15781.8

The unit costs of materials are obtained from our previous visit to Honduras. Certain price information is gathered recently through FUCHOHSO, an organization in Honduras.

6. Education

Sustainability of the project depends largely on educating the community about the new system and their health. Workshops will be held to emphasize the importance of hand washing, toilet flushing and cleaning, and also general maintenance of the latrines and issues with emptying the latrines. Long term plan such as incorporating sanitation education in school curriculum is also a
means to make the project more sustainable. Formation of a sanitation committee to deal with common latrine problems also helps to lengthen the benefit the project offers to the community.

7. Technological Innovation

After designing for the most cost-effective and sustainable latrine, we still have several design challenges. We realize that the pit latrine design fails if the gets full and clog the system; therefore, we design an alarm system for the user. Also, to save the cost for shelter, we design one that uses as little material as possible. Lastly, emptying the pit latrine is difficult; therefore we design a tool to plough out the solid content without user contact. Therefore we come out with a design for the tool for emptying. Refer to Attachment G-9 for details of these technological innovations.

7. Limitations and Suggestions

1. We have yet to obtain the exact data about the property of soil; its strength, permeability and groundwater level. Specific tests, like percolation test, must be conducted during our next trip to collect these data. These results may affect the final design and costs. Refer to Attachment G-10 for details of specific tests.

2. We design a single pit size to fit the largest family in La Fortuna and Tule (9 members). However, many families are smaller (around 5 members) and several families are much smaller (1 or 2 members). We would need to balance out the inefficiency of having only one pit size with the difficulty of communication of design to local workmen. Depending on our further findings on the community preference and ease of communication, there might be slight variation to the dimensions of pit for smaller families.

3. New York Help, an international organization working to improve the quality of life of rural communities in Honduras, is planning to build latrines in La Fortuna and Tule as well. The exact number of latrines constructed will depend on how many latrines New York Help is going to build. Currently they plan to build is 6 latrines.

4. There might be a need to build latrines in the community’s public buildings such as the school and the health center. This will also affect the final number of latrines we will construct.