Survey of sanitation conditions in Burkina Faso for design of toilet

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Abstruct

In Burkina Faso, 62.8 % still continue to practice of open defecation. Because the main job of people in the rural area is farmer, increase of fertilizers price may hit seriously. To improve their life, installation of composting toilet is one idea. The pilot model is designed and manufactured based on the design policy established from the survey in the 3 villages in the country to find acceptable model for the people, then the production price and problems on was production was discussed. As a result, the target family for design of the pilot models, which are sitting and squatting types was set. The model was installed and showed to the people. Their impression said, people don't want to see their feces, to show their visitor it, and to touch the reactor directly. So, the reactor must be covered or separated from their view range. Only few actions are accepted for the toilet. This will related to easy operation of the toilet system. Total 900,000 FCFA for sitting style and 100,000 FCFA for squatting toilet are required. Half of the cost was house construction. So, development of acceptable cheaper house for the toilet is required to reduce the construction fee.

Keywords; *life style, design criteria, interface, engineering reactor, reuse of human excreta*

1. Introduction

The government of Burkina Faso reported 3.1 % of people in Burkina Faso has improved sanitation and 62.8 % still continue to practice of open defecation in the 2012 Sanitation and Water for All High Level Meeting (Government of Burkina Faso, 2012). And, 76% of people lives in rural area in the country(UNDATA, 2008). These facts show the main target to promote sanitation system is people in rural area.

On the other hand, the main job of people in the rural area is farmer. Increase of the unit prices of the fertilizers as shown in Figure 1 (FAO, 2009), results serious poverty problem, which is expected that the people become harder to buy sufficient amount of fertilizers. Here, human excreta has enough amount of nutrients (Almeida, Butler, et al., 1999; Ralf Otterpohl, Grottker, et al., 1997; Malisie, Prihandrijanti, et al., 2007), because the nutrients in the food is metabolized and

mineralized but most of them will be excreted in the feces and urine. So, the recovery of the nutrient can resist against the price increase of fertilizer. The feces require the composting process to be ready for utilization of the nutrients as fertilizer, since the easy biodegradable organic matter in the feces has bad effects for the plants. Therefore the composting toilet is an idea to improve sanitation and to solve poverty issue.

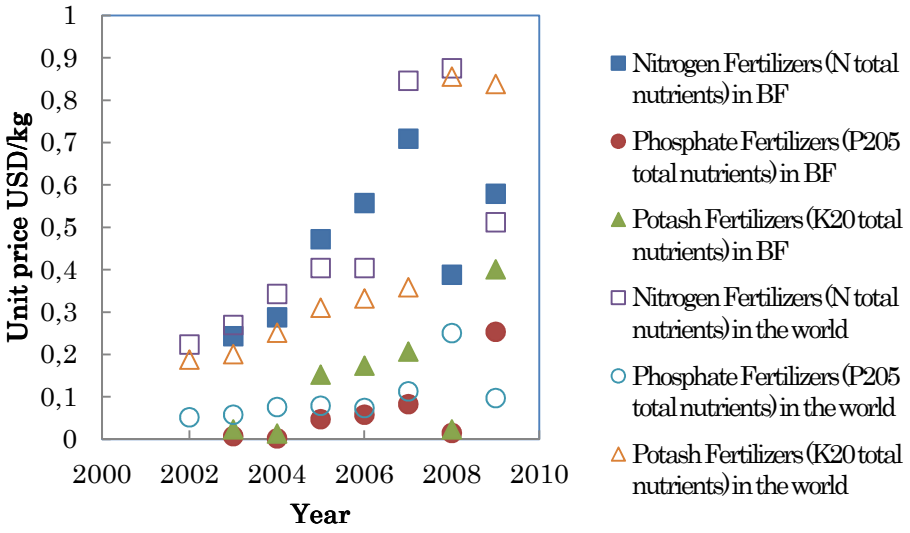

Figure 1. Time course of unit price of fertilizers

According to the composting process, many reports are available (Baca, Esteban, et al., 1993; Turner, Williams, et al., 2005; Levy and Taylor, 2003; Zambra, Moraga, et al., 2011). The primitive composting process is just dumping the manure with agricultural wastes as carbon source. Then the compost is mixed periodically to supply fresh air into it. The microorganisms metabolize the easy biodegradable part of the organic matter, ammonium nitrogen and orthophosphate to grow their body. Lopes et al. proposed the decentralized water treatment system (Lopez Zavala, Funamizu, et al., 2002), while the composting toilet is one of the key equipment of the system. Their composting toilet is designed for small family and has much amount of sawdust as the composting matrix in the reactor, the devices to mix the matrix and ventilation (Lopez Zavala and Funamizu, 2006). The composting matrix has several functions: 1. Big pore volume to keep moisture and air, 2. Large surface area to provide for the place of microorganisms, to spread out the feces to form thin layer, and exchange carbon dioxide, oxygen, water etc. between gas phase and liquid or solid phase. The behavior of the composting processes and inactivation of pathogens in the reactor is well studied and the operation conditions are made cleared (Lopez Zavala, Funamizu, and Tetsuo Takakuwa, 2004b; Lopez Zavala, Funamizu, and Tetsuo Takakuwa, 2004a; Lopez Zavala and Funamizu, 2005; Lopez Zavala, Funamizu, et al., 2005; Kazama and Otaki, 2010; Hotta and Funamizu, 2007; Hotta and Funamizu, 2009).

To familiarize the toilet system in the country, the toilet system must be acceptable for them, because the sanitation system to treat their excretion is quite new for the people who have the practice of open defecation. So, the demand for the function of the system and current situation is surveyed with careful consideration of their culture and behavior. Then, the pilot model is produced. In this paper, the pilot model is designed and manufactured based on the design policy established from the survey in the 3 villages in Burkina Faso, then the production price and problems on is production is discussed.

2. Methods

2.1.Survey in the villages

The survey is done in the 3 villages; Barkoumba, Kologonduesse and Kanboinse. We had questionnaire on ethnic, religion, component of the family, something for practice of defecation, construction materials for the toilets, construction style, experience reusing night soil from human feces, and demands for new toilet. After the installation of pilot model to the pilot families, we asked first impression of the model.

2.2.Design of the pilot model

The design policy is set based on the results of the survey. Wood, iron and cement were considered as construction materials. Several pilot models were designed and manufactured experimentally. Then, the production cost was calculated

3. Results and discussions

3.1.Design policy

The model family is assumed as follows based on the survey;

1. The number of family members is 5 – 20 persons including 2 – 6 adults.
2. The ethnic is Mossi and Peul.
3. The religion is Christian and Muslim,
4. The current defecation style is sitting style with the hole on the cement floor on a pit, some family is open defecation.
5. The construction material of the toilet is local adobe bricks.
6. The shape of the wall is like shell of a snail without roof and door
7. The height is 1.5 m to hide their body during defecation.
8. The toilet booth is square shaped of 2 m per side.
9. Muslim people looks south during defecation, and washes their body with small amount of water scoped by small bucket, then the water goes into the pit.
10. Christ people use paper etc. for cleaning their body.
11. The toilet is placed near their concession in Peul village.
12. The toilet in Mossi village in rural area has distance from concession, but 2 families require the toilet just next to their concessions.
13. Some families have experience to reuse of night soil from the human feces and compost from livestock manure, garbage, agricultural wastes etc.
14. People demands squatting type toilet and one family want to use sitting style.
15. No electricity is available.
16. The water is taken from the well.

To adopt this situation of the assumed family, the design policy is described below;

i. Basic technology is composting toilet: no water use and production of fertilizer.
ii. Sitting style and squatting style toilet must be considered.
iii. Urine and feces should be separated: to eliminate high water load to the reactor(Lopez Zavala and Funamizu, 2005; Lopez Zavala and Funamizu, 2006) and low recovery rate of the nitrogen (Hotta and Funamizu, 2007).
iv. The third hole to collect body cleaning water for Muslim.
v. Material should be available in Ouagadougou which is capital of Burkina Faso.
vi. The house for the toilet is made from cement block.
vii. The size of the toilet is 3 or 4 m^2.
viii. The ventilation should be natural ventilation.
ix. The mixing of the composting matrix is by hand.
x. The composting reactor is detachable for easy replacement of the contents.
xi. The separated urine and the cleaning water are collected in the tank.
xii. The capacity of the toilet is 5 – 10 persons/unit.

Therefore, the rough design of the toilet is drawn as Figures 2 and 3. The toilet bowl is on the

stage or the platform. The reactor and tank are placed under the toilet bowl. The reactor has a hole to put the feces and the hole is just under the hole of the bowl for feces. The support is set to allow the reactor rotate. People can rotate the reactor of the sitting style by hand with lifting the toilet bowl. For the rotation of the reactor of squatting type, a long bar is connected to the shaft of the reactor and people can operate the rotation on the platform. The tank is connected to urinal of the bowl with the flexible tube.

3.2. Manufacture of the pilot model

Figure 4 is the photograph of the prototype of the reactor and support. The reactor and the support are made of wood, and the shaft and handle is iron. Figure 5 shows the prototype of sitting style toilet. The stage for putting the sitting style toilet bowl is installed and the reactor is rotated with lifting the stage. These prototypes are made of wood. Figure 6 shows the house for the toilet and it is constructed with cement blocks. In Burkina Faso, people in the rural area use local adobe bricks for construction of their houses. But, they are easy to break by rainfall, requires long takes time for preparation and 3. people need to collect the materials for the bricks by themselves. Woods cannot be construction material for the house, because termites will eat them to destroy the construction when they directly contact on the soil of the ground. Therefore, we decided to use cement blocks which are available in the marked near the village for the pilot model. Inside the house, we put the pilot models of sitting and squatting type as shown in Figures 7 and 8. The support is made of iron and the stage and platform are woods. The composting reactor is placed under the stage of sitting style toilet or under the platform of the squatting type toilet as in Figure 9. For the squatting type toilet, the black rubber sheet which the small tube is plugged is installed for collection of the body cleaning water.

3.3. Impression of the people

We had the training workshop to tell how to use the toilet for the people as shown in Figures 10 and 11. After the workshop, we asked the first impression on the pilot model to the people and it is summarized as follows;

For sitting style;

1. They are ashamed to see their feces in the reactor. The reactor must be covered.
2. The stage is too high. They don’t like the step because unstable.
3. They don’t want to touch the reactor by their hands. The handle or other mechanism for rotation of the reactor is required.
4. The toilet bowl is too big for their children. Some additional tool is required.
5. Body washing space is required.

For squatting type;

1. The rotation of the reactor is hard work. Currently more than 8 times movement of the bar is required.
2. Some time it has mechanical problems.
3. They almost satisfied.
4. Children will break some equipment.

From their impression, people don’t want to see their feces, to show their visitor it, and to touch the reactor directly. So, the reactor must be covered or separated from their view range. Only few actions are accepted for the toilet. This will related to easy operation of the toilet system.

3.4. Cost for the construction of pilot model

For the construction of the pilot model including the house is as follows (655 FCFA = 1 EUR);

1. House: 500,000 FCFA
2. Reactor with support for sitting style including stage: 350,000 FCFA
3. Reactor with support for sitting style: 300,000 FCFA
4. Platform for squatting style: 150,000 FCFA
5. Tank for collection of urine and body cleaning water: 2,000 FCFA
6. Tube: 2,000 FCFA

Total 900,000FCFA for sitting style and 100,000 FCFA for squatting toilet are required. Half of the cost is shared by house construction. So, if the people accept cheaper house for the toilet, we can reduce the construction fee.

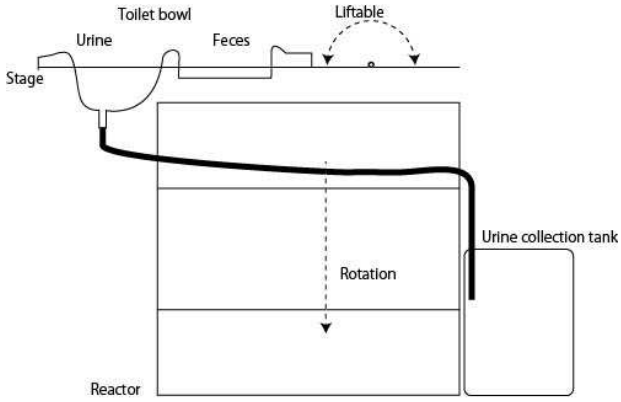

Figure 2. Arrangement plan of sitting style toilet

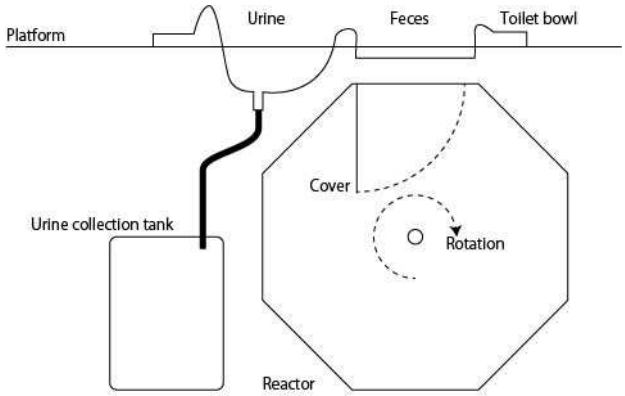

Figure 3. Arrangement plan of squatting type toilet

Figure 4. Prototype of the reactor and support

Figure 5. Prototype of sitting style toilet.

Figure 6 Outside of the pilot model of the toilet

Figure 7. Inside of the pilot model of sitting type toilet

Figure 8. Inside of the pilot model for squatting type toilet

Figure 9. The composting reactor and tanks under the platform

Figure 10. Training of the people

Figure 11. Technical training of the people

4. Conclusion

To familiarize the toilet system in Burkina Faso, the toilet system must be acceptable for people in the country. The pilot model is designed and manufactured based on the design policy established from the survey in the 3 villages in the country, then the production price and problems on was production was discussed. As a result, we set the target family for design of the pilot model. Then the 2 models of sitting and squatting type were designed and manufactured. The model was installed and showed to the people in rural area of the country. From their impression, people don't want to see their feces, to show their visitor it, and to touch the reactor directly. So, the reactor must be covered or separated from their view range. Only few actions are accepted for the toilet. This will related to easy operation of the toilet system. Total 900,000FCFA for sitting style and 100,000 FCFA for squatting toilet are required. Half of the cost is shared by house construction. So,

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