CZECH UNIVERSITY OF LIFE SCIENCES PRAGUE

Faculty of Tropical AgriSciences

Assessment of perception and acceptability of composting toilets in West Sumba, Indonesia

Master thesis

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Supervisor:

doc. Ing. Jan Banout, Ph.D.

Author:

Bc. Soňa Valčíková

Declaration

I hereby declare that I have written presented master thesis "Assessment of perception and acceptability of composting toilets in West Sumba, Indonesia" by myself with help of the literature listed in references.

Prague, April, 2016

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Soňa Valčíková

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Abstract

Lack of access to improved sanitation in Indonesia is reflected in persistence of practicing open defecation causing diarrhoea that is a major reason of under-five mortality. Composting toilets are considered as ecological sanitation representing dry type of sanitation system that is independent of water supply. Due to natural processes of composting that occur under specific conditions, human waste is transformed into compost that can be used as fertiliser. Although the approach of sustainable sanitation is being introduced in many developing countries, ecological sanitation have not yet been widely implemented in Indonesia except small pilot projects. However, due to sanitation programme of local non-government organisation Project Hope Sumba settled on Indonesian island of Sumba, composting toilets have been built to serve local people as improved sanitation to eradicate open defecation. The objective of the thesis was to assess user acceptance of composting toilets and perception of ecological sanitation in sub-district of Wewewa Tengah of West Sumba. Additionally, identification of criteria that influence acceptance of composting toilets have been summarized. Primary data have been collected in February and March 2015. The research was based on the interview accompanied by the structured questionnaire with 80 respondents who obtained the composting toilets within the sanitation programme. Waterless single-vault and double vault composting toilets without mixing urine and excreta device were installed as well as urine-diverting ones. Based on the survey, majority of the beneficiaries 57.5% has decided to quit using the composting toilets and rebuilt them to septic tank system. The main reasons for stop using the toilets were the fact that composting toilet does not work correctly because of lack of instructions. Based on the results of the survey, the most important factors affecting acceptance of composting toilets were frequency of using the bulking agent as it contributes to ensure correct process of composting, the experience of final compost application, understanding process of composting and having an off-farm activity. Despite certain failures, the project represents unique experience of composting toilets in Indonesia and can serve as source of valuable information for further projects.

Key words: *acceptance, composting toilet, ecological sanitation, sustainable sanitation, Sumba, Indonesia*

Abstrakt

Nedostatečný přístup k základním sanitačním zařízením v Indonésii se odráží ve stále přetrvávajícím vykonávání potřeby v přírodě, jenž způsobuje průjmová onemocnění, která jsou hlavní příčinou dětské úmrtnosti. Kompostovací toalety jsou považovány za ekologický sanitační systém, nezávislý na přísunu vody. Díky procesu kompostování, který probíhá za specifických podmínek, jsou lidské výkaly přeměněny v kompost, který může být použit jako hnojivo. Ačkoliv je koncept udržitelné sanitace zaváděn v mnoha rozvojových zemích, Indonésii se dosud vyhýbal s výjimkou malých pilotních projektů. Za největší projekt tak můžeme považovat snahu organizace Project Hope Sumba, jež se pokusila kompostovací toalety nabídnout obyvatelům ostrova Sumba. Cílem práce bylo zhodnotit přijetí kompostovacích toalet a pohled na ekologická sanitační zařízení v oblasti Wewewa Tengah, Západní Sumba. Kromě toho byla identifikována a shrnuta kritéria, která ovlivňují přijetí kompostovacích toalet. Data byla sbírána v únoru a březnu 2015. Výzkum byl založen na rozhovorech doplněných o strukturované dotazníky s 80 respondenty, kteří obdrželi kompostovací toalety. V rámci projektu byly vybudovány kompostovací toalety s jednou či dvěma komorami, jak s možností separace moči, tak i bez ní. Z dat vyplynulo, že se většina příjemců kompostovacích toalet (57.5%) rozhodla přestat používat tuto technologii a přestavěla kompostovací toalety na septikové s využitím vody. Na základě výzkumu bylo zjištěno, že nejdůležitější faktory ovlivňující přijetí kompostovacích toalet jsou četnost používání zásypového materiálu, jenž ovlivňuje správný proces kompostování, zkušenost s aplikováním výsledného kompostu, porozumění procesu kompostování a provozování nezemědělské aktivity. Navzdory jistým obtížím při zavádění této technologie, sanitační program organizace Project Hope Sumba představuje jeden z prvních pokusů o implementaci kompostovacích toalet v Indonésii v širokém měřítku a může sloužit jako zdroj hodnotných informací pro další projekty.

Klíčová slova: *kompostovací toaleta, přijetí, ekologická sanitace, udržitelný sanitace, Sumba, Indonésie*

Table of Content

Tables

Figures

Acronyms and Abbreviations

C/N	Carbon-to-Nitrogen
EcoSan	Ecological Sanitation
JMP	Joint Monitoring Programme
LIPI	Lembaga Ilmu Pengetahuan Indonesia
MDGs	Millennium Development Goals
SuSanA	Sustainable Sanitation Alliance
UDDT	Urine Diversion Dehydration Toilet
VIP	Ventilated Improved Pit
WSP	Water and Sanitation Program
YHS	Yayasan Harapan Sumba

1. Introduction

Access to adequate sanitation together with the access to water is crucial for human development and it is considered as human right (UNW-DPC, 2015). Despite many efforts and development aid programs, desired aim to ensure improved sanitation and eradicate open defecation will require further progress. Although Millennium Development Goals (MDGs) target of halving the proportion of people without access to improved drinking water sources was successfully reached five years ahead the end of the programme, the same target concerning improved sanitation was missed (WHO, 2015). Globally, there was 2.4 billion people recorded, who have been lacking proper sanitation facilities in 2015. Furthermore, concerning rural areas there are still "seven out of ten people without improved sanitation facilities, and nine out of ten people still practising open defecation" (WHO, 2015). Situation in Indonesia reflects tiny connections between health, clean water, hygiene habits and adequate sanitation. Open defecation, which is practiced by 17% (41 million inhabitants of Indonesia), is health and social issue that requires an immediate intervention. In Indonesia, diarrhoea is a major reason of under-five mortality and it is higher by 66% in families practising open defecation in rivers and streams than in families with improved sanitation (UNICEF, 2012).

Composting toilets refer to dry toilets, where human waste with addition of carbon-rich material (straw, sawdust or ash) under specific conditions is naturally transformed into the compost (WHO, 2006). It may be with or without urine separation device. Composting toilets have been successfully introduced in many developing countries. Moreover, small-scale enterprises of selling compost are being raised. This kind of ecological sanitation, have not yet been used widely in Indonesia, and its application is limited to technical trials and small pilots. Despite the fact that several small projects have been implemented within development aid of foreign organizations, most of them failed after time. This paperwork brings information of unique project on Indonesian island Sumba, where composting toilets have been implemented and some of them survived until today. Additionally, new sanitation project is currently in progress in Sumba. Research focused on assessment of acceptance of composting toilets implemented by local organisation Yayasan Harapan Sumba (YHS). Merit of this study is a disclosure of factors that affecting user´s acceptance

of ecological sanitation within particular sanitation project, which might help to understand needs of users better and avoid realization of ineffective and unsuccessful projects. Moreover, contribution of filling knowledge gap within this topic in Indonesia is desired. Results of this research might be useful for other researchers, implementers of this technology, NGO´s and any other stakeholders involved in issue of sustainable sanitation.

2. Literature review

This chapter brings overview of composting toilets and ecological sanitation in terms of its definition and meaning, sustainability, classification and types of composting toilets. Furthermore process of composting, reuse of human waste and its implementation as fertilizer is described. Last but not least, factors affecting acceptance of composting toilets have been collected from several case studies. All the information focusing on the ecological sanitation issue were summarized by studying relevant scientific literature resources, mainly from scientific articles of electronic resources i.e. e-database like Web of Science and Science Direct. Many useful information and case studies have been gained from reports and resources of Sustainable Sanitation Alliance (SuSanA). Statistical data were obtained from free and open-accessed database of World Bank, United Nations and Indonesian Statistical Agency (Badan Pusat Statistik).

2.1. Composting toilets as sustainable sanitation

Generally, the main function of sanitation is to treat human waste. In fact, term "sanitation" covers group of processes like collection, transport, treatment and disposal or reuse of human excreta, domestic wastewater and solid waste as well as hygiene promotion (WaterAid, 2011). Due to sanitation system human waste is organised and treated, which serves to keep a safe and clean environment and protect human health. To be considered as sustainable, "sanitation system has to be not only economically viable, socially acceptable, and technically and institutionally appropriate, it should also protect the environment and the natural resources" (SuSanA, 2015). According to Anand and Apul (2013) and Hu et al. (2016), current conventional sanitation system of water-flushing toilets, which means that toilets are connected to both centralized water and wastewater infrastructure, this approach is not sustainable and has many disadvantages in term of treating wastewater as well as use of water and energy resources. On the other hand, perfect sustainable system probably does not exist as the concept of sustainability presents the direction and way of the manner rather than a stage to reach (Susana, 2015). Considering characteristics of composting toilets as decentralized sanitation system that requires no water, transforms human waste

into fertilizer and may decrease pressure on the water supply and current wastewater infrastructure, this technology represents sustainable sanitation approach (Anand and Apul, 2013). Composting toilets are recognised by the Joint Monitoring Programme of the Millennium Development Goals as improved sanitation (WHO, 2015). Composting toilets are considered as ecological sanitation which is "a new paradigm in sanitation that recognizes human excreta and water from households not as waste but as resources that can be recovered, treated where necessary and safely used again"(WB, 2011). Composting toilets as ecological and sustainable sanitation aim to keep the nutrient and water cycle closed and offer health protection, pollution prevention as well as return valuable nutrients in form of humus back to the soil. This approach represents the idea of closing the loop as well as reusing and recycling and serve it as alternative to conventional sanitation technologies.

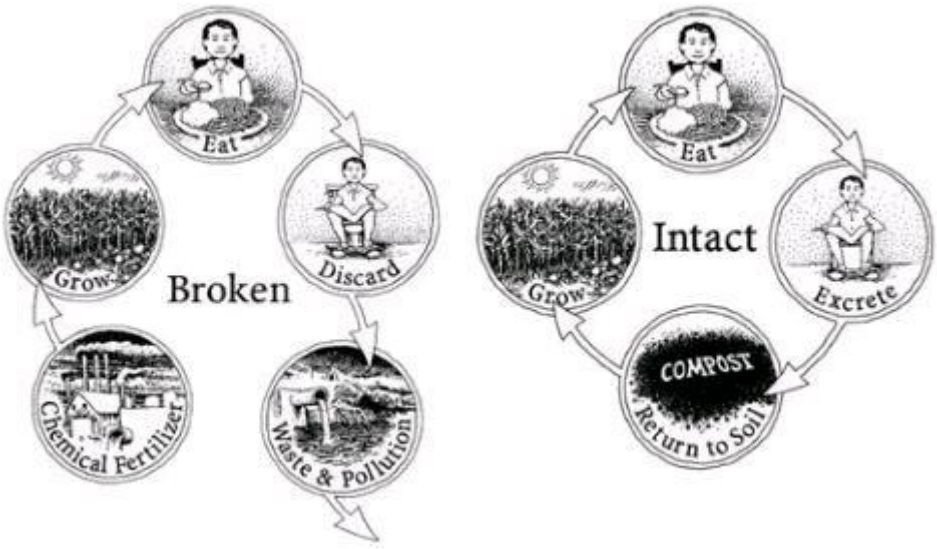

Figure 1: Closing the nutrient cycle (Jenkins, 2005)

Composting toilets are sometimes being termed "eco-toilets". They should not be confused with urine diversion dehydration toilets (UDDTs), which are primarily based on process of dehydration and drying, not on biological process of composting. Although composting toilets has been used primarily in rural areas, and areas with water shortages (WHO 2008), there is several project which have been implemented in urban areas of both developing and developed countries.

Sanitation systems can be divided by the place of treating human waste into on-site and off-site technologies, or water based and composting based. On-site technologies collect, store and also process human waste directly at the place of its generation. Among this types are concluded ventilated improved pit (VIP) latrines, double vault composting latrines, pour-flush toilets, septic tanks, ecological sanitation. In case of composting latrines material needs to be stored under specific conditions to ensure pathogen-free output that can be used as fertilizer. Construction and operation of in-site systems is generally cheaper than off – site ones.

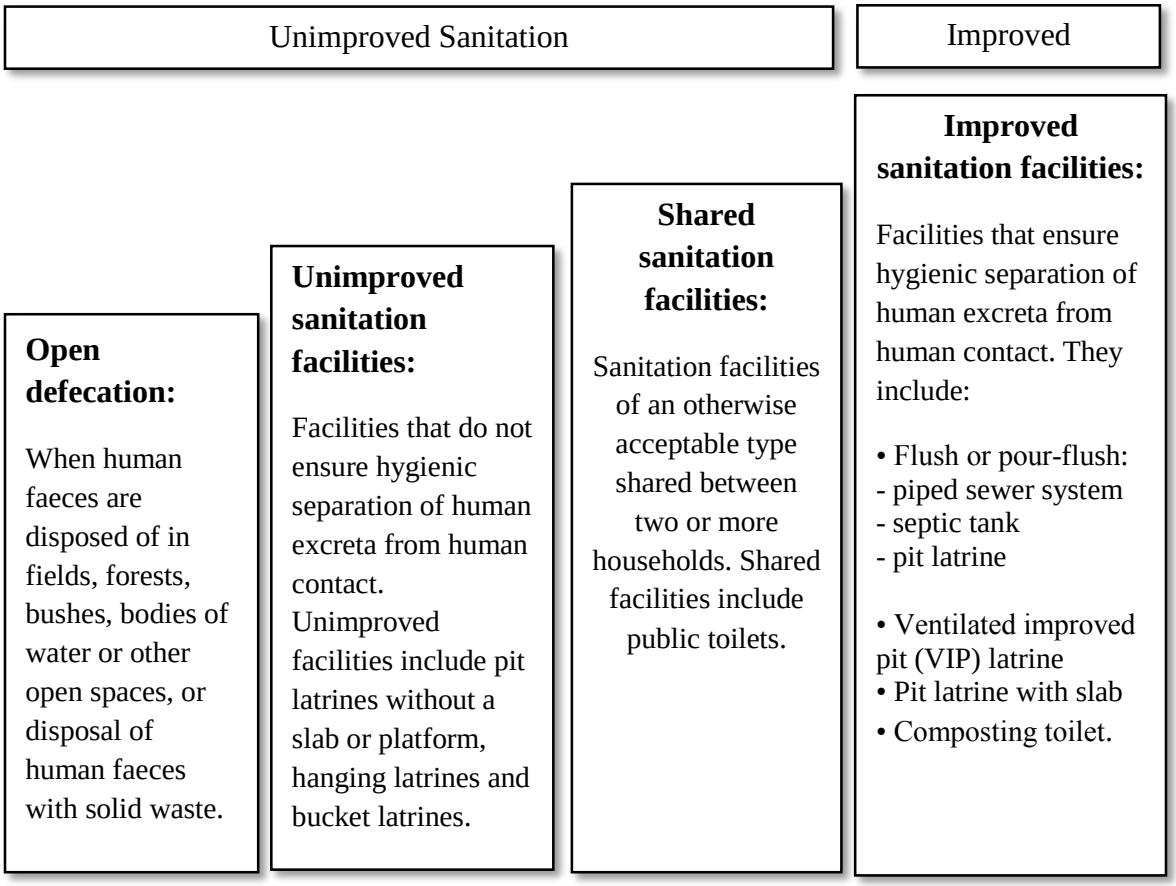

Figure 2: Sanitation ladder. Author compilation based on WHO (2015)

2.2. Evolution of composting toilets

Ecological sanitation has a long history as the first composting toilets have been already used by ancient Asian nations settled in regions of India, Pakistan, Vietnam and China. The ancient people of Hunzas, who are well-known for their longevity, settled in mountains of Himalaya and composting of their excreta in purpose to be used as fertilizer was part of their way of life (Jenkins, 2005). The Vietnamese double-vault toilet is widespread in northern Vietnam. In the past untreated human waste used to be commonly applied on rice fields in Vietnam, which represented certain risk. Therefore, efforts of the health authorities led to raise a campaign to develop sophisticated system of double-vault composting toilets in 1956. The long-term and comprehensive action included promotion of information concerning health aspects and importance of pathogen destroy before application on the fields. Vietnamese design was accepted by many countries worldwide e.g. China, Mexico, Sweden (Winblad and Simpson-Hébert, 2004).

In 1940s Appasaheb Patwardhan invented a double chambered composting toilet in India and final product was used as fertiliser in agriculture (Del Porto and Steinfeld, 1998). The first evidence of composting toilet in Europe occurred in 19th century. Officially, the first dry toilet „Earth closet“, was developed in 1860 and patented in 1873 by English priest, Henry Moule. The wooden commode was based on adding soil or ash into the bucket after each flush (Del porto and Steinfeld, 1998). Currently, there are many companies producing commercial composting toilets which are available on the market. The famous Swedish company Clivus Multrum meaning “inclining compost room” is officially on the market since 1964. However, their invention started in 1933, when Rikard Lindström inspired by horse manure applied to the soil, created a single vault composting toilet with the aim to protect Baltic Sea (Anand and Apul, 2013). Another successful Swedish company Sun-mar also produces sophisticated self-contained units. Company´s history is dated from 1966 when the first composting cottage toilet based on incineration was created (Sun-Mar, 2013). Also in Norway, the phenomena of ecological sanitation has spread as design of carousel system was developed in 1973 and then introduced in many countries around world (Winblad and Simpson-Hébert, 2004). Evidently, composting toilets have history in both developed and developing countries.

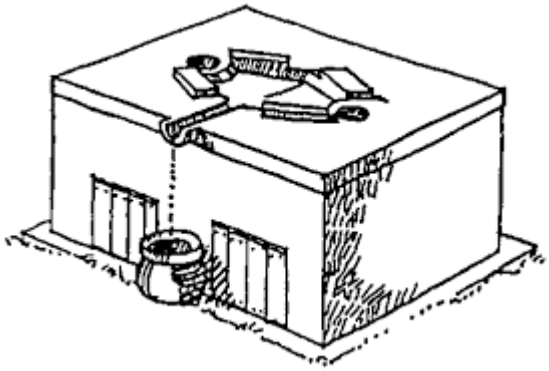

Figure 3: Vietnamese double-vault toilet, SIDA – WHO (1997)

2.3. Types and design of composting toilets

Currently, there are many different types of ecological sanitation systems available in various types of designs. There are models suitable for rural areas of developing countries as well as modern ones which are operated electrically. Composting toilets have been categorized by Berger (2011) and Anand and Apul (2013) very similarly by available technologies of composting toilets on self-contained or central (toilet and storage facility in one unit or separated), single or multiple chamber and urine separating or mixed composting. However, Anand and Apul (2013) also distinguish composting toilets operating electrically or manually (low-tech or high tech systems), situated in single or multi-stored building and with or without foam-flushing. Additionally, composting toilets can be built by owner or commercially manufactured.

Composting toilet system consists of two main parts i.e. the toilet with its superstructure and composting chamber. Usually there are also other components like vent pipe or fan to ensure circulation of air and removal of odour, and drain for removing excess liquid – leachate. For comfortable operating, access doors allow to get compost out are presented (Anand and Apul, 2013). The human waste is collected in the composting chamber, where the content is digested aerobically. It is also possible to use method of vermicomposting using earthworms as alternative to aerobic composting process (Hill and Baldwin, 2012).

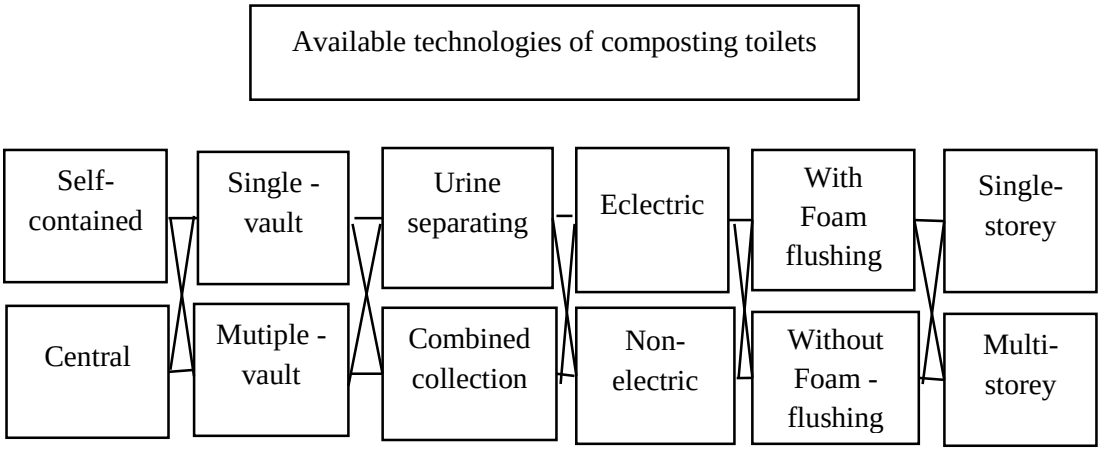

Figure 4: Available technologies of composting toilets. Author compilation based on Berger (2011) and Anand and Apul (2013).

According to Berger (2011), four main types of composting toilets are single – vault composting toilet, multiple vault composting toilet, mobile bucket and composting toilet with mechanical device.

Single-vault composting toilets

Single-vault composting toilets are consisted of one large container (vault) which is usually designed as steep sloped chamber situated just under the toilet seat or squatting pan, bellow the floor level. Human waste possibly together with organic household waste and bulking material is collected in the chamber which works as continuous reactor, where process of decomposition occurs while long-term retention and aeration is ensured. As fresh human waste is regularly added to the top of the inside heap, treated material as the final product is being taken out periodically usually via back doors from the bottom. In dependence of the toilet design, urine might be diverted or not. Surplus liquid (leachate) is due to slope design directed down to collecting space to be separated. Under appropriate conditions, human waste is after certain time converted to soil-like material. According to Berger (2011) retention time is at least 2 years. Then the final compost, which is about 40 l per person per year on a household level, can be removed (Berger, 2011). The example of single vault toilet is Arborloo, which is very simple and low cost system developed in Africa (Morgan, 2007). Arborloo has a shallow pit which is situated in the depth of 1.5 m under the toilet construction to collect and compost human waste accompanied by soil, ash and dry leaves. Once the pit is almost full, thick layer of soil is added to cover the hole and

young tree is planted in this point. Consequently another pit is being dug and superstructure is relocated just above the pit for further usage.

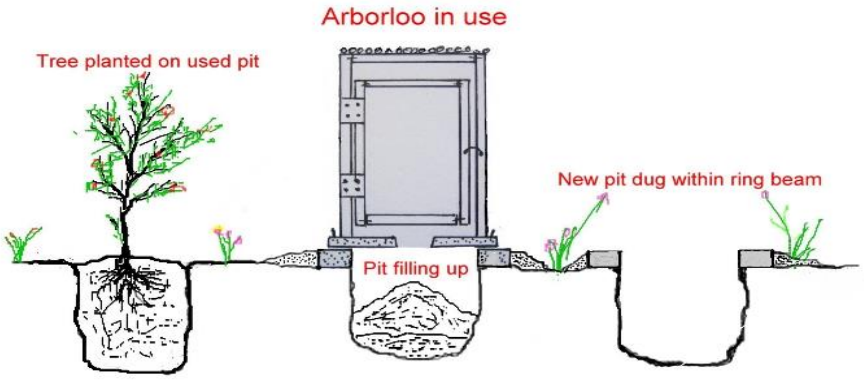

Figure 5: Arborloo – the simplest single-vault composting toilet (Morgan, 2007)

Multiple-vault composting toilets

Multiple-vault composting toilets have two or more collecting chambers. Once the one of the chambers is full, collected material is left to get matured and another one is being to be used. The urine diversion is optional. The active chamber which is in use is separated from the one where matter can undergo composting process, therefore contamination from fresh excreta is avoided. The simplest example of multi-chamber system is Fossa alterna. It is low-cost system that was developed specially for African regions. System has two pits with depth of approximately 1.2 m. While one chamber is in use, the second one, which is already filled up, stores the matter. Soil, ash or leaves are being added and after one year the end product can be removed. Movable superstructure is relocated over the empty pit once compost is matured and removed (Morgan, 2007).

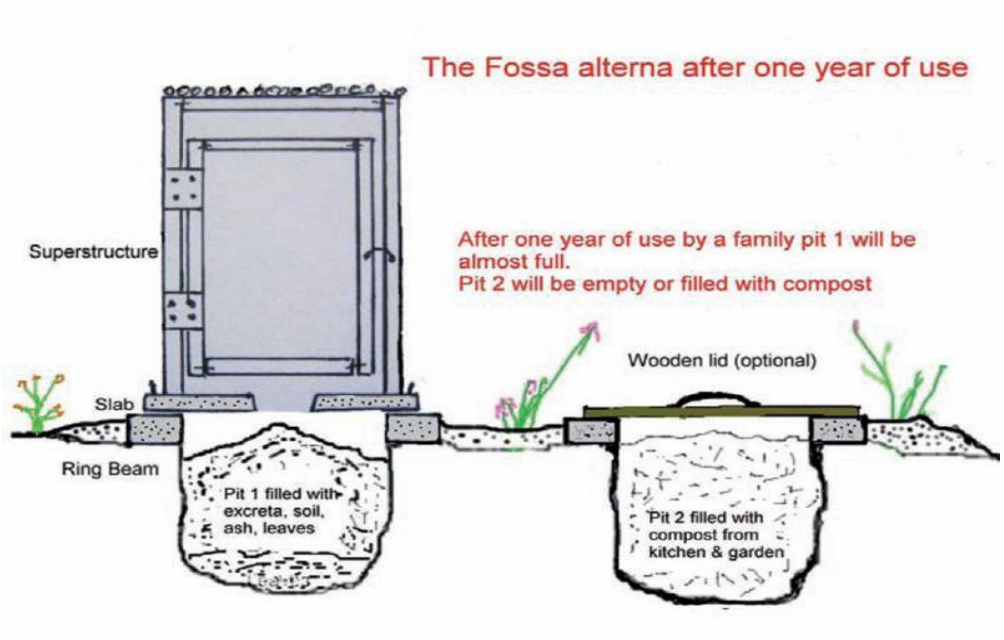

Figure 6: Fossa alterna – double - alternating pit composting toilet (Morgan 2007)

Rotating multi – chamber composting toilets are type of multi-vault composting toilets. This type has the cylindrical rotating inner tank with usually four chambers. As soon as one of the chambers is filled up, the mechanism is rotated and another chamber can serve as empty collecting bin, while the full one is moved within the carrousel and is left to mature. Once all the chambers are full, the matter from the originally first tank is supposed to be ready to be removed.

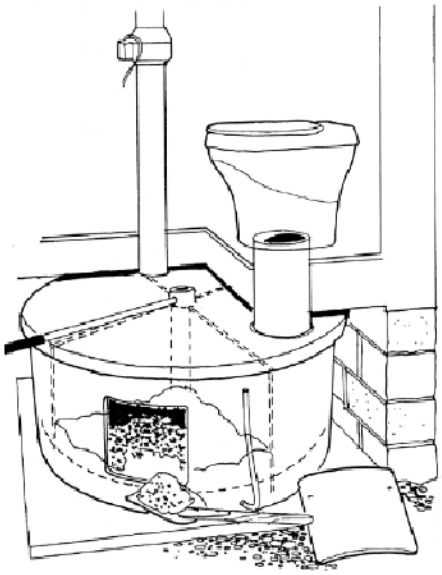

Figure 7: Carousel composting toilet (Winblad, 2004)

Removable bucket toilets followed by composting of human faeces

Toilets using bucket or bin are widespread and practical way to manage operation of the system. Nevertheless this type is not considered composting toilet because it serves as collection container only. This technology is very simple to be realized by user, self-built as well as sophisticated versions with wheels, exhaust and leachate drain are commercially. Important fact is that process of composting does not occur directly in the bucket, but outside in the compost heap or external compost bin, so human waste need to be removed regularly. Urine diversion can be applied within the system. However, it works well with mixing urine and faeces if bulking agent is added on the bottom and after each use. (Berger, 2011).

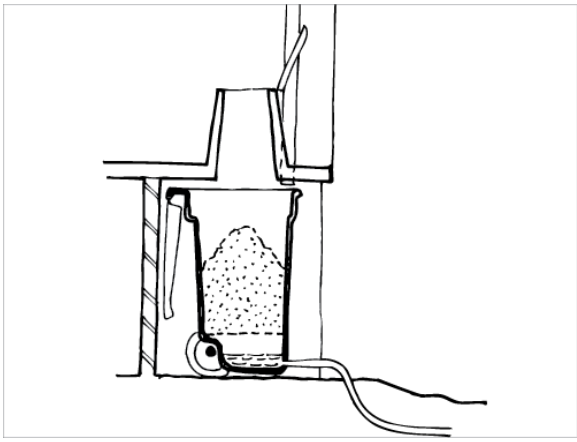

Figure 8: Wheelie – bucket toilet (Winblad and Simpson-Hébert, 2004)

Composting toilets with mechanical devices

Nowadays, various models of technically sophisticated mechanisms are available on the market. This type of composting toilets consist of turning or stirring devices located under the seat inside of the model that ensure aeration and support decomposition of the material. Usually, sawdust is added as bulking agent. Moreover, electric heaters are being part of the toilet. The mixing device may be operated mechanically or manually by foot or hand.

Urine diversion composting toilet versus "mixed composting"

Composting toilets can be designed with or without urine diverting system. Composting toilets with urine diversion might require to be watered in case water content fall down rapidly under 40%. The water content of faeces is 65-80% and is ideal for good processing

together with addition of bulking agent (Berger, 2011). Separation of urine reduces the level of leachate and contributes to keep C/N ratio balanced. If urine s not separated, it cumulates at the bottom of the tank and must be taken out. Furthermore addition of bulking agent is necessary to regulated nitrogen and water content.

2.4. Principles of composting process

Composting is the natural process of rotting or decomposition of organic matter. Microorganisms oxidize organic compounds under aerobic conditions producing ammonia, carbon dioxide, volatile compounds, water and heat. The primary organisms involved in the decomposition of organic matter in a compost pile are bacteria and fungi (Anand and Apul, 2013) and (Berger, 2011).

For microorganisms to survive and carry out the process of composting in the composting vault, suitable environmental conditions need to be maintained. The factors affecting the process of composting are mainly carbon/nitrogen ratio, pH, particle size, porosity, oxygen concentration, water content and temperature. These parameters depend on the formulation of the compost mix (Anand and Apul, 2013). Conditions for the initial thermophilic composting are: Good aeration – sufficient oxygen supply, water content 45-65%, C/N ratio 30-40 / 1. These optimal conditions are rarely achieved in composting toilets. Human excreta and food waste alone do not provide these optimum conditions as both the water and nitrogen content are too high. For that reason bulking material is added to lower the water content, improve the aeration and increase the carbon content of the material. During the decomposition process, there is a considerable volume and mass reduction through the processes of evaporation, digestion and mineralisation (a reduction of up to 90% of the original volume of the organic waste). The final products are CO2, heat, water and compost (Berger, 2011).

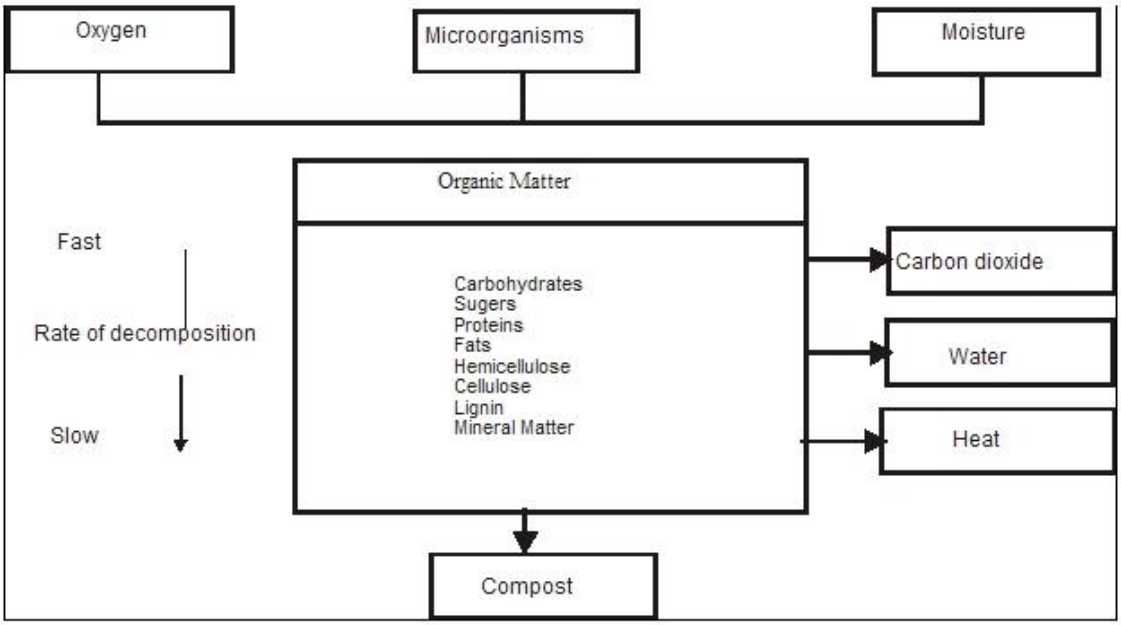

Figure 9: Composting Process, Epstein (1992)

Aeration

Aerobic composting requires large amounts of oxygen, particularly at the initial stage. Where the supply of oxygen is not sufficient, the growth of aerobic micro-organisms is limited, resulting in slower decomposition. Moreover, aeration removes excessive heat, water vapour and other gases trapped in the pile. Lack of oxygen in the pile can cause anaerobic conditions, which leads to odour issues and lowers the rate of composting. Therefore, good aeration is indispensable for efficient composting. It may be achieved by controlling the physical quality of the materials (particle size and moisture content), pile size and ventilation and by ensuring adequate frequency of turning (Misra et al., 2003).

pH

pH affects the growth of microorganisms in a compost pile. Different bacteria survive at different pH levels, pH range not exceeding 8.0 is recommended (Misra et al., 2003). More recently, Bernal suggested a pH range of 6.7–9.0 in a review of animal manure composting. Maintaining pH in 6.7–9.0 range helps to control nitrogen losses by ammonia volatilization (Bernal et al., 2009). pH typically drops as the composting process

progresses due to the breakdown of carbonaceous material to organic acidic intermediates by acid forming bacteria. The pH of the compost pile is observed to increase with increasing temperature (Anand and Apul, 2013).

Porosity and particle size

Particle size plays a role in balancing the surface area for growth of microorganisms and maintaining adequate porosity for aeration. The larger the particle size, the higher the porosity and the lower the surface area to mass ratio. Compost with large particles does not decompose adequately due to microorganism inaccessibility to the interior parts of the compost particles. On the other hand, very small particle size may compact the mass and reduce the porosity. A porosity of 35–50% is recommended for composting (Bernal et al., 2009).

Moisture content

Moisture is necessary to support the metabolic activity of the micro-organisms. Moisture and urine in faeces contribute to the moisture content in compost. The moisture content of faeces is around 82%. Too much moisture in the compost heap can create anaerobic conditions. If the moisture level is too low, below 40%, the dry conditions slow down the process of decomposition and require addition of water for activation (Yamada, Kawase, 2006). Composting materials should maintain a moisture content between 40-65%. Many studies showed that the optimum moisture content for proper composting is around 50-60% (Zavala, Funamizu, 2006). Zavala and Funamizu (2006) proposed that a moisture content of 65% be considered the critical level above which should be avoided.

Temperature

Different phases of composting are indicated by differing temperatures. Composting begins with and the readily degradable organic matter is degraded by mesophilic organisms that function at a temperature range of 19–45 °C. Maximum degradation of organic matter

and destruction of pathogens occur during the thermophilic phase (45-65 °C) at a temperature range of about 50–65 °C (Bernal et al., 2009). A more recent study suggested 60 °C as the optimum temperature for faeces degradation (Zavala, Funamizu, 2006). At temperatures over 65 °C, the compost activity reduces, as most thermophilic organisms cannot survive this temperature (Germer et al., 2010). As the supply of fats, proteins, and complex carbohydrates decreases in the pile, the temperature of the pile reduces. During this cooling stage, the compost appears ready to be applied on agricultural lands. However, coarser organic matters still need to be digested. As the temperature reduces, the organisms from the mesophilic range work on decomposing the remaining organic matter. The last stage of composting is the curing/maturing stage where compost is set aside allowing the organisms left in the compost pile to complete the composting process (Jenkins, 1999).

Carbon and nitrogen content and C/N ratio

Nitrogen and carbon content of human faeces is around 65 mg- N/g-dry and 500 mg-C/g-dry. During composting, both the carbon and nitrogen content of the compost are reduced. Hotta and Funamizu (2007) note that 66% of faecal nitrogen decomposes to ammonia whereas 34% remain as biologically inert type of nitrogen. In other studies, nitrogen losses from 17% to 94% have been reported in presence of sawdust as the bulk matrix (Bai and Wang, 2010; Hotta et al., 2007). In thermophilic conditions all nitrogen loss to ammonia gas can be from inorganic nitrogen whereas the organic nitrogen can be fully retained in the compost (Bai and Wang, 2010). This is because ammonifying bacteria are mesophilic and their absence in thermophilic conditions would hinder ammonification. In the case of faecal carbon, approximately 80% is mineralized to CO2 (a greenhouse gas) whereas further 20% remains in the composted material (Hotta and Funamizu, 2007). The variability in nutrient loss values has been attributed to manure type (beef, dairy, poultry, pig, human), bulking agent type (straw, woodchip, cotton waste, sawdust), and composting process (turned or unturned windrow, in vessel system, forced ventilation, static pile) (Bernal et al., 2009).

The practical management of compost focuses not on managing the loss of carbon or nitrogen but on adjusting the ratio of carbon to nitrogen in the compost pile. Researchers use the ratio of the total carbon to total nitrogen, yet it is really the ratio of biodegradable

fractions that affect the composting process (Guardia et al., 2010). Carbon to nitrogen ratios of 25–35 have been recommended for composting of municipal waste and sewage sludge (Bishop and Godfrey, 1983; de Bertoldi et al., 1983).

Since the carbon to nitrogen ratio of human faeces (C:N = 8) is deficient in carbon, a large amount of carbon has to be added to the compost pile. Fresh grass cuttings, wood chips, and kitchen wastes are examples of high carbon content bulking materials. Fresh grass cuttings and leaves have a carbon nitrogen ratio of 15:1. Dried leaves might have an even higher ratio (Depledge, 2013). Toilet paper has a carbon to nitrogen ratio of 200–350:1(Compost ingredients, 2012). Saw dust has a carbon to nitrogen ratio of 190:1 and is recommended to be used on a dry weight ratio of faeces/sawdust as 1:4 (Bai and Wang, 2010) resulting in a carbon to nitrogen ratio of approximately 16.

2.5. Factors influencing acceptance of ecological sanitation

Despite all the benefits of ecological sanitation, there have been already noticed several project failures based on non-acceptance of the technology by recipients. Due to project evaluation and monitoring reports from various projects implemented in different countries, lessons learned brought and identified particular factors which have been considered affecting the acceptance of ecological sanitation like composting toilets. Level of acceptance is a crucial factor to assess the project success. There are several factors that have been observed and highlighted by researchers within particular studies or that occurred as the output of case studies worldwide. Some of the factors are being mentioned repeatedly and independently within different studies.

Review of EcoSan experience in Eastern and Southern Africa (WB, 2005) suggests four questions aiming to define the degree of acceptance: Are the toilets still in use? Are they being correctly used? Are they being copied without external support? Are EcoSan products being used in agriculture? Barriers of poor adoption of composting toilets have been defined by Cordova and Knuth (2005). The main of them are lack of awareness of technology of composting toilets, perception of odour and maintenance, expectation of inconvenience and burdensome, insufficient experience and research of this topic in term

of not enough successful implementation and good practices examples, missing of detailed design and information about ventilation, heating, and use of bulking agents. According to Albrecht et al. (2010), there are certain reservations about the use of composting toilets. However, potential probability of acceptance have been indicated and success is possible if "detailed consumer research is undertaken, followed by carefully designed and tailor-made low-cost EcoSan separating pans that allow people to undertake anal cleansing with water and that dispose of the black water separately to the excreta"(Albrecht et al.,2010) According to Holden et al. (2003), factors influencing decision of potential users once choosing sanitation are lack of smell, minimum handling of excreta; low capital and maintenance costs, security, privacy and comfort. Important assumptions for successful adoption of new ecological sanitation is to give a choice of sanitation system and material as well as meeting the demand of users based on consultation. To achieve sustainability, it is necessary to choose flexible and appropriate types rather than high-cost and overdesigned ones (WB, 2005). Experience from Nepal proves that promotion of EcoSan was more successful once it was provided as option together with other technologies instead of one way offer (Rajbhandari, 2005).

In following text, factors affecting the acceptance of ecological sanitation within particular sanitation projects that have been realized in the past in developing countries were summarized.

2.5.1 Awareness and information of composting toilet technology

Lack of awareness of technology of composting toilets is considered as barrier to adopt this technology by Cordova and Knuth (2005). The reason is lack of research and evidence of successful examples which also causes a negative image of this technology. Based on Indonesia, missing information about fertilizer effectiveness and its safety to be applied on the fields causes doubts among potential users (Albrecht et al., 2010). Respondents claimed that example of good practice of other farmers would motivate them to achieve the same success. Similarly, according to 4, possibility to see the real toilet rather than model or pictures would be appreciated by potential users. Experience from Northern Cape proves that awareness about ecological sanitation was successfully spread when potential

users have been taken to the communities, where this technology was already implemented, which helped to introduce this technology to other parts of the country. According to story from Zimbabwe, availability of sufficient user education is crucial within the first year, when chambers should be regularly checked with user and mistakes must be pointed immediately. According to Holden et al.(2003), long-term support (4-5 years) provided by implementers was considered as influencing factor of acceptance to be sure that whole process of composting toilets have been understood and learned. Additionally, extended awareness, information campaigns and workshops would be needed to raise the level of acceptance and awareness, because as currently almost no information about EcoSan is available at local level (Holden et al., 2003). Level of education was proved as significant factor in case study in Western Uganda (Tumwebaze et al., 2011) as well as in Sri Lanka, where was revealed that with increasing level of education the acceptance of ecological sanitation is decreasing (Bandara et al., 2014)

2.5.2. Maintenance and handling excreta

To ensure composting toilets are working well, certain maintenance has to be ensured. Therefore certain user´s activity is necessary to keep ecological sanitation functional. User is supposed to ensure enough bulking agent and its regular usage, take care of emptying the chamber, turning of compost, cleaning the toilet with minimum of water (Albrecht et al., 2010).

Inseparable activity of handling excreta within operating composting toilets represents the reason of higher demand for flush toilets or VIP. According to Holden et al. (2003), acceptance of ecological sanitation increased when handling of excreta have been solved out due to 45 litre bucket, which can ensure sufficient capacity for a month. However, on the other hand those communities that are using chamber pots are handling excreta once a day already without thinking about it.

2.5.3. Odour

Odour is expected by potential users to be a barrier. However, correct usage of composting toilets can avoid odour production. The addition of bulking material like sawdust, soil, ash, straw or husk decrease the moisture and helps to regulate the presence of the smell (Albrecht et al., 2010). Proved by experience from Nepal "covering the faeces with additives effectively reduces the smell, and zero smell can be achieved by ventilation" (Rajbhandari, 2005). In fact, problems with odour does not reflect technology fault, it is result of missing awareness and knowledge how to maintain it, together with complex understanding of the process of composting (WB, 2010). Holistic understanding of process of composting, and particularly of the importance of adding dry soil to aid the desiccation process is assumption to adoption of the ecological sanitation. Confirmed by experience from South Africa, where process of composting is virtually unknown suggests that principles of composting should be presented more to explain how the natural processes destroy harmless pathogens (WB, 2010).

2.5.4. Design of composting toilet

Detailed design and information guide concerning use of bulking material, heating and ventilation still missing. According to Anand and Apul (2013), designs of composting toilets are mainly inspired by experience rather than facts from scientific sources. The main problem is lack of information and research on this issue. There are various types of composting toilets e.g. single or multi-chambered, with urine separation or not. Basically, in single-vault composting toilets, as fresh human waste is added continuously, pathogens can contaminate the finished matured material (Anand and Apul 2013). In multi-chambered toilets this risk is overcame due to separation of fresh and end product. Suggestion to improve design allowing the user to check and monitor temperature, moisture content and other factors might reduce the maintenance barrier and support adoption of this technology. Preferences of users to have toilet inside of the house building occurred in Africa, with aim to ensure privacy and safety (WB, 2005). Contrary in Pakistan, as it is against law of Sunna, toilet cannot be situated inside of the house and

need to be oriented North-South to avoid facing Mecca (Nawab et al., 2006). User´s needs, cultural customs and habits play important role within designing the toilet.

2.5.5. Re-use of excreta

According to Holden et al. (2003), re-use of excreta as fertilizer is currently highlighted as one of the motivating factor for adopting this technology rather than claiming that in fact product is similar to "good manure or that the separated urine can be used as fertiliser." Contrary, based on study by South African Sanitation Programme, ecological sanitation should be promoted through its social advantages rather than reuse. Although ecological sanitation have not been accepted mainly for contributing agriculture in Africa, obvious benefit have been noticed and became driver for acceptance. In Malawi, the fact of continuous soil infertility was considered as significant factor, which raise interest of ecological sanitation. Moreover, the cost of fertilizer increased to around US$14 for a 50 kg bag (WB, 2005). Same demand for fertilizer has been recorded in Indonesia, where 82 % of respondents believe EcoSan system is beneficial in term of production own fertilizer, which might increase user´s income or reduce household expenditures for fertilizer. (Albrecht et al., 2010). Therefore demand for product of organic fertilizer is the most significant driver for this technology. Although, willingness to use fertilizer based on human waste might be very optimistic within the pre-research, in reality situation is often opposite. For example in Tanzania, only 46% of households with EcoSan toilets are using urine as fertilizer (Shayo, 2007). According to Holden et al. (2003) reuse of excreta in case study in Africa occurred by default during the disposal of the excreta rather than a deliberate act. However since the decomposed faeces are returned to the soil and the urine disposed of in the root zone where it can be taken up by plants the same effect is achieved. This success has been achieved by marketing to people's aspirations rather than promoting reuse of excreta, which is a major turnoff to most people (Holden et al. 2003).

2.5.6. Gender

Gender roles refer to social and cultural traits that different societies assign to males and females. Based on experience from Indonesia, Eastern and Southern Africa and Pakistan, different attitude towards ecological sanitation have been noticed with regard to gender. Water and Sanitation Program study from Indonesia claims that decision to build a toilet is generally made by men (Albrecht et al., 2010). However, initial impulse expressing the need for a toilet is done by women. Indonesian women participates on decision making about type of toilet. On the contrary, experience from Pakistan case study reflects that discussion about sanitation, specifically about toilets and re-use of excreta is taboo within men meetings, as well as between man and woman at home. Furthermore, the role of women is very limited in decision making as their tasks are mainly to take care of children and house, preparation of food and keeping cleanliness (Nawab et al., 2006). The fact that gender matters as factor was proved also within African projects mainly in different needs of men and women with regard to design of the toilet and possible re-use of human waste (WB, 2005).

2.5.7. Religion

Based on case studies, ecological sanitation is touching religion issue in two points – the fact of handling and re-use of human waste for agriculture purpose, and special practices e.g. anal-cleansing. However, results of survey in Indonesia comparing attitudes of Muslims and non-Muslim found out that religious habits do not affect an attitude towards using fertilizers made of human excreta and anal-cleansing. Both were considered more as cultural issue than as a religious one (Albrecht et al., 2010). Similarly, results from African projects admit that project of ecological sanitation was successfully adopted by Christians and Muslims in some areas as well as in some cases anal cleansing caused problems. (WB, 2005). Religion was proved as significant factor in study case from Western Uganda (Tumwebaze et al., 2011). Sanitation project in Pakistan brought fact that tradition, culture and religion affecting daily life and decision of local community more than state law. Furthermore, attitude to re-use of human waste as fertilizer is influenced by religious

concern of impurity of faeces so much that one of interviewed man answered: “We would prefer than eating back our faeces” (Nawab et al., 2006).

2.5.8. Health benefit of ecological sanitation

Although health protection is considered as one of the basic principles of ecological sanitation (Esray et al., 2001), it very rarely plays a role as motivating factor in choosing a type of toilet. (Holden et al., 2003). Experience from Bangladesh sanitation programme mirrors that success was ensured due to social marketing rather than health promotion, which supports idea that factors like no odour, safety and security, privacy, minimum handling of human waste are more motivating factors for improvement of sanitation rather than health (Holden et al. 2003).

2.5.9. Environmental benefit

Although environmental contribution of composting toilets is obvious, it is not considered by users as a driving factor of acceptance. The main reason for this is caused by lack of proper rules and regulations for the prevention of pollution in natural water bodies and lack of awareness of environmental problems (Rajbhandari, 2005). To gain wider acceptance a social advantages of EcoSan are recommended to be promoted rather than the ecological advantages (Holden et al. 2003). For households who currently have no toilet, they perceive that proximity and cleanliness are the most important factors for getting a toilet, followed by not having to share, privacy, non-pollution and comfort (WB, 2011). 2.5.10. Cost

From a user’s perspective and in presence of low water and sewer utility rates, composting toilets are not currently economical. Therefore, the cost is a barrier from a building designer or a home owner perspective. However, the true cost of large scale use of composting toilets is not known since system level analyses comparing composting toilets to centralized infrastructures have not been researched (Cordova and Knuth 2005).

2.5.11. Social Status

At present, most Ecosan toilets are constructed in poorer communities with financial subsidies as a promotional tool. Unfortunately, this fact is considered it is labelling users of composting toilets as poor as it is understood EcoSan toilets were specifically developed for poorer sections of the community (Holden et al. 2003).

2.5.12. Security and Privacy

Going to an outside toilet can be dangerous. In rural areas people have a fear of snakes and in urban areas fear of attack, especially at night. Therefore the idea of own safe protected place motivating for potential users. Furthermore, an inside toilet means that no-one sees you going to the toilet. Convenience of an inside toilet is immeasurable. No getting dressed, getting wet if it is raining etc. An inside toilet is generally well lit and warm compared to an outside toilet. (Holden et al., 2003).

2.6. Current situation of environmental sanitation in Indonesia

Based on data from Indonesian Statistical Agency (2015), there is 62% of households in both, rural and urban areas of Indonesia, that have access to improved sanitation. The most of the implemented types of wastewater infrastructure are septic tanks, which are in 95% leaching and the liquid is discharged directly to the ground or surface water and causes contamination of water sources (Kerstens et al., 2016).

Ecological sanitation have not yet been used widely in Indonesia, and their application is limited to technical trials and small pilots. This lack of substantial experience makes it difficult to assess people’s real acceptance of, and attitudes towards sustaining EcoSan toilets.

The preliminary assessment of attitude towards ecological sanitation have been conducted by Water and Sanitation Program by WB in 2010 in five provinces of Indonesia and focused on social, religious, cultural and gender- related factors. Other WSP study was

developed by Kathrin O´Connel, who summarized factors influencing sanitation behaviour as well as emotional, physical and social drivers leading to quit the open defecation and decision to manage the improved sanitation. Ecological sanitation trial of composting toilet was held by Indonesian Institute of Sciences (Lembaga Ilmu Pengetahuan Indonesia, LIPI) in West Java that focused on culture´s barriers of introducing dry toilet, reducing resistance of Bio Toilet users etc., sustainable design of sanitation system based on material and value flow analysis for urban slum in Indonesia was published as scientific article. Ecological sanitation pilot plat with urine diverting toilet took place in Surabaya, where faeces have been processed by vermicomposting method and tested as fertilizer on the roses (Malisie et al., 2007). Organisation Engineers without borders together with Live & Learn Indonesia realized "Sanitation park" in Lombok to present and test the technology in 2011.

Based on the data from Indonesian Statistical Agency (Badan Pusat Statistik, 2014) Nussa Tengara Timur, where Sumba is part of, has the 16% access to improved sanitation which is the lowest in comparison to the other provinces of Indonesia.

Situation of Sumba was described by Dutch development organisation Hivos, which aims to achieve a complete independence of fossil fuels and to be 100% based on renewable energy. According to survey conducted by Hivos (2013) in Sumba, sanitation and hygiene of local people is considered poor, similarly as inadequate condition of water tanks, houses, specifically kitchens, and areas surrounding houses. In whole island of Sumba, 57% of households does not have improved sanitation system and 41% of households practice open defecation. Potential spread of diseases caused by human waste contamination is likely to increase within the local society (Hivos, 2013).

WASH project realized by local organisation Yayasan Harapan Sumba in association with Rotary Club and other partners provided both septic and composting toilets to 38 villages since 2006 (YHS, web). Actually, implementation of UDDTs with solar dryer is in progress.

3. Objectives

The main objective of the thesis is to assess user´s acceptance of composting toilets and their perception of the ecological sanitation system in Kecamatan (Sub-district) of Wewewa Tengah, District Sumba Barat Daya (West Sumba), Province of Nusa Tenggara Timur, which has been provided by local non-government organization Yayasan Harapan Sumba since 2008.

The specific objective is to identify criteria that influence acceptance of composting toilets and suggest recommendations ensuring sustainability of further projects. Based on user´s feedback and experience, it is possible to define the specific weaknesses occurring while using the composting toilet, operating the technology and applying final compost as fertilizer.

4. Materials and Methods

4.1. Site Area Description

Implementation of composting toilets in rural area of North-West Sumba was organised within the "Access to sufficient and safe water and sanitation" programme by Yayasan Harapan Sumba (YHS) – Project Hope Sumba in English, which is an Indonesian-registered, non-profit, non-political and non-religious community-based development organization working in partnership with the local people of West Sumba, particularly in Sumba Barat Daya District. YHS been working in West Sumba since 2002 addressing the basic needs of the local people for water, education, health information and sustainable livelihoods. YHS works in co-operation with the local government, the local hospital and above all with the villagers. In October 2010 the co-founder of YHS, Ann McCue, was awarded in United Kingdom by Her Majesty the Queen for services to the Sumbanese people of Indonesia.

One of the organization´s project is focusing on access to sufficient and safe water and sanitation programme. Water is considered as the biggest problem in Sumba. There are only two natural clean water sources in this whole area, and in the six-month dry season 60-70% of the population relies on very dirty lakes or water holes. Many of the villagers still walk several kilometres each way to fetch water from these sources. Most hamlets have no rainwater storage tanks and can fill only buckets and jerry-cans in the rainy season. YHS has already provided non-local materials such as cement and iron bars to build community water tanks. The people supply the local stone for building as well as all the labour, in a real community effort. Water tank program started in 2002. In total 266 rainwater catchment tanks were built.

According to YHS, about 97% of the villagers in West Sumba have no toilets and relieve themselves in the fields behind their huts causing diarrhoea and spreading disease among children and vulnerable old people. In 2006, the first groups of villages started with the project to build one toilet for each household. The families provided all the local materials and all the labour and received help from us to buy cement and pipes. First toilets were proved as great example for other villages around and further requests for help building

toilets from new villages came. Composting toilets were implemented in the villages with no access to water. In these cases, sawdust and other quickly-decomposing materials were used to turn the waste into clean compost for use in the fields. Project were realized with funding from the Rotary Club.

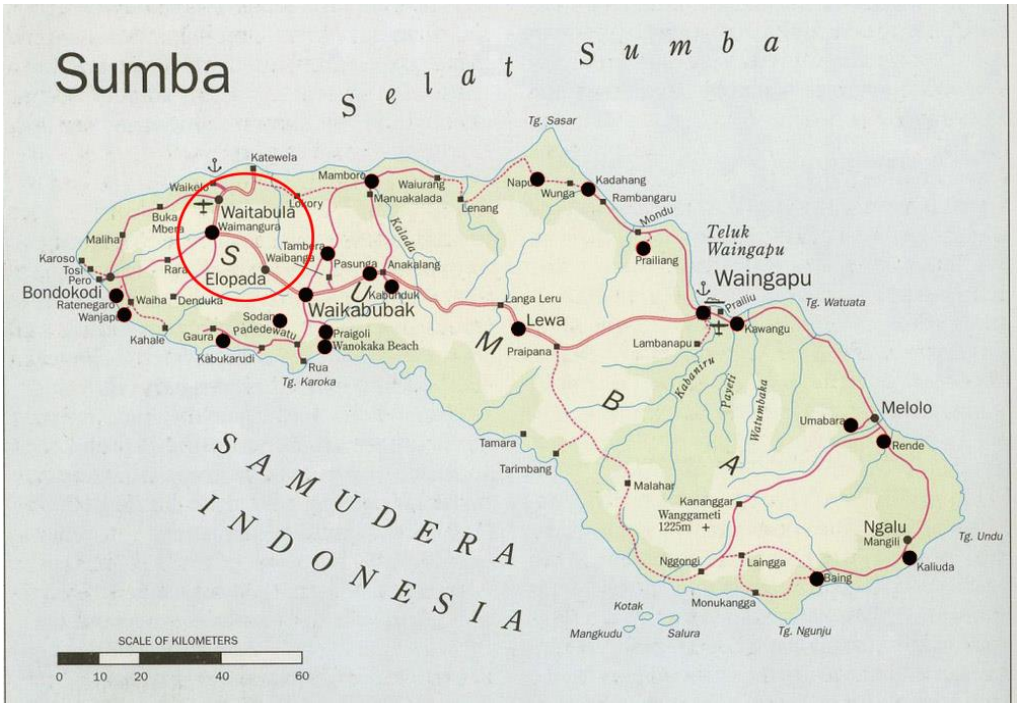

Figure 10: Map of Sumba with designated study area (Himpunan Mahasiswa Geofisika Universitas Gadjah Mada, 2015)

4.2. Primary data collection and field survey

Primary data have been collected in several villages and its neighbourhoods in Kecamatan (Sub-district) of Wewewa Tengah during January – March 2015. The research was based on the interview accompanied by the structured questionnaire of 45 multiple-choice and both open and close-ended questions with 80 respondents who obtained the composting toilet within the project of Yayasan Harapan Sumba, which have been implemented since 2008 until 2014. Inspection of construction of composting toilet, design and chamber contain, as well as photo documentation was part of each visit. Total time for fulfilling one questionnaire was approximately 45 minutes. The interview and process of fulfilling the

questionnaires was carried out in Indonesian language - Bahasa Indonesia. Each interview was held in respondent´s household.

Respondents have been selected on recommendation of project implementers, who accompanied us to each village and helped to get allowance for research of local head of village (Kepala desa). The snow ball sampling method was used to develop chain of respondents. The pilot testing of questionnaire was necessary to avoid potential misunderstanding and to check suitability of questions. The questionnaire was modified based on discovered fact that several composting toilets have been modified to septic toilets or was already out of order. The questionnaire contains of 6 parts including general information about user and household, type of sanitation system and user´s satisfaction, using of bulking agent, reuse of urine and treated faeces, water issue, implementation of the project and recommendations. Except daily cooperation with 2 main implementers of the project, the design of the toilet was discussed with Chakra Widia in Ubud, Bali. Chakra Widia provided the workshops and taught Sumba implementers how to build the composting toilet.

4.3. Data analysis

The collected data were summarized and statistically processed in software IBM SPSS Statistics 23 and in MS Excel 2007. Descriptive analysis like comparison of means and modes, frequencies or cross tabulation was used to express and summarize data. Statistical analysis like correlation was used to describe relationship between particular data. Chi-square test for independence was applied to test if there is significant relationship between using composting toilet and particular factors such as age, sex, education and religion. Probability of factors that might affect acceptance of usage composting toilets was calculated via logistic regression model.

4.4. Limitation of the study

There are few facts that might have limited the study. Firstly, absence of the founder of the project and NGO, Ann McCue which has influenced the limited access to internal

information and documents about project realisation. Difficult terrain and broken roads did not allowed to access some villages.

5. Results and Discussion

5.1. General information about the user and household

The respondents of the survey are mainly subsistence farmers with low levels of education, poor health and traditionally a non-cash economy. However, 25% of respondents admitted off-farm activity. All of the farmilies are living in simple hamlets in mountainous villages in the 'counties' or Kecamatan of Wewewa Barat and Wewewa Timur, Regency of Sumba Barat Daya, namely Weekokora, Lete Ngarona, Kali Ngara, Golu Uta, Wano Lara. All of these villages consist of small neighbourhoods. The first part of the questionnaire focused on age, gender, education, religion and name of the village (Table 1).

Table 1: General information about respondents, N=80

		N	Percentage
Village	Wano Lara	6	7.5%
	Lete Ngarona	21	26.3%
	Golu Uta	14	17.5%
	Kali Ngara	14	17.5%
	Weekokora	25	31.3%
Age	21-30	16	20.0%
	31-40	51	63.7%
	41-50	8	10.0%
	51-60	3	3.8%
	60+	2	2.5%
Gender	Male	74	92.5%
	Female	6	7.5%
Religion	Christianity - Protestant	35	43.8%
	Christianity - Catholic	43	53.8%
	Marapu	2	2.5%
Education	Primary school	14	17.5%
	Junior high school	50	62.5%
	Senior high school	15	18.8%
	College	1	1.3%
Total		80	100%

Author elaboration of fieldwork data (2015)

The majority of respondents, around 93% was represented by men. The reason where respondents were women was the fact that men were working that time in the field. Only in 2 cases the households were headed by women.

The most frequented category of number of members of household was 6-10 persons. According to Hivos survey (2012) the average household size of respondents in Sumba was 5.7 persons. Concerning the age of respondents, majority represented by 64% were between 31-40 years old.

Indonesia education system consists of four levels. First is a primary school that lasts three years, followed by three years of junior high school, senior high schools and college or universities. In our research, the most frequented type of achieved education was junior high school represented by 62.5% of respondents.

5.2. Type of sanitation system and user´s satisfaction

This part of questionnaire focused on identification of type of sanitation system which have been using before the project implementation, as well as specific type of composting toilet obtained within the project as there were various models of composting toilets provided. Beside the year of implementation, the fact if the implemented composting toilet is still in use had to be asked with regard to several cases when users decided to modify the provided composting toilet system to septic tank toilet based on specific reasons after time. Further questions focused on advantages, disadvantages and potential health benefits of composting toilet.

The original type of sanitation used in household before the implementation of the composting toilet was inquired. Open defecation practice was proved by 15% of respondents. However, the most common type of sanitation for 85% of respondents used to be ordinary pit latrine, also called “emergency toilet” (Table 2). Although open defecation was admitted by 15% of respondents, according to YHS (2006) open defecation have been practiced by 97% villagers in West Sumba in 2006 and Hivos survey (2013) claims there is 41% households practising open defecation in whole Sumba.

Table 2: Type of toilet used before the implementation of composting toilet, N=80

	N	Percent
Open defecation	12	15
Ordinary pit latrine (emergency toilet)	68	85
Total	80	100

Author elaboration of fieldwork data (2015)

Composting toilets have been observed in four types within the study area. The most often option was single-vault composting toilet with mixing urine and excreta that occurred in 65% of households. Second most frequented type was double-vault composting toilet with two chambers with mixing urine and excreta. Single and double-vault composting toilets with urine separation system occurred rarely as this design was adopted in time when implementers just discovered this system, so they built them as first prototypes.

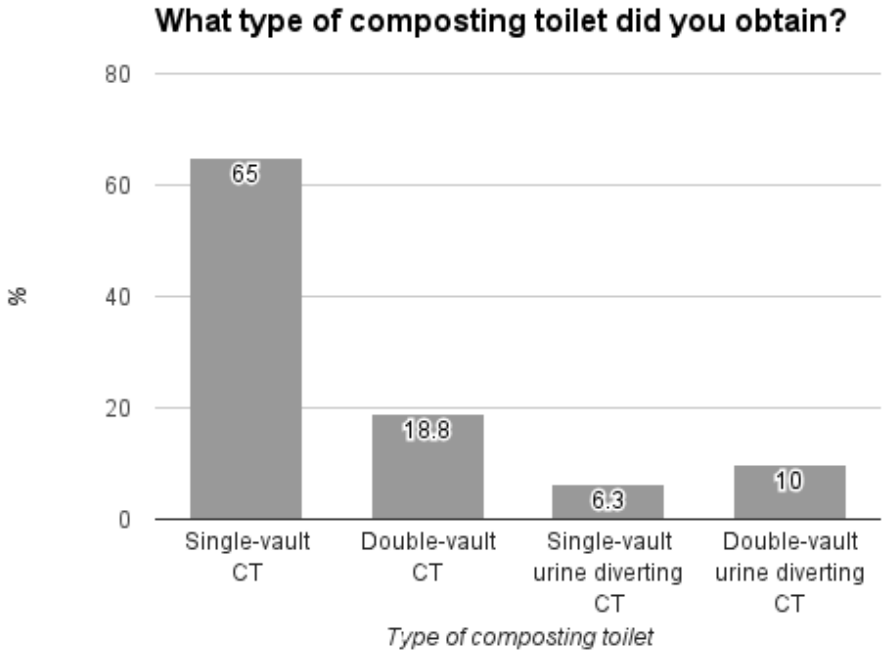

Figure 11: Frequency of specific types of composting toilets. Author elaboration of fieldwork data, 2015.

The question about current situation of implemented composting toilets and their daily usage was developed due to pilot testing of questionnaire in study area when unexpected fact of rebuilding composting toilets to septic tanks was found out. Surprisingly only 42.5% respondents kept the composting toilet in its original design and use it daily all the time. However, the majority of 57.5% asked respondents have already quit using of composting toilet and rebuilt it to septic tank toilet (Figure 10).

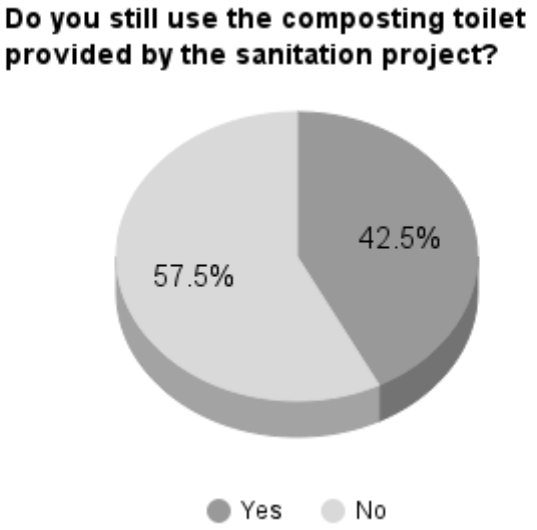

Figure 12: Distribution of users and non-users of composting toilets (those who kept continue using it, and those who quit using of this type of sanitation or modified it to the septic tank). Author elaboration of fieldwork data, 2015.

Feedback from the users who had quit the using of composting toilets brought the specific reasons which have led to decision of termination that type of sanitation. The most frequented reasons were: composting toilet does not work correctly because of lack of instructions (43.8%), presence of smell, flies, mosquitoes (32.5%), toilet construction has broken (26.3%), presence of faeces in the toilet is visible and disgusting (12.5%), social status (10%) (Figure 13). However, within one interview which was not included to the survey, farmer admitted that he accepted concept of composting toilet within sanitation project and then he directly modified that as septic tank just to use the opportunity to obtain construction.

In cases when toilets where signed as they are not working correctly, the fact of leaking was mentioned and observed. This fact was caused by pouring water for anal cleansing into the collecting chambers instead of to the designated area for washing, moreover with no sufficient addition of dry material as these instructions have not been stressed enough. Furthermore, too wet matter inside of the toilet accompanied by leaking out from the back doors attracted flies and mosquitoes. Those who had composting toilet superstructure made of bamboo material experienced that construction was destroyed due to weather conditions like strong wind or heavy rain after time. The fact that human waste is collected directly in the chamber and possibility to see this raw material was perceived as not aesthetic and disgusting, although it might have been solved out by using sufficient amount of bulking agent. Factor of social status have been mentioned mainly in context of family and friends visitors who are not familiar with composting toilet system. As guests perceive system negatively, owners of composting toilets feel shame and perceived system unrepresentative.

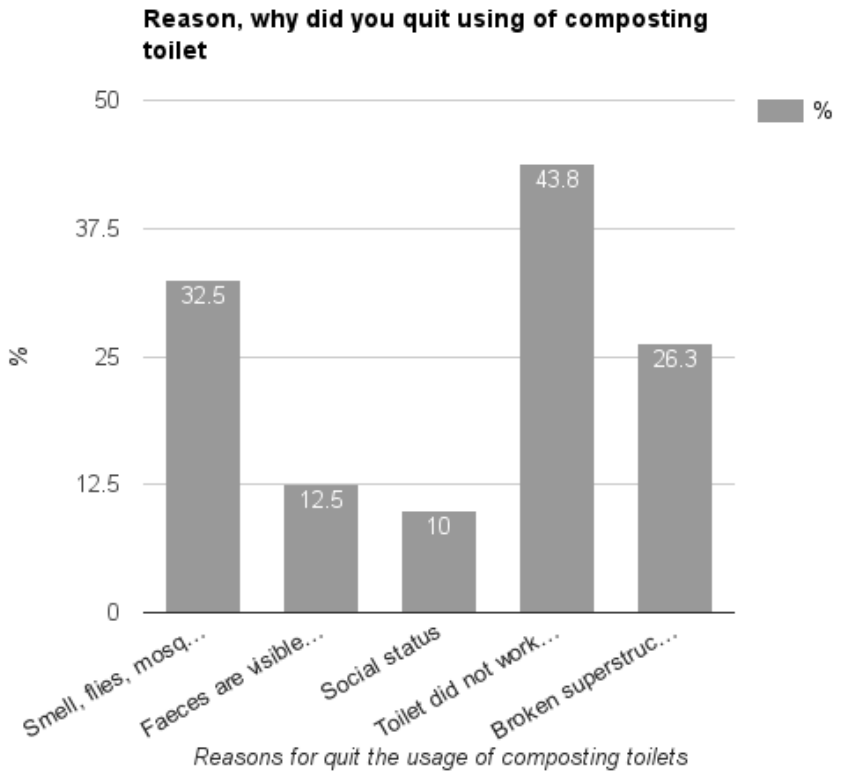

Figure 13: Frequency of main reasons for quit the usage of composting toilet. Source: Author elaboration on fieldwork data, 2015.

A chi-square test of independence was performed to examine the relation between constancy of using composting toilet and factors such as age, sex, education and religion (Table 4). The only significant relation was with age χ^2 (4, N = 80) = 10.605, p <0.05. Age was also significant in study by Tumwebaze et al. (2011). Concerning gender, decision to build a toilet is generally made by men in Indonesia together with initial impulse from women (Albrecht et al., 2010). However according to experience from Pakistan (Nawab et al., 2006) and Africa (WB, 2005) the whole issue is very controversial and needs of men and women with regard to design differs. Education level was proved as significant factor in case study in Western Uganda (Tumwebaze et al., 2011) as well as in Sri Lanka, where was revealed that with increasing level of education the acceptance of ecological sanitation is decreasing (Bandara et al., 2014)

Table 4: Chi- Square test: relationship between age, education, sex and religion of respondents and keeping using of composting toilet.

	Value	Degree of freedom	p
Age	10.605	4	0.031
Education	3.911	3	0.271
Sex	1.771	1	0.183
Religion	3.167	2	0.205

*Correlation is significant if $p < 0.05$. Author elaboration in fieldwork data (2015).

To further explain the factors that predict take-up of composting toilet, logistic regression analysis was performed using age, sex, education, off-farm activity, understanding process of composting and frequency of using bulking agent as predictors (Table 5). Dependent variable is a dummy variable that takes value of 1 if users are still using toilet and **0** when they quit the using.

Table 5: Description of variables in the Logistic Regression Model

Independent Variable	Mean	Mode	Std. Deviation
Age	3.050	3	0.825
Sex	1.08	2	0.265
Education	2.04	2	0.645
Off-farm activity	1.75	2	0.436
Understanding the process of composting	1.51	2	0.503
Frequency of using bulking agent	2.41	2	0.630

Author elaboration on fieldwork data, 2015.

The formula for logistic regression is:

$$\Lambda(x'\beta) = e^{x'\beta} / (1 + e^{x'\beta})$$

Where:

$$x'\beta = \beta_1 x_1 + \beta_2 x_2 + ... + \beta_\kappa x_k$$

There are significant factors which are having off-farm job, understanding process of composting and frequency of using bulking agent. The results indicate that the probability of usage is increasing with having off-farm job. People in West Sumba take off-farm jobs in the nearest towns. Based on survey, there is 20% of respondents who confessed they have off-farm job. The most common off-farm activities are weaving and selling traditional textile "*ikat*", sewing, trading on the market, helping as mason or driving. To explain their acceptance, it might be due to their frequent contact with information sources as they are more close to urban centres. Moreover certain ability of people to have extra off-farm activity mirrors their open-minded attitude and ambitions to learn and work besides farming activities.

Understanding the process of composting and possibility of simple explanation was proved by the survey. Those who are aware of basic principles of composting toilet understand the importance to keep water away of the compost chamber as well as importance of adding dry material to avoid difficulties with wet material and leaking. Generally, if users have

idea of comprehensive process, they are more familiar to the system. Therefore, sufficient instructions are recommended to be promoted and provided. On the other hand level of education which is considered as significant factor by Tumwebaze et al. (2011) as well as Bandara et al. (2014) was not confirmed.

Table 6: Logistic Regression Model

Independent Variable	B	S.E.	Wald	Prob.
Age	0.291	0.454	0.412	0.521
Sex	0.775	1.368	0.321	0.571
Education	-0.347	0.589	0.327	0.556
Off-farm	2.113	0.739	8.183	0.004*
Understanding the process of composting	1.761	0.667	6.974	0.008*
Frequency of using Bulking agent	2.104	0.647	10.575	0.001*
		4.008	8.947	0.003
Constant	-11.984			
Model χ^2 =	21.753, p = 0.003 < 0.05			
Pseudo R^2 =	0.344			
N =	80			

Author elaboration on fieldwork data, 2015.

* significant at 0.05 level of confidence.

All the respondents confessed they prefer composting toilets rather than previous type of toilet they had before the project implementation if they even had any. Concerning the main advantages of composting toilets, fact of working as dry toilet and saving water was the most answered question together with providing fertiliser. According to the fact that Sumba suffers severe droughts, the waterless composting toilets are likely to be considered as suitable for these regions. Possibility to use final product of composting toilets, natural fertiliser is perceived as advantage similarly as report from Indonesia by Albrecht et al. (2010) claims. Based on the interview with respondents within the survey, environmental benefit of composting toilets in its wider context is not understood and was necessary explain that by particular examples like water pollution etc. However, according to

Rajhandri (2005) environmental benefit of composting toilets it is not considered by users as important as there is generally lack of awareness about this issue. Health benefit of composting toilets was asked within other question and was recognised by 81% of respondents when decrease of diarrhoea was mentioned. According to Rotary report, local beneficiaries admitted that due to this sanitation project, diarrhoea decreased and it is just malaria which they mainly fight with.

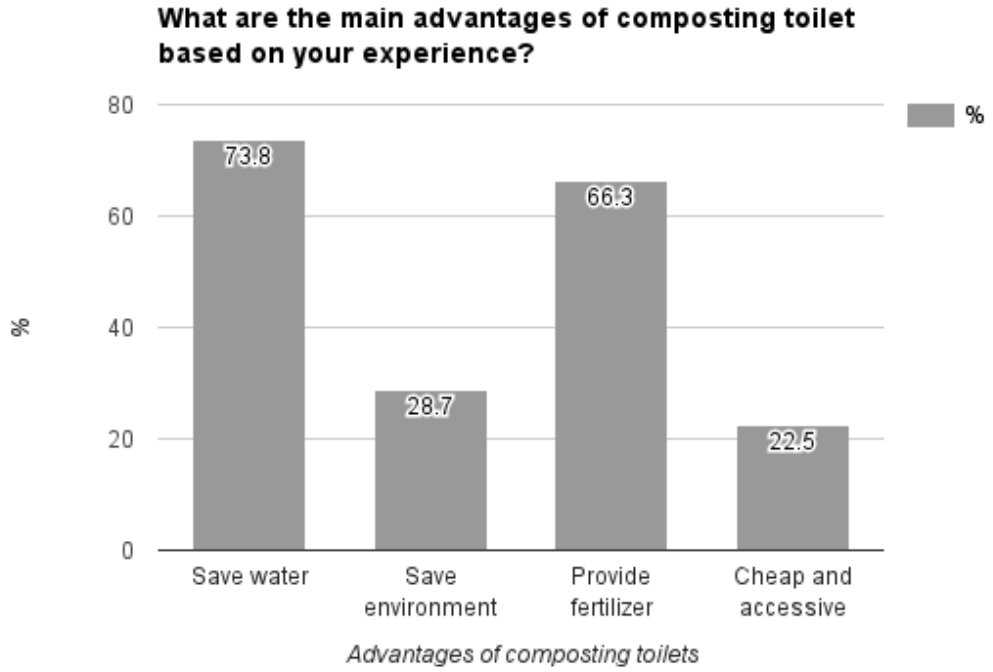

Figure 14: Main advantages of composting toilets. Author elaboration of fieldwork data (2015)

According to results of the survey, 63.7% of respondents consider maintenance of composting toilets as the main disadvantage, followed by discomfort when they practice anal cleansing which might be solved out by more suitable design of the toilet with more comfortable zone for washing. Other disadvantages like inadequate social status, presence of faeces and psychological barriers to operate with faeces have been chosen less frequently.

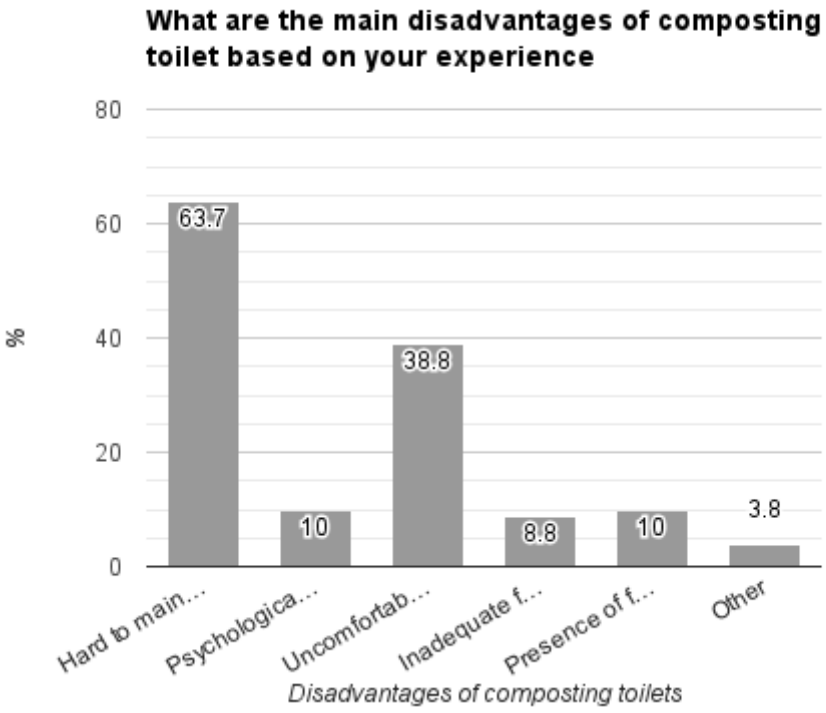

Figure 15: Main disadvantages of composting toilets. Author elaboration of fieldwork data (2015)

Satisfaction was discussed within the interview (Figure 16). Although sincere thankfulness for the sanitation project was clearly expressed, it was connected mainly to the fact of receiving the first proper toilet. However the concept of composting toilet was welcomed, the fact of final quitting the usage of some of the respondents are mirror of the satisfaction in the reality.

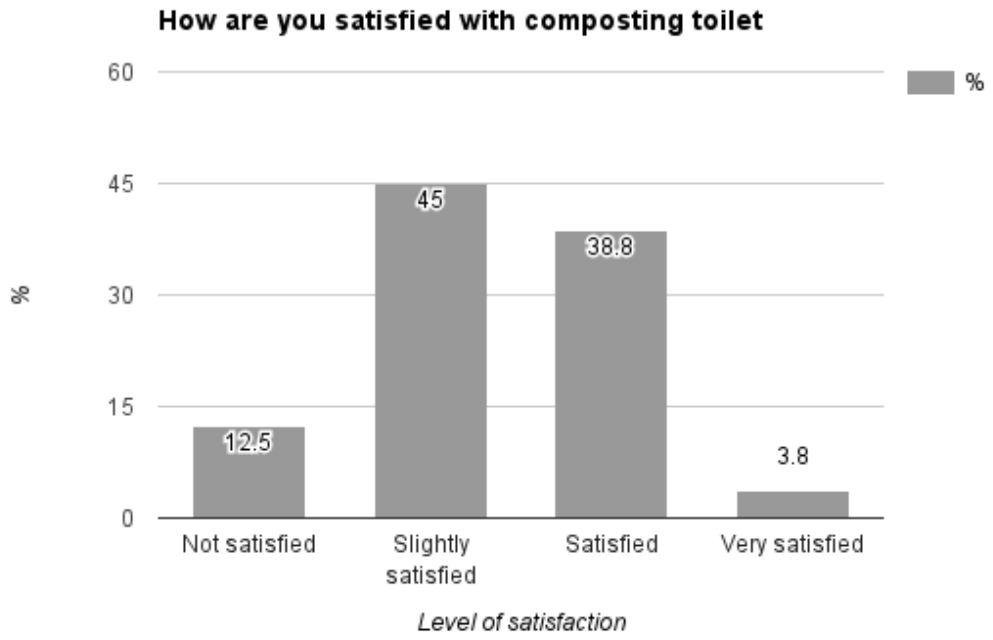

Figure 16: Level of user satisfaction of composting toilets. Author elaboration of fieldwork data (2015)

5.3. Using of bulking agent

Composting toilets require specific care and maintain to ensure appropriate process of the whole system and composting process. Therefore it is necessary to add bulking materials regularly to increase the carbon content and to absorb surplus moisture. Typical bulking agents are sawdust, ash, dry leaves or straw.

Majority of respondents represented by 67.5% have been using sawdust, followed by dry leaves and the less common is ash.

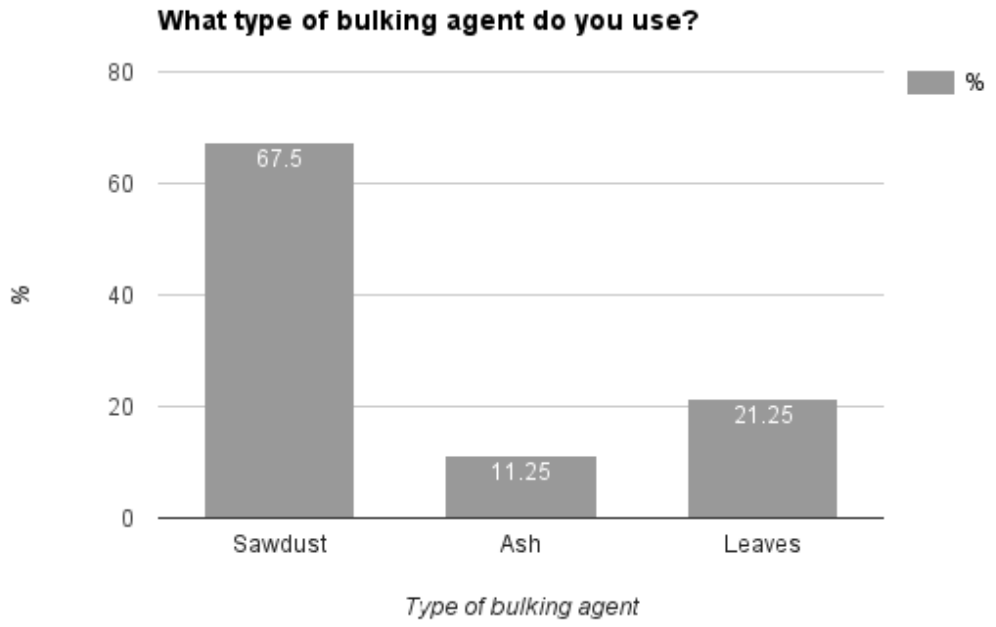

Figure 17: Usage of certain types of bulking agent. Author elaboration of fieldwork data 2015)

Usage of bulking material was observed as insufficient as the matter was too wet and in some cases toilets were leaking. Using of dry material is necessary especially in cases where composting toilets do not separate urine. According to the survey 89% of respondents stated that they did not received information about importance of adding the bulking agent.

According to the observation, in neighbourhoods where profession of carpenter was presented, people used sawdust more frequently and generally easy access to the source of bulking material influenced better conditions of whole process of composting.

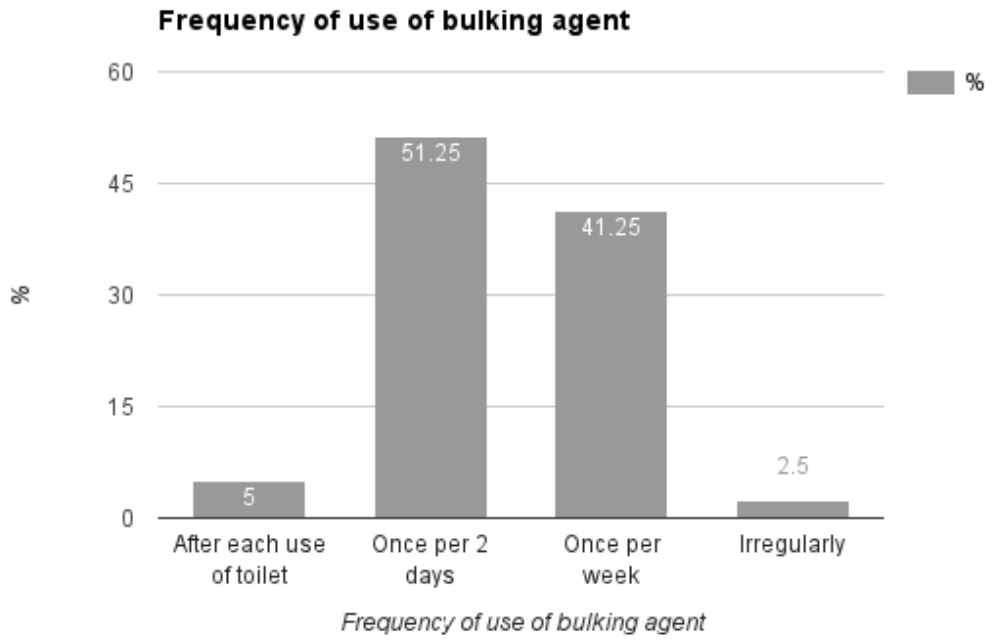

Figure 18: Frequency of applying bulking agent. Author elaboration of fieldwork data (2015)

Regular use of bulking material in composting toilet contributes to the correct processes of composting that leads to getting a final safe composted matter. According to observation and the fact that villagers use bulking material only once per 2 days or even only once per week, the content of the chamber is usually very liquid and brings specific inconveniences. Those inconveniences affected respondents, who did not use bulking agent regularly at least once per day, to quit the using composting toilet as they were more likely to decide to rebuilt the toilet. To ensure that the previously mentioned hypothesis is true, a correlation analysis was performed to test the relation between frequency of using bulking agent and the degree of using composting toilets. Result shows that the two variables are positively, but moderately correlated, r (80) = 0.47, $p < 0.001$. More frequent usage of bulking agent reflects that user is aware of information and rules how to maintain the composting toilet as bulking material helps to prevent content to be too wet and leaking of the leachate out of the toilet. Therefore, as the composting toilets work correctly with regular usage of bulking agent, users are likely keep the composting toilet instead of to rebuilt them or quit.

Table 7: Correlation between usage of bulking agent and maintaining usage of composting toilet.

		Usage of bulking agent
Composting toilet in use	Correlation coefficient (r)	0.471*
	Sig. (2-tailed) (p)	0.000
	N	80

*Correlation is significant if $p < 0.05$. Author elaboration in fieldwork data (2015)

5.4. Water issue

Sanitation is closely connected to water issue e.g. source of water or access to water. Composting toilets have been chosen by implementers mainly because of the severe droughts during dry seasons in the study area. In areas with enough water, respondents might have chosen composting toilet or septic tank system. Problems to get enough water during dry season was proved by 82.5% of respondents, while 17.5% of respondents disagreed. Respondents admitting the lack of water added that they need to buy cistern of water to refill their community or private water tank during dry season. Beside the project of composting toilet, 266 rainwater catchment tanks was built by YHS since 2002.

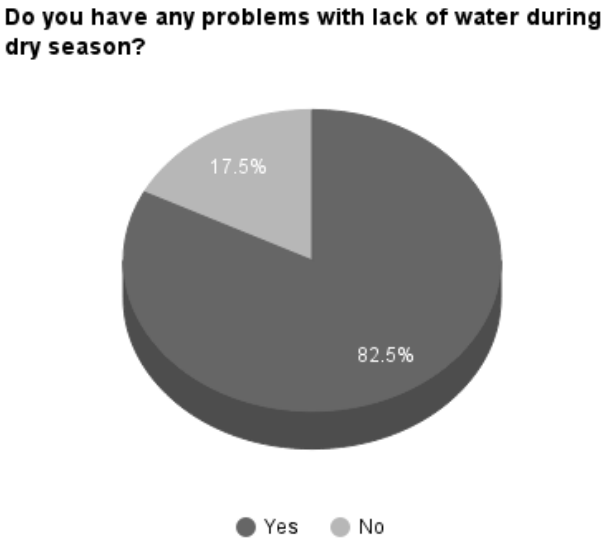

Figure 19: Distribution of respondents with and without problems of lack of water during dry season. Author elaboration of fieldwork data (2015)

According to the survey, the most common source of water is community well represented by 47.5% of respondents, then private well owned by 30% of respondents and water from natural springs is used by 22.5% of respondents. According to Hivos survey (2012), long dry season is causing difficulty to get water for household purposes in 54% of households within whole Sumba. Furthermore in West Sumba District, difficulty is even during rainy season when water sources and wells are often filled with mud. Due to YHS organisation community wells and catchment tanks for rain water have been implemented within the program since 2002 (YHS, 2006).

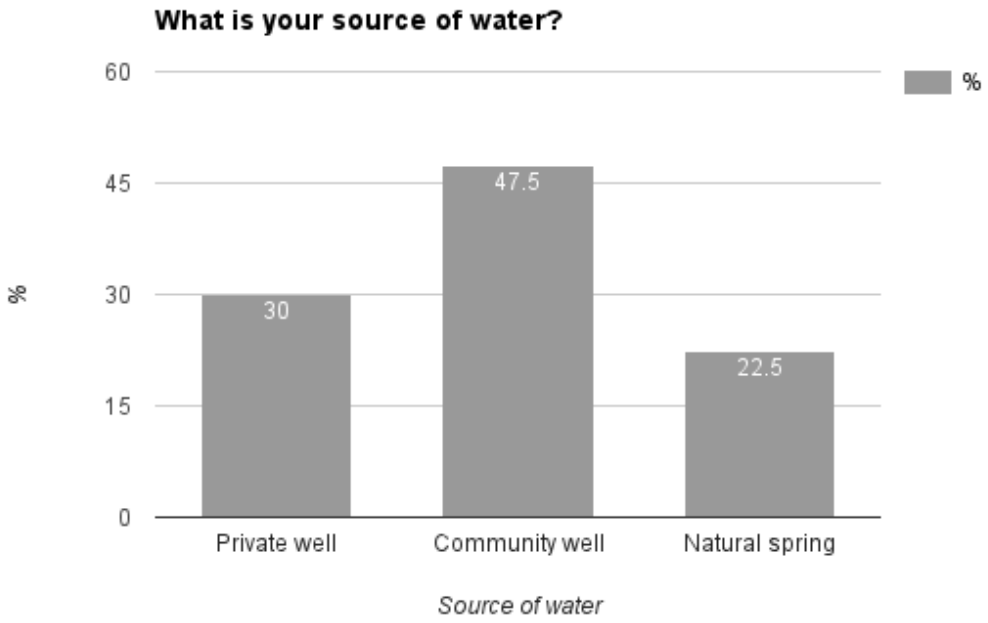

Figure 20: Source of water. Author elaboration of fieldwork data (2015)

Based on the fact that difficulties to ensure water especially during dry season, it was expected that composting toilets would be an appropriate sanitation system as they do not require water. Similarly, continuous soil infertility in Malawi was considered as important factor, which affected interest of ecological sanitation almost immediately. Therefore problem to get the water and severe droughts have been expected as driving factor to appreciate dry composting toilets and keep this system in use. However, results do not prove this. The correlation analysis was applied and there was no significant relation between the keeping composting toilet in use and lack of water in dry season, r (80) =

-0.136, p = 0.228. Therefore, we can conclude that lack of water during dry season has no tendency to influence respondents to keep composting toilets in use.

Table 7: Correlation between problems with lack of water in dry season and using of composting toilet.

		Problems with lack of water
Composting toilet in use	Corr. Coefficient (r)	-0.136
	Sig. (2-tailed) (p)	0.228
	N	80

Correlation is significant if $p < 0.05$. Author elaboration in fieldwork data (2015)

The way of anal cleansing must be considered once designing the toilet, especially in case of dry composting toilet. For ensuring adequate comfort for users and to keep content of chambers without additional water, special place for washing need to be provided within the toilet. According to Albrecht et al. (2010) using water for anal cleansing is considered as cultural issue than as a religious one. Therefore, usage of water for anal cleansing is common for people of Sumba, although they are not followers of religion that asked this practice. Based on result of our survey, there is 96.25% respondents who use water for anal cleansing, and 3.75% of respondents use leaves (Figure 21).

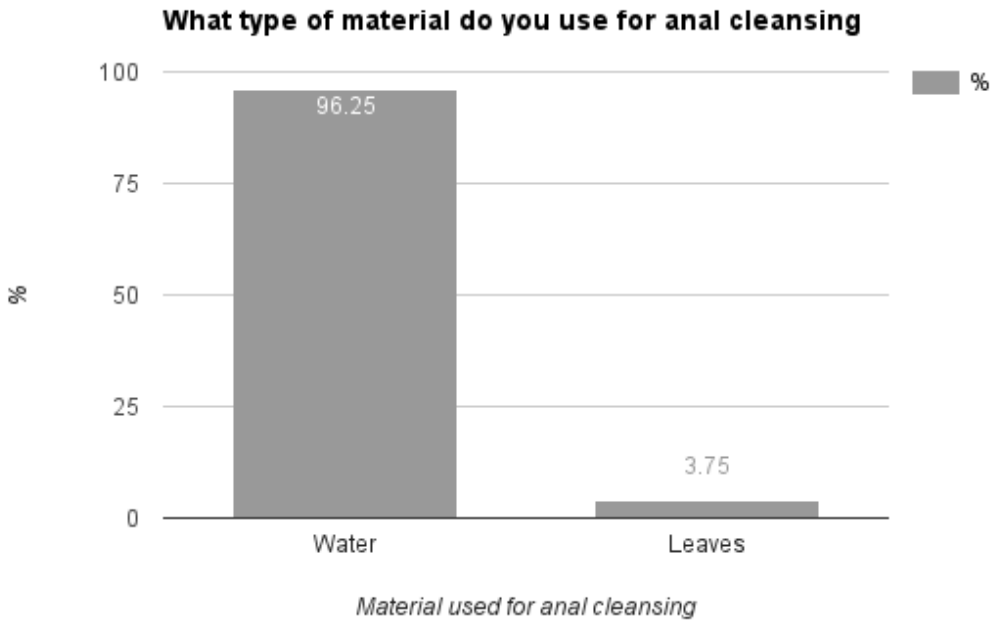

Figure 21: Types of material used for anal cleansing. Author elaboration of fieldwork data (2015)

5.5. Reuse of treated human waste as fertiliser

The idea of composting toilet system is to transform human waste to safe and valuable fertilizer. According to pre-research conducted within the survey in Indonesia by Albrecht et al. (2010), demand was fertiliser as the product of composting toilets was noticed. Same within our research in Sumba, farmers see product of fertiliser as benefit, but in practice, there are certain obstacles to its application. Similar experience has occurred in African surveys by Holden et al. (2003) and Shayo (2007), where reuse of treated urine and faeces were practicing with barriers and obstacles, or occurred by default during the disposal of the excreta rather than to be applied as fertiliser for purpose.

According to our results in figure 20, there is 30% of respondents who has already applied treated faeces as fertiliser as soil-conditioner or for trees and other plants.

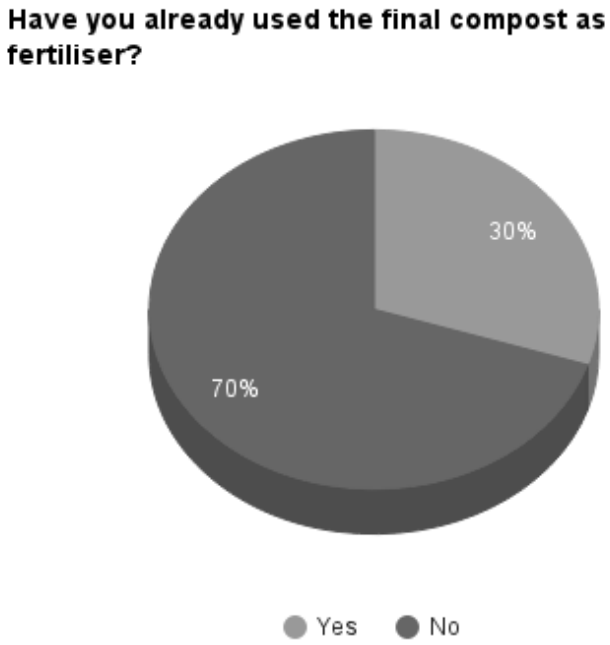

Figure 22: Distribution of users and non-users of final compost as fertiliser. Author elaboration of fieldwork data (2015)

In 70% of cases (figure 22) when fertiliser have not been used, the reason of this fact was asked to be explained (figure 23). Majority of those who have not used the final compost as fertiliser was consist of those respondents who quit the usage of composting toilet (46 households) and rebuilt it earlier than the harvest of matured compost occurred or they just did not even aimed to apply that. Argument from those who still using composting toilets was that they do not know how to do that (11.9%) and that matter is not composted yet (10.2%).

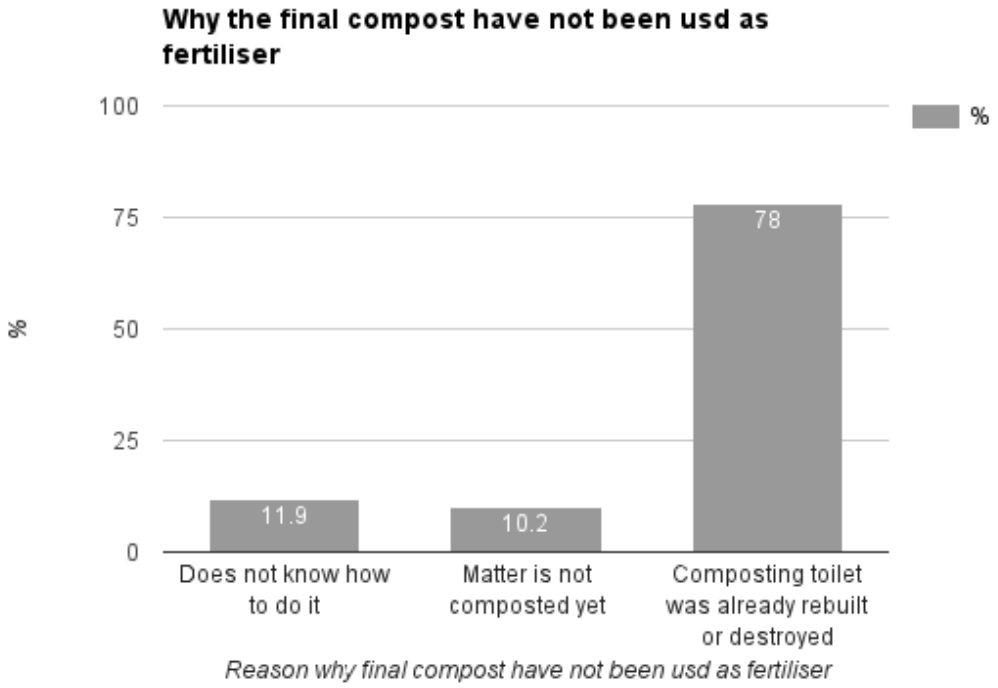

Figure 23: Reason why final compost have not yet been used as fertiliser. N= 59. Author elaboration of fieldwork data (2015)

There is majority (57.5%) of all respondents who stopped using composting toilets and changed for septic tank who did not try to apply final compost as fertiliser. As they did not try to apply compost on field, they have not experienced potential benefit of this fertiliser, which might have persuaded them to keep this system. However, there are also respondents, who despite the fact they are still using composting toilets, have not used final compost as fertiliser yet. It was expected that since farmers experienced successful benefit of fertiliser, it will motivate them to keep continue using this system more likely and after this moment of experience and application of the compost will be motivated to continue in using composting toilet. To test that hypothesis, a correlation analysis was made to test the relation between keeping usage of composting toilet and usage of final compost as fertiliser. The results show a positive strong correlation between the two factors, r (80) = 0.76, $p < 0.001$.

Table 8: Correlation between usage of final compost as fertiliser and keeping composting toilet in use.

			Usage of final compost as fertiliser
	Composting toilet in use	Correlation Coefficient (r)	0.761*
		Sig. (2-tailed) (p)	0.000
		N	80

Correlation is significant if $p < 0.05$. Author elaboration in fieldwork data (2015)

5.6. Project implementation and participation of the user, information provided

Sanitation programme by YHS was developed with aim to solve out open defecation, which have been practiced by 97% villagers in West Sumba in 2006 (YHS). YHS organized discussions with local inhabitants about heath issue that revealed consequences between open defecation and spreading diseases like diarrhoea. Output of the discussions resulted in group decision and desire to manage their first toilets. Villagers demand was a clear impulse for YHS to help to raise the first sanitation project, therefore in 2006 first toilets have been built for several local households (YHS). Based on information from YHS, local families used the local materials to construct toilets by themselves. However, YHS provided support to purchase cement and pipes. Since the first toilets have been finished, other requests from surrounding neighbours occurred. Two YHS workers have attended course of constructing composting toilets so they actively provided expert advices and participated on building the toilets. Except NGO experts and family members, since 2010 French students are coming to Sumba to volunteer, so they also contribute to building sanitation.

All the respondents supported the project by physical, material or financial contribution. Figure data shows that material input in term of available construction material i.e. limestone, send, bamboo was provided by all households. Majority of household members participated on the building the toilet together with implementation team. There were 83% of respondents who donated 50,000 IDR. However, explained by YHS, all the farmers

contributed by mentioned fee, which was collected within the community. All the households also added that they provided food and drink for constructors.

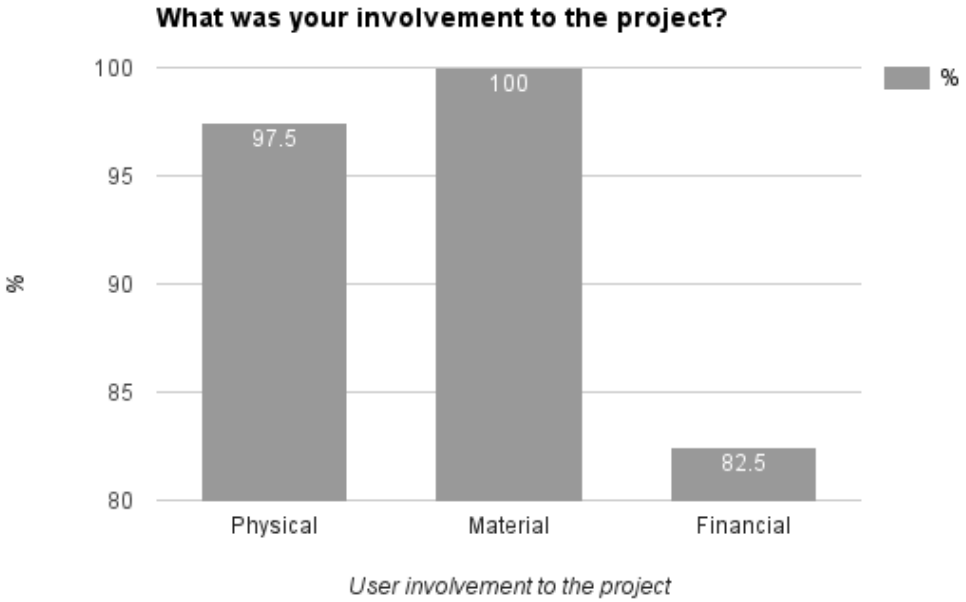

Figure 24: Users involvement to the project. Author elaboration of fieldwork data (2015)

Table 9: Cross tabulation of type of users involvement to the project of the respondents and using of composting toilet

			Type of users involvement		
			Physical	Material	Financial
Composting toilet in use	Yes	Count	33	34	31
		% Row	33.7%	34.7%	31.6%
	No	Count	45	46	35
		% Row	35.7%	36.5%	27.8%

Author elaboration in fieldwork data (2015)

Among those who are still using the composting toilets, 33.7 % provided physical contribution, 34.7% provided material contribution and 31.6% provided financial contribution. As chi-square analysis brought insignificant relationship (p value is higher than 0.05) we can say that there is no relation between the involvement of respondents and their using of composting toilets.

Concerning provided information about composting toilets and its operation, all the respondents obtained instructions within the community meeting or individually from implementation team or head of the village. However, nobody was given practical workshop or informative materials about composting toilets. Question about understanding process of composting have been asked within the interview. While 49% of respondents proved awareness about decomposition process, 51% of respondents confess they do not understand the principle of composting. To further test this result, another test of correlation has been made. There is significant but moderate correlation between understanding process and keeping using of composting toilet r (80) = 0.33, p = 0.003, this proves importance of ensuring farmers' awareness towards the complex process which might be achieved very simply by instructing manual and workshops and field training.

Table 10: Correlation between understanding process of composting and use of composting toilet.

		Understanding to process of composting and ability of its explanation
Composting toilet in use	Correlation (r)	0.325*
	Sig. (2-tailed) (p)	0.003
	N	80

*Correlation is significant if p < 0.05. Author elaboration on fieldwork data (2015).

Staying in touch with the receivers of the technology provided within projects as well as after project visits by implementers are considered to be beneficial practice to help keeping the project sustainable. Holden et al. (2003) recommend to ensure long-term support for 4-5 years. According to table 11, only 18.8% of the users were visited after project termination.

Table 11: Implementation team after-visits in the households.

Number of visits after the realisation of the composting toilet	N	Valid Percent
1 x	15	18.8
Never	65	81.3
Total	80	100.0

Author elaboration in fieldwork data (2015)

6. Conclusion

The main objective of the thesis was to assess user´s acceptance of composting toilets and their perception of the ecological sanitation system in sub-district of Wewewa Tengah of West Sumba, which has been provided by local non-government organization Yayasan Harapan Sumba since 2008. The specific objective was to identify criteria that influence acceptance of composting toilets and suggest recommendations ensuring sustainability of further projects.

As the open defecation is still widespread in Sumba, the composting toilets provided within the sanitation programme have represented the first toilets for most of the families. 15% of respondents confessed the practice of open defecation and 85% had used provisional pit latrines before the project. Waterless single-vault and double vault composting toilets without mixing urine and excreta device were implemented as well as urine-diverting ones to serve as improved sanitation and transform human waste to fertiliser.

Based on the survey, majority of the beneficiaries 57.5% has decided to quit usage of the composting toilets and rebuilt them to septic tank system. The main reasons for stop using the toilets were the fact that composting toilet does not work correctly because of lack of instructions (43.8%), presence of smell, flies, mosquitoes (32.5%), toilet construction was broken (26.3%), presence of faeces in the chamber was visible and disgusting (12.5%), and social status (10%).

Based on the results of the survey, the most important factors affecting acceptance of composting toilets were frequency of using the bulking agent, the experience of final compost application, ability to understand process of composting and having an off-farm activity. Correct operation and use of composting toilets have been seen as problematic as in several cases the material inside of the composting chamber was too wet and was leaking out of the toilet. Although 67.5% respondents claimed that they are using sawdust as dry material, frequency of application was mostly once per two days or even once a week only, which is not sufficient. Currently there is only 30% of respondents who have already used the final compost as fertiliser. The most common argues why compost have not been used yet was the fact the some respondents quit and rebuilt the toilet earlier than they even gain matured compost, followed by the reality that they do not know how to

apply compost and also the fact that matter is not composted yet. User awareness and understanding basic principles of process of composting have been identified as significant factor of acceptance the composting toilets, while level of achieved education did not have significant influence. Based on results, having an off-farm activity affecting acceptance of composting toilets that is probably given by individual ability to be open-minded, ambitious to learn and be active besides farming.

As island of Sumba is suffering severe droughts especially during dry seasons, it was expected that ecological sanitation will be better accepted and the fact of water difficulty will be a driver to accept and keep this technology. Based on results, water difficulties do not represent significant factor for acceptance. Local people are used to buying water during hot seasons, furthermore practice of anal cleansing with water is cultural habit.

Last but not least remarkable founding is concerning awareness of ecological sanitation, its promotion and explanation. Providing sufficient instruction, practical workshops and trainings, supported by simple pictographic manual are crucial for acceptance and sustainability of new technology. After project visits by implementation team have not been realized in 81% of cases. Sufficient information about operating composting toilet, using bulking agent and applying fertiliser were missing and were not clear to the respondents.

Currently the new project of sophisticated urine-diverting dry toilets is running by Yayasan Harapan Sumba. Based on the observation, technology and extension method is much better developed. Community discussions and organised workshops are being practiced for children in local school and villagers. Sustainability of the project and aim to spread the technology naturally is ensured by the fact that two local men have been learned how to produce special toilet pan for diverting urine and excreta with adjusted hole for water from anal-cleansing.

Although information about technology and biological processes of ecological sanitation are plentifully available, literature and research about acceptance of this technology is still insufficient. Identification of criteria that influencing acceptance is necessary to avoid failures of development projects implementing ecological sanitation in the future.

Despite certain failures, the project represents unique experience of composting toilets in Indonesia and can serve as source of valuable information for further projects.

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8. Annexes

Annex 1 Questionnaire English-Indonesia version

Annex 2 Photo documentation

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Questionnaire

This questionnaire will be used as a source of information concerning **assessment of user acceptance of composting toilets in rural area of Sumba.** The obtained data will be processed in my diploma thesis at Czech University of Life Sciences Prague. I would be very glad if you help me and participate in my research. Thank you in advance for your participating.

Best regards,

Soňa Valčíková

Czech University of Life Sciences Prague
Tel. number : +420 724 488 733
E-mail: sona.valcikova@gmail.com

I. General information about the user and household

1.1. Name of the village / Nama desa

.....

1.2. Age / Umur

a) 15-20 b) 21-30 c) 31-40 d) 41-50 e) 51-60 f) 60+

1.3. Sex / Jenis Kelamin

a) Male/ Laki-laki b) Female/ Perempuan

1.4. **Religion/ Agama**

a) Christianity - Protestant b) Christianity - Catholic c) Marapu d) Islam

e) Other/ Lain-lain

1.5. What is your highest level of completed education? Apa pendidikan terakhir Anda?

a) Primary school/ SD sekolah dasar b) Junior high school/ SMP sekolah menenga pertama

c) Senior high school/ SMA atau SMU d) College /S1 e) University /S2

1.6. What is the number of members of your household? Ada berapa orang tinggal dalam rumah anda?

a) 1-5 b) 6-10 c) 11-15 d) 15+

1.7. How many people work from your household?/ Ada berapa orang yang bekerja dalam keluarga anda dan apa profesinya?

a) 0 b) 1-3 c) 4+

1.8. What is their profession? (e.g. mother-farmer, father –carpenter etc.) / Apa profesinya?

a) Farmer/ Petani b) Other, please / Lain-lain

1.9. Do you have any off-farm activities? Ada kerja yang

a) Yes b) No

If *yes*, please explain……

II. Type of sanitation system and user´s satisfaction

2.1. In which year was the composting toilet implemented?

a) 2008 b) 2009 c) 2010 d) 2011 e) 2012 c) 2013

2.2 Do you still use the composting toilet?

a) Yes b) No – *in this case, all the questionnaire questions will be asked in relation to the composting toilet that was implemented within the project and according to user´s experience within the time when it was used.*

2.2.1. If no, please explain the reason why you quit using it?(multiple choice question)
a) smell, flies, mosquitoes
b) disgusting presence of faeces in the toilet is visible
c) Social status (family visitors)
d) does not work correctly because of pouring water inside and lack of instructions
e) bamboo construction has broken

2.2.2. If no, what kind of toilet do you use now instead of it?

a) The toilet that was rebuilt to the septic tank system toilet
b) The same toilet without any technical changes using water for pour flushing

2.3. What particular type of composting toilet did you obtain in term of number of vaults?

a) Single- vault composting toilet
b) Double vault composting toilet
c) Single-vault urine diverting composting toilet
d) Double- vault urine diverting composting toilet
e))Mobile bucket or bin toilets followed by external composting of the excreta (keranjang/ember)

2.4. What kind of sanitation system did you use before the project realization?/Penyuluhan apa yang anda sudah lakukan atau ikuti sebelum memulai mengunakan toilet?

a) Open defecation/ Di luar
b) Ordinary pit latrine – dry toilet (emergency toilet)/ Toilet kering
c) Pour -flush toilet with septic tank
d) Composting toilet/ Toilet kering
f) Other, *please specify*.....

2.5. Which of two options of the systems you have had used do you prefer? Menurut Anda system apa yang kalian lebih suka?

a) Previous type of toilet/ Toilet lama b) New type of composting toilet /Toilet baru

b) Don't know/ tidak tahu

2.6. Based on your experience, what are the main advantages of composting toilet? (multiple choice question)

a) save water
b) save environment
c) provide natural fertilizer and save money as we do not need to buy fertilizer
d) cheap and effective
d) other, please specify……

2.7. Based on your experience, what are the main disadvantages of composting toilet? (multiple choice question)

a) hard to maintain the composting process
b) psychological barriers to operate with faeces and use as fertilizer
c) uncomfortable for anal cleansing and operating with water
d) inadequate for user´s social status
e) presence of the faeces is disgusting, can see the composting matter
f) other, please specify…….

2.8. How are you satisfied with this type the composting toilet? Apa kesan anda dengan toilet yang sekarang?

a) Not satisfied/ Tidak puas
b) Slightly satisfied / sedikit puas
c) Satisfied / puas
d) Very satisfied / sangat puas

Please justify your answer
……...

2.9. In your opinion, do you think that the composting toilet facility brought some health and environmental benefit? Menurut anda apakah kegunaan toilet ini membawa keuntungan kesehatan anda?

a)Yes b) No c) Do not know

2.9.1. If yes, please explain how?
a) Diarrhea decreased b)Malaria decreased c)Other
…….

III. Using of bulking agent

3.1. What kind of bulking agent/dry material do you use the most after using toilet? Bahan apa yang anda gunakan setelah menggunakan toilet?

a) Sawdust/abu kayu b) Ash/abu dapur c) Leaves/daun daunan

d) Straw/ jerami e) Other, *please specify*……

3.2. What is the source of this material? From where do you usually get it? Di mana anda selalu mendapatkan bahan kering seperti contoh abu dapur, abu kayu?

a) Local carpenter
b) Kitchen
c) Collected in the farm or nature / Dari kebun, mengumpulkan sendiri dari alam
d) Other, *please specify/ lain-lain,* …….

3.3. Is there a carpenter in your village? (Carpenter can give you sawdust for free)

a)Yes b) No

3.4. How often do you use the bulking agent/ dry material?

a) After each use of toilet
b) 1x per day
c) 1x per 2 days
d) 1x per week
e) Irregularly

3.5. Have you been informed about importance of adding the bulking agent/drying material?
a) Yes b) No

IV. Water issue

4.1. Do you have any problems with lack of water during dry season?
a) Yes b) No

If *yes*, please explain – need to buy water.....

4.2. What is the main source of water for your house?
a) Private well b) Community well c) Natural spring
d) Other, please explain…….

4.3. What material is usually used for anal cleansing? Bahan apa yang kalian gunakan untuk cebo?

a)Water/ air b) Leaves (daun –daunan) c) Toilet paper – tisu toilet

e) Other, *please specify*.....

4.4. To where the water used for anal cleansing is discharged? Di mana air cebo itu mengalir?

a) To the particular designated area for waste water without further treatment/ Terbuang keluar

b) To the particular designated area for waste water with further treatment (Constructed wet land, French drain) terbuang keluar ke tempat yang tersedia.

c) To one hole for urine and faeces

d) To the urine hole – ke lobang air kencing

e) To the faeces hole - ke lobang po´e

f) Other, *please specify*.....

V. Reuse of urine and treated faeces

5.1. Do you have any beliefs or opinions concerning the handling of faecal matter? Apakah anda mempunyai prasangka atau pendapat lain tentang menangani po´e?

a) No b) Yes, *please specify your belief* ……

5.2. Where are the faeces stored until they get ready to be used as fertilizer? Di mana anda membuang po´e yang sudah dikumpulkan sebelum siap digunakan sebagai pupuk?

a) Stored in the bottom part of the toilet all the time
b) Special dryer pile/ tempat yang sudah disiapkan
c) Special solar dryer bin

d) Other, please describe…….

5.3. For how long are faeces/urine stored before reuse?

a) up to 3 months b) 3- 6 months c) Up to 1 year d) More than 1 year
e) Other

5.4. Have you already used the final compost?

a) Yes b) No

5.4.1. If *no*, please explain your answer
a) Does not know how to do it
b) Matter is not composted yet
c) Composting toilet was already rebuilt or destroyed
d) Other, please explain
…….

5.6. Do you think there is a health risk to use treated faeces and urine as fertilizer? Menurut pandangan anda apakah ada masalah tentang kesehatan dalam menggunakan pupuk ini?

a)Yes, *please explain*…….. b) No, *please explain* ……

c)Don´t know

5.7. Do you think the use of urine and faeces has any impact on crop production? Menurut anda dalam menggunakan pupuk ini apakah ada pengaruh untuk produksi tanaman anda?

a) Positive impact, please explain Pengaru positif ……..

b) Negative impact, please explain Pengaru negatif……

c) Don´t know

5.8. Do you buy the fertilizer on market?

a)Yes b) No

<u>VI. Project implementation and participation of the user, information provided</u>

6.1. Did you get any information or practical training about operating composting toilet before the project from the project implementers?
a)Yes b) No

6.2. Did you get any practical training/ workshop?
a)Yes b) No

6.3. Did you get any information material about composting toilet?
a)Yes b) No

6.4 If yes, from who did you get those information?
a) Head of the village b) Project implementer c) Nobody d) Other……..

6.5. If yes, how many times you got a meeting/training?
a) once b) twice c) more than twice

6.6. Do you understand the composting process within the composting toilet? Can you explain?

a) Yes, does understand and can explain
b) No, does not understand and cannot explain

6.7. What was your involvement in the setting up of the composting toilet? Apa keterlibatan anda dalam membuat toilet ini? (Multiple-choice question)

a) No involvement / tidak terlibat

b) Physical work contribution / menasehati dengan

c) Material input to complete construction/ Kebutuhan

d) Financial input to complete construction/ keuangan

e) Other, *please specify* …….

6.8. Are you still in touch with the project implementation team? Apakah anda masih punya hubungan dengan tim pelaksana?

a)Yes b) No

6.9. How many times did they (project implementers) visit you after project? Berapa sering mereka mengunjungi anda ?

a)0 b)1x year b) 2- 4x year c) Other, *please specify*……...

VII. Recommendations and general feedback on the composting toilet

7.1. Do you have any suggestion how to improve composting toilet/ design/ construction/ operation/ feedback to YHS?

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Annex 2 Photo documentation

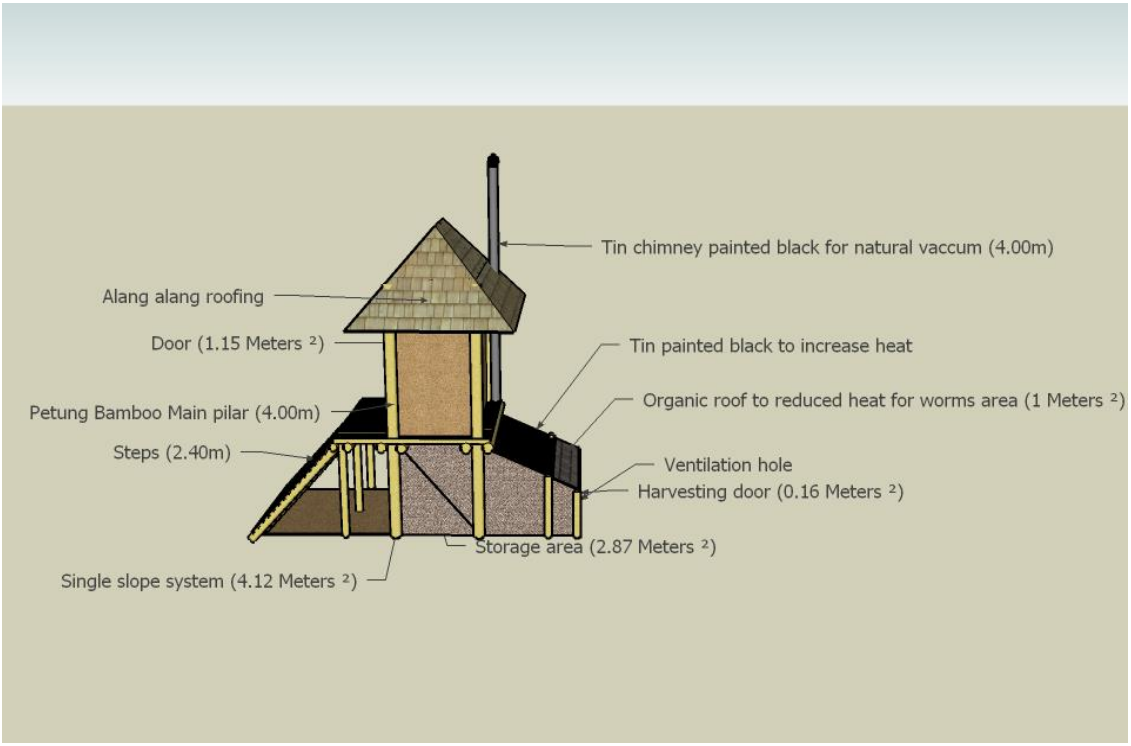

Figure I: Model of composting toilet provided by Chakra Wydia, THK (2010)

Figure II: Single-vault composting toilet with bamboo superstructure

Figure III: Double-vault composting toilet with urine-separation with back side doors to access the compost.

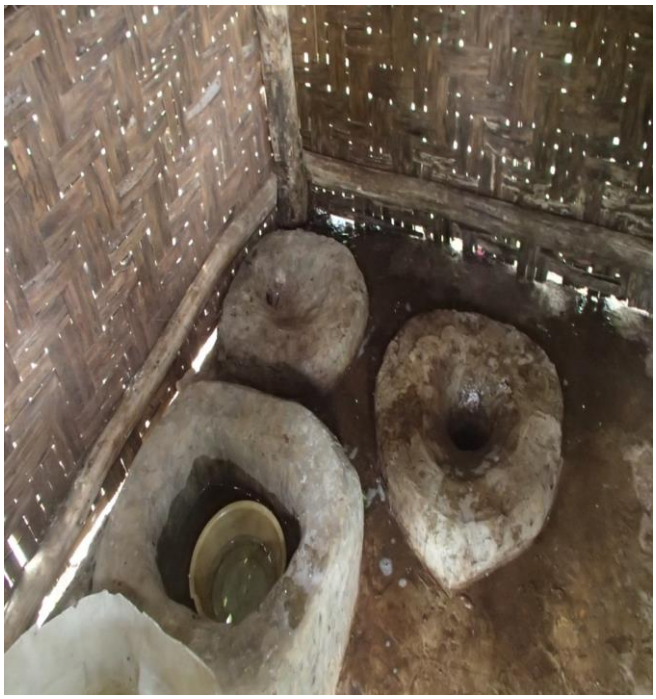

Figure IV: Interior of composting toilet with water collector and designated place for anal-cleansing and urine.

Figure V: Interior of double-vaut composting toilet with three holes for separating urine, excreta and water used for anal-cleansing.

Figure VI: Women collecting sawdust to be used as bulking material