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An Evaluation of Pit Latrines and User Perception of Excrement in Ngäbe Communities in Panama

James A. Libby
University of South Florida, libbyj@mail.usf.edu

An Evaluation of Pit Latrines and User Perception of Excrement in Ngäbe Communities in Panama

by

James A. Libby

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Major Professor: James R. Mihelcic, Ph.D.
Maya A. Trotz, Ph.D.
Qiong Zhang, Ph.D.

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ABSTRACT

At the end of the Millennium Development Goal (MDG) period in 2015, 2.3 billion people, 31% of the global population, still did not have access to even basic sanitation services. Of these people, 892 million still practice open defecation, and 856 million people use unimproved facilities such as pit latrines without a slab or platform or hanging latrines or bucket latrines (JMP 2017). Sustainable Development Goal (SDG) Target 6.2 now aims to achieve adequate and equitable sanitation and hygiene for all and sets the ambitious target of eradicating open defecation by 2030. While the number of people open defecating was reduced from 1229 million to 892 million between 2000 and 2015, that pace must accelerate to be achieved (JMP, 2017). In Panama, it is estimated that countrywide sanitation coverage is 71%, and rural coverage 54% (WHO/UNICEF, 2013). Even so, in indigenous areas like the Comarca Ngäbe-Buglé, only 25% of the population has adequate access to basic sanitation (ANAM, 2006).

This research builds upon the research presented in (Hurtado, 2005, Kaiser, 2006, Mehl, 2008, and Wilbur, 2014). These theses researched double vault urine diverting (DVUD) latrines, or composting latrines, in indigenous communities in the province of Bocas del Toro and the Comarca Ngäbe-Buglé in Panama. Hurtado, Kaiser, and Mehl researched the design, construction, and pathogen destruction capabilities of composting latrines. Wilbur studied how human attitudes and perceptions serve as incentives or barriers to composting latrine use. In this research surveys, interviews, and observations were recorded in 6 indigenous Ngäbe communities in Bocas del Toro and the Comarca Ngäbe-Buglé. The study quantifies usage of ventilated improved pit (VIP) and basic pit latrines in these communities, assesses positive and negative perceptions of composting latrines, and determines perceptions of feces and the reuse of composted human excrement.

The results reveal that of n=103 latrines 88.3% were completed and in use, but only 35.2% were properly covered. To promote proper usage of latrines, continued education and trainings need to be carried out in these communities. Respondents were also favorable to the use of composting latrines, with 61.2% of respondents saying they would be interested in building a composting latrine for their households. The main perceived benefit of composting latrines is the compost, and the most identified barrier to use was lack of prior experience. Other main barriers included user disgust and the amount of work it takes to own and operate the latrine. There were more identified incentives (12) than barriers (11) to composting latrine adoption. Respondents also reported they would react more favorably to their neighbor implementing the technology and using compost than their neighbor would react should the respondent do the same thing. These results indicate the importance of pilot projects in communities, allowing people to see the benefits of the technology and how it works before implementing a larger scale project. These projects would also reduce the stigma associated with being a first adopter.

Statistical analysis revealed that the demographics of community, sanitation classification, gender, and primary occupation were significantly linked to survey statements used to measure perceptions on composting latrine use and the use of composted human excrement as a fertilizer. Age, gender, and household size were not found to have a statistically significant link to user perceptions on the same survey statements. Logistic regression analysis was then performed using SPSS statistical analysis software (version 24). The results of this research indicate the importance of setting up follow up trainings as many respondents had forgotten how to properly maintain their latrines. It also suggests the setup of pilot projects for composting latrines, as many respondents were favorable to the technology but did not want to try to own and operate a composting latrine without seeing a successful composting latrine first.

CHAPTER 1: INTRODUCTION

The construction and adoption of improved sanitation technologies remains a major challenge across the developing world. Although 1.8 billion people have gained access to improved sanitation since 1990 (JMP, 2012), the 2015 Millennium Development Goal (MDG) to halve the proportion of the population without sustainable access to basic sanitation was missed by nearly 700 million people (JMP, 2015). In fact, at the end of the MDG period in 2015, 2.3 billion people, 31% of the global population, still had no access to even basic sanitation services. Of these people, 892 million still practice open defecation, and 856 million people use unimproved facilities such as pit latrines without a slab or platform or hanging latrines or bucket latrines. The remaining 600 million people use improved sanitation facilities that are shared among multiple households (JMP, 2017).

Sustainable development is defined as "development which meets the needs of the present without compromising the ability of the future to meet its needs" (WCED, 1987). Sustainable Development Goal 6 aims to "ensure availability and sustainable management of water for all" (JMP, 2015). Target 6.2 aims to achieve adequate and equitable sanitation and hygiene for all and sets the ambitious target of eradicating open defecation by 2030. While the number of people open defecating was reduced from 1229 million to 892 million between 2000 and 2015, that pace must accelerate to achieve SDG Target 6.2 (JMP, 2017). If a systems approach is used to analyze the interconnectedness of the sustainable development goals, advances in sanitation development reach much farther than SDG Goal 6 alone. For example, implementing an appropriate sanitation resource recovery, such as composting latrines, not only improves access to sanitation technologies (Targets 6.2 and 6.3), but also addresses Targets 2.4, 12.2, and 12.5 that relate to sustainable food production, sustainable management and use

of natural resources, and environmentally sound management of chemicals and all wastes respectively. Furthermore, if those technologies are used in schools, they help achieve targets 4.5 and 4.7a (Zhang et al., 2016). By using a systems approach, small improvements in one development goal can lead to advances across the SDG's.

Among 12 Latin American countries, Panama has the largest gap between indigenous and non-indigenous populations in sanitation coverage (World Bank, 2015). In fact, while 71% of people living in Panama have access to improved sanitation, only 54% of rural Panamanians do (JMP, 2013). Worse, in indigenous regions areas such as the Comarca Ngäbe- Buglé, only 25% of the population has adequate access to basic sanitation (ANAM, 2006).

Furthermore, it is well documented that in coastal regions of Bocas del Toro and the Comarca Ngäbe-Buglé, heavy rainfall and a high-water table make pit latrines unfeasible as they will fill with water (Wilbur, 2014, Kaiser, 2006, Mehl, 2008). Open defecation in these regions is also very common, especially into streams, rivers, and beaches. This allows one to easily clean them self with water after defecation but leads to the propagation of waterborne illness. To address the issue, efforts are being made to encourage more sanitary practices. The United States Peace Corps and the Panamanian Ministry of Health (MINSA) have invested time and resources to develop Double Vault Urine Diverting (DVUD) composting latrines in the region, to mixed results. Some communities have high success and usage rates, while others struggle to even complete building the latrines (Wilbur, 2014).

This thesis aims to build upon the knowledge created by former USF Master's International student Patricia Wilbur. Wilbur (2014) set out to measure the usage and success of existing composting latrines, while also studying user perceptions, motivations, and barriers to the long-term longevity and sustainability of composting latrine projects. Her research quantified the usage of 142 completed composting latrines and of the composted waste in the Bocas del Toro province and Ñö Kribu region of the Comarca Ngäbe-Buglé in Panamá. It also evaluated people's attitudes and perceptions towards

human excrement, composted excrement, and excrement reuse. Moreover, it assessed how these attitudes may serve as incentives or barriers to the use of those latrines. Wilbur (2014) studied a sample of 201 total DVUD latrines, of which 71.8% were in use, and 65% of which were used properly. Of the original 201 latrines visited, 29.4% were unfinished or broken. She also found that while owners of unfinished latrines cited economic barriers to finishing latrines, other community members cited lack of interest of the stakeholders for the unfinished latrines (Wilbur, 2014).

In the Wilbur (2014) study, DVUD latrine owners' primary identified advantage for the latrines was the resulting compost that the latrines produce. Other identified advantages included lack of flies, smell, and contamination, which also served as important reasoning for their preference of DVUD latrines over pit latrines. The primary identified disadvantage of composting latrines was the inability to use water for anal cleansing. Other main disadvantages included the sawdust or ash requirement for proper usage, and the need for daily maintenance.

These factors attributed to Wilbur's conclusion that socio-cultural factors (i.e., attitudes and perceptions) influence the success of composting latrine projects. Yet there remains a knowledge gap with regards to owners of other sanitation technologies, and more research needs to be done to link socio-cultural factors to the success of sanitation technologies in the development context. Accordingly, this study expands research into Ngäbe pit latrine owners. It then identifies the likes and dislikes of several sanitation technologies and perceived values and drawbacks of composted human excrement. The goal is to help align the characteristics of a technology with socio-cultural values to increase the likelihood of sanitation project success. For this study, the author surveyed 103 pit latrine owners across six communities in the Panamanian indigenous regions of Bocas del Toro and the Comarca Ngäbe-Buglé. There are three research objectives: 1) to quantify the usage of the 103 studied pit latrines, 2) to measure the perceived benefits and value the owners place DVUD latrines and free human compost, and 3) to

document the difference in opinion of the use of composted excrement and compare it to results presented in Wilbur's research.

There were two hypotheses at the onset of the study. 1) The type of latrine a family owns is highly indicative of their perceptions of the use of composted excrement, and 2) pit latrine owners will be averse to the adoption of composting latrines and the use of human compost. It was believed that the high interaction level required to find desiccant and turn excrement in the upkeep and maintenance of a composting latrine would be perceived barriers for respondents in this study. These barriers would lead to the respondent preferring a simpler technology to maintain (e.g. a flush toilet or a ventilated pit latrine.)

To address the first research objective, this research identifies the number of pit latrines that are in use. The research also documents the number of pit latrines not in use, characterizing them as full, broken, or unfinished. The second objective is addressed by discussing likes and dislikes of VIP and pit latrine owners. The perceptions of feces and use of human compost are also evaluated with respect to several socio-demographic factors. The third objective is addressed by comparing the results of this study's surveys to those presented in the Wilbur Thesis. Statistical analysis is performed to understand the relationships formed across variables. Logistic regression is performed to show the link between latrine type and the perception of the use of composted excrement.

The remainder of the thesis consists of four chapters. A literature review is provided in Chapter 2, covering an introduction to global sanitation and the transition from the MDGs to the SDGs. It also reviews pertinent literature relevant to the research objectives. It discusses composting and pit latrines and address the importance of the social sciences in sustainable development. Chapter 3 discusses the methods used to collect data the occurred over three phases. Chapter 4 presents the results of the research. Finally, Chapter 5 concludes the thesis, revisiting pertinent information addressed, and what was learned. It then discloses opportunities for future research.

CHAPTER 2: LITERATURE REVIEW

2.1 Global Sanitation

In 2000 the United Nations created the Millennium Development Goals (MDGs), an effort to eradicate "poverty, environmental degradation, and patterns of unsustainable development" (UN, 2002). These were time-bound targets proposed to be accomplished by 2015. The Joint Monitoring Program (JMP) of UNICEF and the World Health Organization (WHO) began monitoring and reporting on the status of water and sanitation infrastructure in 1990, and assists many countries with the monitoring of water, sanitation, and hygiene (WASH) infrastructure and practices (Kvarnström et al., 2011). The JMP has continued to monitor these activities in the transition to the Sustainable Development Goals (SDGs), which were ratified in 2015 as the successor to the MDGs. The SDGs provide the development agenda until 2030. The SDGs aim to achieve many more goals than the MDGS, growing from 8 total MDGs to 17 SDGs. The SDG's main agenda includes ending poverty and hunger, protecting the planet from degradation, ensuring the world's people live prosperous and fulfilling lives, fostering peace and inclusion, all while acting as a global partnership (United Nations, 2015).

Target 7C of the MDGs was to halve by 2015 the proportion of the population without sustainable access to safe drinking water and basic sanitation. Development workers made great strides to accomplish these goals, reaching the drinking water goal in 2010, and improving access for 1.8 billion people to improved sanitation between 1990 and 2012 (JMP, 2012), with improved sanitation being defined as facilities designed to hygienically separate excreta from human contact (JMP, 2017). However, the sanitation goal proved to be much harder to accomplish, as the target to halve the proportion of people without sustainable access to basic sanitation missed by nearly 700 million people. Thirty-two percent of

the world's population still lacks improved sanitation facilities, and one in eight people still practice open defecation (JMP, 2017). This number decreases every year across all regions, and in urban and rural populations. The 2012 JMP report estimates in rural areas that 234 million fewer people practiced open defecation in 2010 as opposed to 1990. Despite this, there remain some 2.3 billion people who still lack basic sanitation or practice open defecation. In fact, it is estimated that 892 million people still practice open defecation, and 856 million people use unimproved facilities lacking key components like a proper slab or platform, or use hanging or bucket latrines. The remaining 600 million people use proper, but shared facilities, which are not recognized by the UN/WHO as improved sanitation technologies. In addition, only two out of five people used safely managed sanitation services in 2015 (JMP, 2017).

Goal 6 of the SDGs is to ensure the availability and sustainable management of water and sanitation for all, with Target 6.2 aiming to "achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations" (United Nations, 2015). While sanitation plays a huge role in the reduction of diarrhea (Prüss-Ustün et al., 2014), reducing the risk of contracting diarrhea nearly to the same extent as an improved water supply, the greatest benefits are documented when water and sanitation are combined, and the people are educated on proper hygienic practices as well (Ashebir et al., 2013). Thus, reduction of diarrheal disease needs a multifaceted approach. The SDGs remain very ambitious targets, at the current pace it is not projected that the sanitation target will be met. Sanitation coverage increased at an average pace of 22 million people per year from 2000-2015, a faster pace is needed to reach total adequate and equitable sanitation coverage by 2030 (JMP, 2017).

The SDGs are not mutually exclusive, and when viewed with a systems approach progress in one goal can achieve favorable results for several others (Zhang et al., 2016). Traditionally, the MDGs and SDGs have been looked at with a reductionist approach, breaking down the complexity of the goals into smaller components. When monitoring and evaluation occurs, the sum of all individual parts is used to define the

more complex system. In reality, the system is much more interconnected than that. For example, sanitation technologies like composting latrines, which compost human excrement to be used later as a fertilizer, address Target 6.2 – adequate and equitable sanitation for all. Under further scrutiny, they also address Target 2.4 which strives to ensure sustainable food production systems and resilient agricultural practices; Target 12.2 that intends to achieve sustainable management and efficient use of natural resources, and Target 12.5, to reduce waste generation through prevention, reduction, recycling and reuse. Additionally, if these technologies are implemented in a school they will also address Target 4.5 and Target 4.7a, which aim to improve access to education for girls by eliminating gender disparities, and ensure safe, equal access to gender sensitive learning environments respectively (Zhang et al., 2016). Accordingly, it is important to consider the context in which development work is done, so that workers are not so enveloped in achieving a sub goal that they fail to see how their impact can be felt across the SDG spectrum.

2.2 Overview of Technologies in this Paper

In this thesis, user preferences were studied for the owners of two types of latrines: pit latrines and ventilated improved pit (VIP) Latrines. The two differ only slightly: VIP latrines have an outlet pipe, which if properly sized and installed can promote air circulation and thus reduce odors and presence of insects such as flies. These latrines consist of a reinforced concrete slab which sits above a pit. It is best practice to line the top of the pit with some sort of masonry liner to prevent the collapse of the walls of the hole and support the latrine floor above. However, in most instances in Panama the pits are unlined. Mihelcic et al. (2009) recommends a minimum pit depth of 3m, but this depth can be adjusted based on the needs of the family and their ability to dig the hole and based on the height of the water table. Peace Corps Panama suggests building latrines with handles on the slab, making the latrine floor moveable and thus increasing the likelihood the family builds another latrine once the original is filled. In a pit latrine, the hole or seat must be kept covered, whereas with a VIP latrine it is to be left uncovered to encourage

air flow. The superstructure is constructed to maintain conditions as dark as possible, to aid in reducing the presence of insects within the latrine. One major difference with a VIP latrine is that there is a pipe located within the structure that stretches from beneath the slab to above the roof. The pipe needs to have a finely pored mesh fixated to the top end so that insects cannot escape out of the latrine, and it can be painted a dark color to increase the temperature difference between the pit and the pipe to increase air flow (Mihelcic et al., 2009). Other references for the design and construction for pit latrines can be found in the following resources (Nyarko et al., n.d., WHO, n.d., SSWM, n.d.).

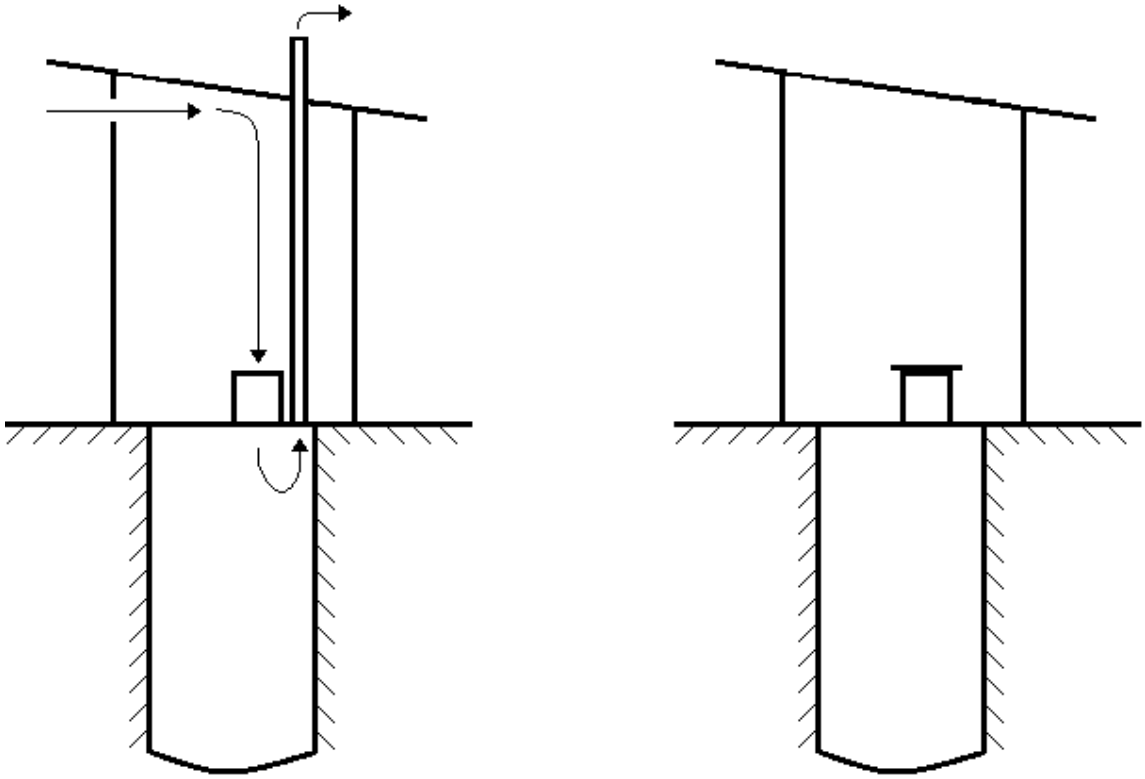

Figure 1 A VIP Latrine (left) and a Basic Pit Latrine (right). Arrows indicate direction of air flow through uncovered seat in VIP latrine, while basic pit latrines have a securely covered seat.

The other technology cited in this thesis is the Double Vault Urine Diverting (DVUD) Latrine (referred to as a composting latrine in this thesis). While there are many types of composting latrines, the DVUD latrine is the one most extensively used in Western Panama. "The design of the DVUD latrine utilized in Panama is concisely described as a concrete block structure with two chambers, urine diverting toilet seats, removable concrete doors at the bottom of each chamber, and a privacy structure with a

corrugated tin roof above the concrete structure" (Wilbur, 2014). Composting latrines can destroy pathogens found in excrement by controlling four variables: moisture content, temperature, pH, and retention time (Katukiza et al., 2012; Mehl et al., 2011, WHO, 2006). However, composting latrines require a higher user interface, or amount of work required to maintain the latrine, than a pit or VIP latrine. These latrines separate urine from the excrement to maintain lower water content in the composting chamber. If there is a container for urine catchment system, it must be regularly emptied. Often the urine diversion is just a tube that runs out of the latrine to a shallow pit with rocks, allowing urine to go directly into the ground. The user is required to find wood chips and other organic material, or wood ash to reduce the moisture content and maintain an alkaline pH in the pit. The addition of dry material can also help to increase the carbon to nitrogen ratio of the pit contents to promote bacterial activity and thus the biological mechanisms of composting. Then the composted excrement must be removed and sometimes dried further before it can be spread and used as a soil amendment. Some advantages of composting latrines are that they typically lack flies and other insects, have a very long lifetime, and the user can obtain a soil amendment as part of the process. Some disadvantages include a high up-front capital cost, higher user interface, and the possibility of low pathogen removal (especially geohelminths) should it not be operated properly. Much more information on the design, operation, and pathogen destroying abilities of composting latrines can be found in previous theses from our research group (Hurtado, 2005, Kaiser, 2006, Mehl, 2008, Gibson, 2014, and Wilbur, 2014), and in peer reviewed literature (Mehl et al., 2010, Kierys and Barkdoll, 2017, and Berendes et al., 2015).

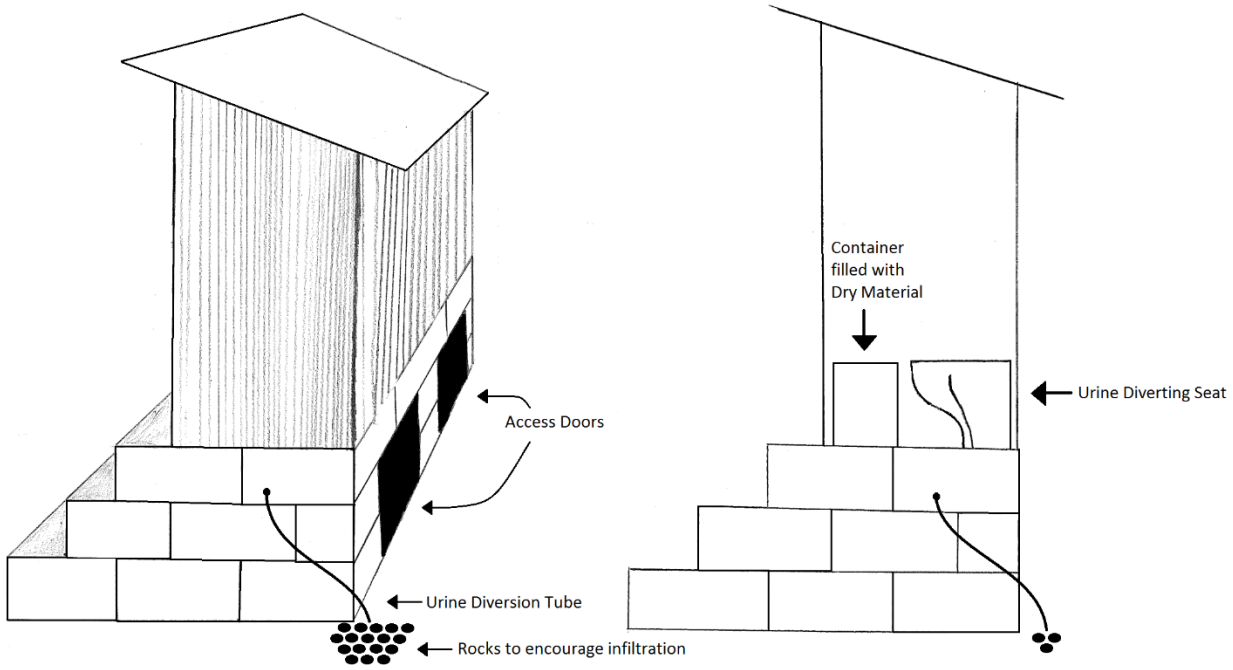

Figure 2 Typical DVUD Latrines

2.3 Introduction to Panama and Ngäbes

Panama has been a rising economy in recent years. Between 2007 and 2012 the country has been able to reduce the percentage of the population living under the poverty line (4 USD/ day) and extreme poverty line (1.25 USD/Day) from 32.2 percent to 25 percent and 19.2 percent to 11.8 percent of the total population respectively (World Bank, 2015). Yet a major gap remains along geographical and ethnic lines. Seventy-five percent of Panamanians live in urban areas, where extreme poverty is recorded at 4%, but 27% of the rural population lives in extreme poverty. The numbers are even worse among indigenous populations, where "poverty is almost universal and persistent," and areas like the Comarca Ngäbe-Bügle have a poverty rate of 93% and an extreme poverty level of 80% (World Bank, 2015). Only six percent of Panama's population live in Comarcas, but 42% of the extremely poor live there (World Bank, 2015). The rate of change varies among these groups as well, "while urban extreme poverty fell 40 percent between 2007 and 2012, in rural areas the decline was 15 percent, and in the indigenous territories, or comarcas, only 4%. This has resulted in an increasing concentration of the extremely poor in the indigenous

territories" (World Bank, 2015). This has also caused a mass migration of indigenous peoples from rural areas to the cities; the 3 largest indigenous comarcas in the country are the Guna Yala, Ngäbe-Bügle, and Emberá Wounaan but only 40, 52.3, and 24% of the overall indigenous populations live within the comarcal boundaries respectively. The World Bank (2015) also states that 22.6 percent of the indigenous population above the age of 15 in 2010 lived in a different district that it had lived 10 years previously, with 48% of them moving to the province of Panama. There is very little opportunity in the rural indigenous areas. The prospect of increased wages and opportunity draws many of the indigenous peoples to leave their communities.

Another factor leading to the difficulty of addressing the well-being of indigenous communities is limited access to education. The average head of household in Panama has 9.6 years of education, as opposed to 5.1 years for those who identify as extremely poor (World Bank, 2015). Indigenous populations also rely heavily upon unskilled agricultural labor and have large households. The average extremely poor worker has 2.2 dependents, whereas the national average is 1.3. "The Indigenous Peoples of Panama have significant social capital, and their lands represent significant wealth and bio-diversity. At the same time, they suffer from multiple deprivations: extremely low incomes, low access to basic services and infrastructure, lower human capital, poorer health outcomes, fewer labor options and de facto land tenure insecurity" (World Bank, 2015). With these economic and educational and barriers, there is little extra cash for poor indigenous peoples to pay for infrastructure projects. Huge families in rural areas put a stranglehold on indigenous people's economic mobility. While many make 7-10 USD a day (personal experience of the author), the majority of those earnings go to the feeding the family, and very little is left for the improvement of their lives.

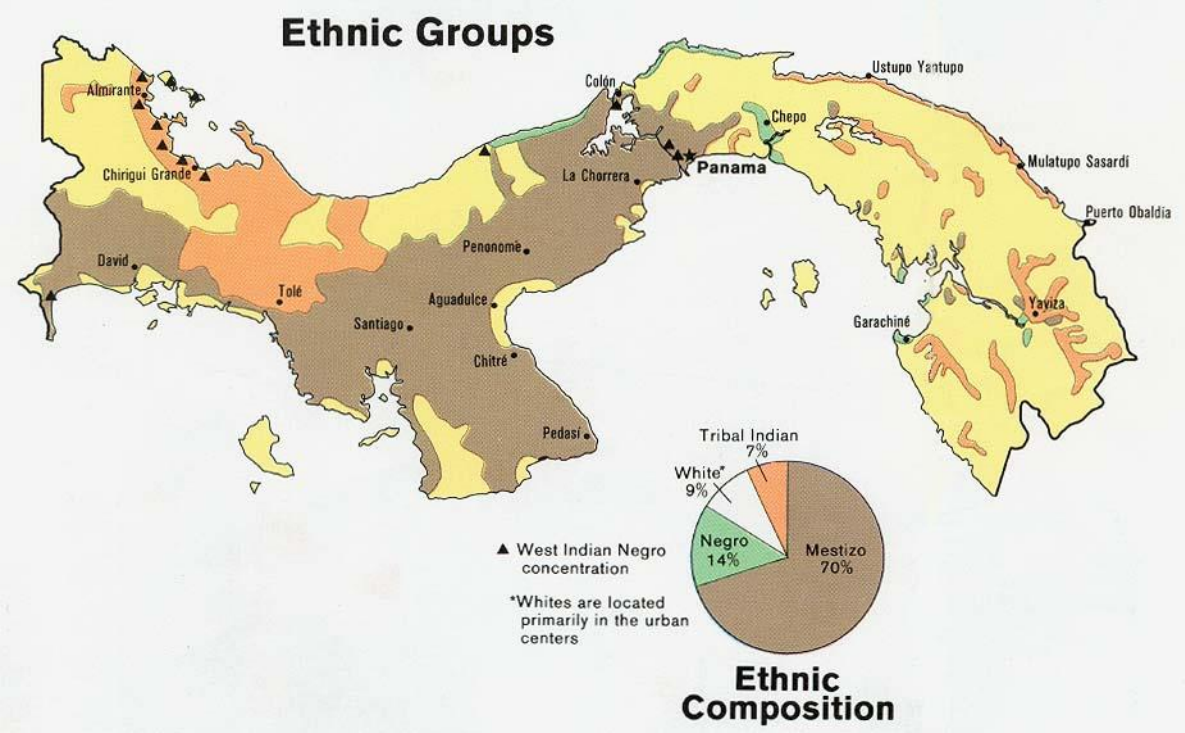

Figure 3 Panama's Ethnic Composition. (Map from Central Intelligence Agency, 1981. Courtesy of the University of Texas Libraries, The University of Texas at Austin.)

Ngäbes are dispersed mainly among the provinces of Bocas del Toro, Chiriquí, Veraguas, and the Comarca Ngäbe-Bügle, in the Western portion of the country. This is a result of early Spanish settlers taking up the fertile lowlands for farming and cattle, while the Ngäbes migrated to the highlands of the Cordillera. Mutual assistance and reciprocity are the basis of the group's society, and the social structure is highly dependent on inter-familiar relationships. A person will go to their close relatives for assistance before asking their in-laws or other friends (Wilbur, 2014, Bletzer, 1991). They also believe in medical pluralism, or the "coexistence in a society of differing medical traditions, grounded in different principles or based on different world views" (Gabe et al., 2004). Thus, they believe in both the concepts of traditional healing and western medicine. Traditional healers, or *curanderos*, find medicines in the environment to cure everything from headaches to high blood pressure. These cures have been passed down from generation to generation orally (personal observation, Wilbur, 2014, Winkleman and Peek,

2004). If something is more severe, like a snake bite or severe illness, they will seek medical attention in health centers or hospitals.

In terms of national statistics, Panama is doing well to advance sanitation coverage across the nation, with 90% of its population having access to an improved sanitation system (ANAM, 2006). This is however most likely an overestimate, as it is estimated that countrywide sanitation coverage is only 71%, and rural coverage as 54% (WHO/UNICEF, 2013). Even so, in indigenous areas like the Comarca Ngäbe-Buglé, only 25% of the population has adequate access to basic sanitation (ANAM, 2006). Furthermore, among 12 Latin American countries, Panama has the largest gap between indigenous and non-indigenous populations in sanitation coverage (World Bank, 2015). Open defecation is also common in indigenous areas, with people open defecating into streams, rivers, and oceans (Wilbur, 2014, and personal experience of the author).

In the experience of the author, open defecation is often a main form of sanitation in the very rural communities. The people go to the rivers and streams to defecate, where one can relieve them self and clean up in the same location. The creeks and rivers are a very important resource to the people, as they are not only a gathering place for people to socialize; they also serve as the place women went to wash clothes, where men go to fish, and a source of water. The indigenous populations are culturally very different than their Latino counterparts, thus what may be a solution in one part of the country may not work in another. “Investments in basic infrastructure… and sewage systems would benefit both rural indigenous and non-indigenous groups. However, improving social service for the indigenous will require special attention to accommodate their cultural norms” (World Bank, 2015). Past development projects have had limited success in rural, indigenous areas because of cultural differences. Although they have achieved great success in some communities, their lack of cultural and societal context has led to failures in many others. “It is important to understand the complexities of addressing the development challenges of the comarcas and the need to pay attention to issues of 1) culturally appropriate economic

opportunities, 2) social assistance, and 3) infrastructure provision. The lack of culturally appropriate models for development for the comarcas has reduced the positive impact of government programs and policies" (World Bank, 2015). Some aspects specified in the World Bank report include how the community is organized and how they view communal property. They also call for awareness of what indigenous peoples are and are not willing to do regarding sanitation as key to the sustainability of these projects.

2.4 Sustainability in Sanitation

Sanitation projects often fail. In the context of the developing world, sanitation projects are much different than water supply projects as they often only deal with the owner/user. Many authors have cited the perceived lack of importance of personal latrines when latrines can be shared amongst several households (Katukiza et al., 2010, Thys et al., 2015). A latrine shared amongst multiple households, while convenient, is not considered a form of improved sanitation. Thus there is a slight disconnect between development workers focusing on building latrines for individual homes and families, and the communities they serve. In any case, an appropriate technology must be chosen for every household to meet SDG guidelines. The technology is determined by a variety of factors: resource availability, social sustainability, economic feasibility, and environmental suitability. In Mihelcic et al. (2009), appropriate technology is defined as "implementation of technologies that account for the location's cultural, economic, and social context and suitability." Fuchs and Mihelcic (2011) take this definition one step further, including sustainability with regards to environmental and infrastructural suitability, defining appropriate technology as "solutions that are culturally, economically, and socially suitable to the community as well as environmentally and infrastructurally suitable to the geography in which they are implemented." McConville and Mihelcic (2007) provides a logical framework for identifying and analyzing factors that affect sustainable development in water and sanitation projects. It uses life-cycle thinking to analyze both sustainability factors and project life stages to indicate the probability of project success.

The importance of social sustainability and behavior change is often overlooked in WASH literature. For example, Fiebelkorn et al. (2012) found that less than 2% of all published articles on point-of use water treatment interventions reported behavioral determinants. Yet the likelihood for project success increases when these considerations are made by development workers. It is important that technical considerations do not take precedence over social sustainability, as it compromises the overall longevity of these solutions.

It is well documented that user preferences are extremely important to the success of sanitation projects, not just choosing a technically feasible technology (Nelson et al., 2014, Thys et al., 2015, O'Reilly and Louis, 2014). This has created a new shift in public policy and research, a shift towards creating demand for sanitation services. This focus on creating demand has led to the important finding that perceived public health benefit is not a strong motivator for new adopters. Comfort, convenience, status, privacy, and dignity are much more powerful motivators for individuals and households (O'Reilly and Louis, 2014). As a Peace Corps volunteer in Panama, the author of this thesis has seen this play out first hand. When latrine owners rarely have more than a first-grade education, concepts of western medicine and microbial disease may be difficult for some to understand. Yet the early adopters of sanitation technologies like pit latrines expressed a desire to have a latrine like those who lived in nearby cities or embarrassment at forcing visitors to open defecate. Owning a latrine was seen as a form of hospitality to the guest, thus owning one lifted one's social status.

One key to successful sanitation projects is that user buy in creates demand for more sanitation implementation. Jenkins and Curtis (2005) stated that the prime motivators which lead to the desirability of sanitation are "1) prestige; 2) well-being; and 3) restrictions on mobility (e.g., illness); and 4) desire to increase rental income." They also identified gender, life stage, education, occupation, experience of travel, wealth, and physical and social geography of the village as motivations underlying drives; cost, lack of available credit, design, soil type, and family problems were identified as constraints. This idea of

prestige was affirmed in Zambia, where participants in a latrine survey stated that a household with a latrine had dignity or respect, as visitors did not have to open defecate. Latrines were seen as a necessary form of hospitality among survey participants (Thys et al., 2014).

Community Led Total Sanitation (CLTS) is a framework developed by Dr. Kamal Kar in the 1990's, which aims to generate demand for sanitation in a grassroots fashion. It requires trained facilitators to visit communities and create demand for sanitation technologies by asking questions about open defecation and prompting disgust of the habit (Meeks, 2014). It works in a five-step process: 1) triggering, 2) igniting, 3) action planning, 4) post-triggering, and 5) scaling up. Triggering involves visiting the community prompting the realization that if people are open defecating, community members are actively eating shit (it is important in this context to use the word shit, as it induces disgust). Igniting uses the natural leaders of the community to prompt discussion that open defecation is a problem, and that the community can do something to change it. Action planning is following up later, and the verification and certification process to declare the community open defecation free (ODF). The last step is scaling up, or using the success of one community to spur on efforts in other communities. Natural leaders from the first successful community are transported to other nearby communities to act as facilitators to begin the process again. They are paired with sanitation marketers to make sure materials are available and keep demand high for the services, and thus helping create business opportunities for those looking to get involved (Meeks, 2014).

CLTS has been criticized because it infringes on people's right to dignity and respect (Robinson 2008). "Stangl and Trasi (2011) argued that shaming impacts marginalized groups more severely and may work against improvements in health behavior. Furthermore, social relationships of power play a role in creating limits and opportunities for individuals' adoption of sanitation, regardless of approach" (O'Reilly and Louis, 2014). Yet it is argued that if facilitators are properly trained, and triggering discussions are just the facilitation of questions with community members coming to their own conclusions, there is nothing

degrading about the process (Meeks, 2014). It remains controversial in the development community; in the experience of the author we were discouraged from using the technique in Peace Corps Panama. Yet those training us on the topic were not trained themselves by a CLTS representative, and therefore trained us with this technique to display disgust at those in the community who openly defecate, not to facilitate discussion within the community to let members reach their own conclusions. If properly conducted, the method can be a very effective, non-demeaning way to create demand for sanitation.

The Integrated Behavioral Model for water, sanitation and hygiene (IBM-WASH) was developed in 2011 after synthesizing 8 theoretical models of WASH and WASH-related behaviors (Dreibelbis, 2013). It was created to better assess the drivers which lead to eventual adoption of WASH related technologies and behaviors. The framework is comprised of three dimensions: the contextual, the psychosocial, and the technological dimensions. The contextual dimension focuses on the individual and examines how a one's environment and setting can influence one's behavior. The psychosocial dimension examines the behavioral, social, and psychological determinants that affect a technology's acceptance. The technological dimension involves looking at the attributes of a new technology, and how those attributes affect its adoption (Dreibelbis, 2013). The model breaks down behavior change further into five levels of each dimension: habitual, individual, interpersonal/household, community, and societal/structural. Each level of the structure builds in size, with the habitual level lying purely within the user, the individual level including sociodemographic factors like age and gender, the interpersonal/household level contains one's closest relationships with family and friends, the community level comprising one's physical and social environment, and finally the societal/structural level referring to broad organizational structure and government policies.

Often, user preferences are very foreign to the development worker. In Zambia, it was found that latrines were perceived to contribute to good hygiene because they prevent pigs from eating human feces. The researchers also found that men were reluctant to abandon open defecation mainly because

of toilet-associated taboos within-laws and grown-up children of the opposite gender (Thys et al, 2014). Yet others in the community expressed a reluctance to give up open defecation as it took away a free source of food for their pigs. Men did not like defecating in the same structure as their in-laws as it created much embarrassment for both parties. Ashebir et al. (2013) found similar results when conducting surveys in Northern Ethiopia. The major reasons for non-use of latrines included cultural beliefs (44%), foul smell (22.6%) and inconvenience of use (17.8%). Other factors attributed to the non-use of latrines included Illiteracy in male heads of households, low monthly income and non-enrollment of households under any sanitation project by local administration (Ashebir et al., 2013). The same study found that of the 422 households with latrines, only 45.5% of respondents were using the latrines. In these instances it is very important that the development worker fully understand the cultural context in which he or she is working.

Bates (2008) studied the long-term success of composting latrines in the rural highlands of Mexico. The most influential attitudes towards composting latrines were fear and disgust of handling human waste, especially in 1) leveling of waste, 2) maintaining urine diversion tubes (which frequently needed attention due to clogging or disconnecting), 3) seeing and smelling the waste while adding dry material, and 4) removing and handling the composted waste. Other important negative factors included odor, insects, and fears of both the waste and the potential for contamination. Bates found that motivational factors for composting latrine acceptance and success include comfort, convenience, cleanliness, and distance/separation from waste. Social acceptance of these projects relies heavily on sufficiently training local people to properly maintain the composting latrines, to control insects, odors, aesthetics and waste handling.

When working with composting latrines in rural Panama, similar problems arise. The author of this thesis found that many farmers were disgusted with the thought of using composted human excrement as a fertilizer. Wilbur (2014) found very low rates of user disgust, but this was because the

study population was made up of people who already built and owned composting latrines. The general population in rural and indigenous parts of Panama has had very little exposure to composting latrines, and thus the thought of using composted excrement on crops produces a negative reaction. Convincing a population with little exposure to the practice can be difficult. In other parts of the world, results can be much different. Researchers in Burkina Faso found that obtaining fertilizer was the greatest incentive for the adoption of DVUD latrines, far outweighing the perceived effect on health. EU sanitation projects led to an adoption rate of 74%, whereas previously open defecation rates were measured at 68% (Dickin et al., 2018). Wilbur (2014) Reported that in Panama, the use of composted excrement as fertilizer was also a major perceived benefit of the latrines, but 40% of 142 composting latrine interview respondents cited that the lack of water for washing after defecating was the biggest problem composting latrines posed. Yet owners of these latrines cited the added benefits of no mosquitoes or odors in addition to the production of compost as drivers for the adoption of composting latrines. Much more information on successful and unsuccessful implementation of composting latrine projects can be found in (Wilbur, 2014).

CHAPTER 3: METHODS

3.1 Assessing Pit and VIP Latrine Use

This chapter will outline the detailed research steps taken to perform a rapid ethnographic assessment to collect and analyze the data needed to address the objectives of this study. The methods consist of four parts: 1) assessment of pit and VIP latrine usage, 2) assessment of likes and dislikes of composting latrines, 3) determining perceptions of feces and the use of human compost as a soil amendment, and 4) comparison of results of this study to Wilbur (2014). The data in this study were obtained through a 3-part survey and informal interview process performed between July and August 2017. Six communities and 103 pit and VIP latrines, hereby only referred to as latrines, were studied in the province of Bocas del Toro and the Comarca Ngäbe-Buglé. The locations of the communities can be found in Figures 2 and 3. Table 1 provides community statistics for the communities studied in this research. In many instances, family members were not available on the day data was gathered, or families owned more than one latrine, thus not every latrine in the community was studied. In the case of Hato Nube, the author fell ill before being able to finish data collection. The communities were chosen because of the presence of pit latrines and VIP latrines as the primary source of sanitation. These latrines were built through support provided through Peace Corps and Panamanian government projects or built by the homeowner without some external support. The research methods outlined in this paper were approved by the Institutional Review Board (IRB) at the University of South Florida prior to data collection (see Appendix A for IRB approval).

Table 1 Community Statistics of Study Populations for this Study

	Community	Approximate Population	Total Number of Houses	Total Number of Pit Latrines Present	Number of Latrines Studied	Percentage of Total Latrines Studied
1	Bajo Gavilán	200	28	15	14	93.3%
2	Nance de Risco	900	110	16	12	75.0%
3	Punta Peña de Risco	475	70	66	35	53.0%
4	Bajo Cedro	800	90	18	10	55.6%
5	Nueva Estrella	215	29	20	12	60.0%
6	Hato Nube	210	30	28	20	71.4%

Table 2 Summary of Research Phases for Data Collection

Research Phase	Methods
1. VIP and basic pit latrine use	Interviews and observations
2. Likes and dislikes of pit and VIP latrines	Informal interviews
3. Perceptions of feces and the use of composted human excrement as a soil amendment	Surveys

3.1.1 Description of Communities

The six communities described in Table 1 were visited to compile interview and observation data. Five are located in the province of Bocas del Toro and one in the Comarca Ngäbe-Buglé. All the communities are classified as indigenous and have populations of less than 1,000. The distance to the main highway by foot for each of the communities varies from 0 to 2 hours. The communities are inhabited by nearly all indigenous populations. However, two communities (Bajo Gavilán and Bajo Cedro) have a small minority of Latinos. The most common house is made of chain sawed wooden boards and an either thatched or corrugated zinc roof, but in rare instances walls are made of concrete cinder blocks. All the communities have access to an improved water source provided by a gravity fed water system. More

information on gravity fed water systems can be found in Mihelcic et al. (2009). However, in most instances communities do not have 100% coverage and some communities do not have water 24 hours a day. This is due to aging systems with broken pipes and tanks which were properly sized in the past, but are no longer sufficient to the needs of the growing communities. Most houses in the communities have a pit or VIP latrine, but in some instances they have a flush toilet connected to septic or latrine hole. Open defecation is also still common in the rivers and streams surrounding the villages.

The primary way of life in these villages is subsistence farming. The main crops grown are cocoa, bananas, plantains, starchy root vegetables like otoe, ñampi, yucca, and ñame, and peach palm. Some men work in banana or plantain plantations as a source of income, and some travel annually to the province of Chiriquí annually to harvest coffee. Others work on local construction projects when they arise, or travel across the country to Panama City to find work. In the province of Bocas del Toro, tourism has grown significantly in the past decade, providing jobs for people on the islands of Isla Colon and Bastimentos.

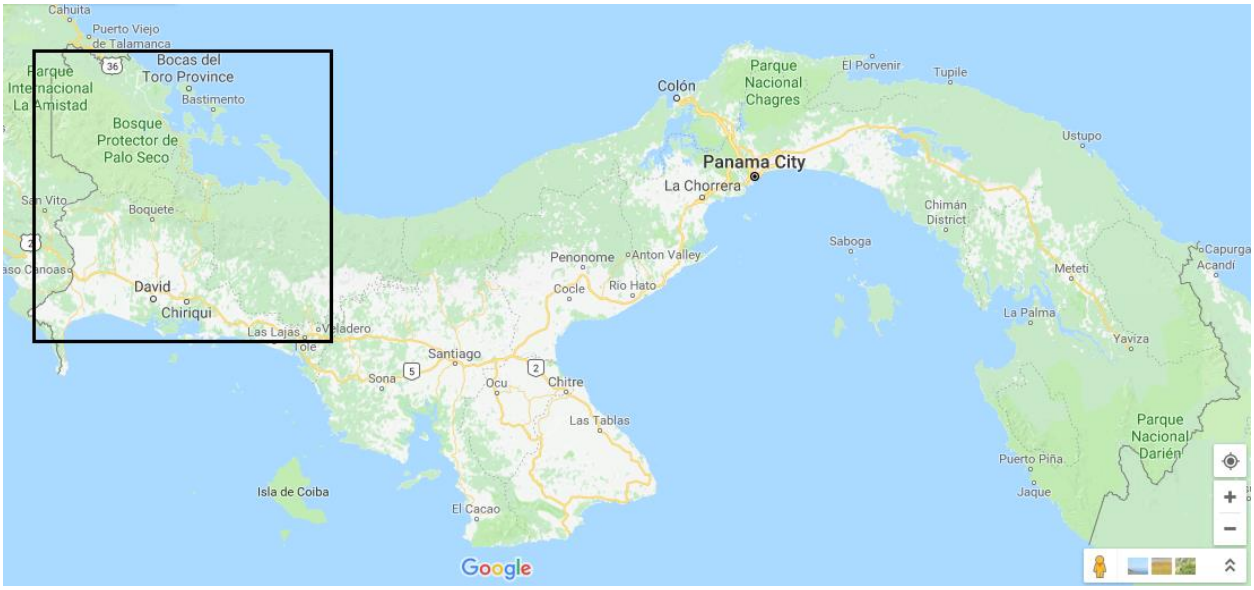

Figure 4 Map of Panama. Inset shows the location of this study. Map is reproduced from Google Maps with Google © 2018 information

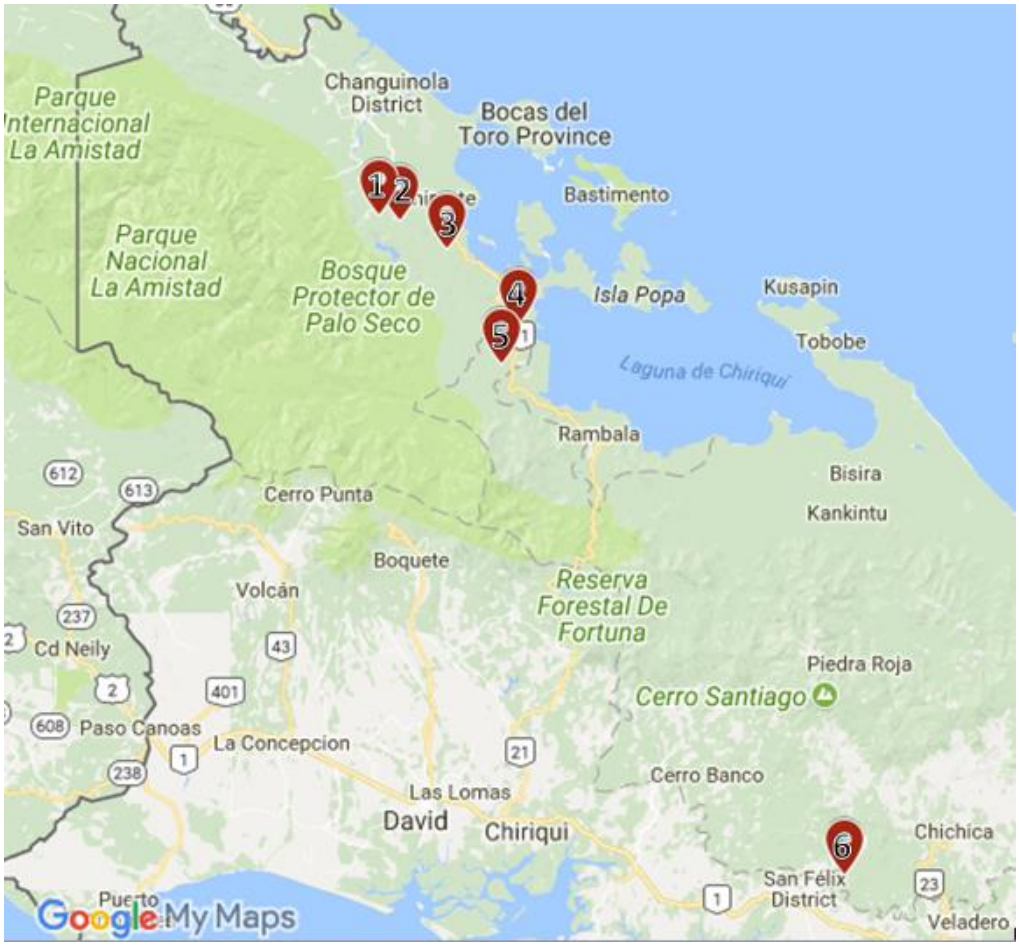

Figure 5 Map of Six Communities Studied for this Research. Numbering of communities corresponds to Table 1. Map is reproduced from Google Maps with Google © 2018 information

The latrines in these communities were funded from a variety of sources. In Bajo Gavilán half of the latrines were partially funded by a Peace Corps training in the community, where the owner of the latrine was only responsible for half the cost of the latrine slab. Several of these latrines were unfinished at the time of this research as it was the responsibility of the owner to then finish the project and pay for the latrine superstructure themselves. In Nance de Risco and Bajo Cedro, all latrines were paid for independently by the owner of the latrine. The latrines in Punta Peña de Risco were funded by the Panamanian Ministry of Health (MINSA). The latrines in Nueva Estrella were funded by a sanitation project by the first lady of Panama. Finally, the latrines in Hato Nube were funded in part by Peace Corps Partnership grants, and by the owners of the latrines.

3.1.2 Interviews

Interviews were conducted in 6 communities, and 103 pit latrines were visited. The author conducted unannounced visits to each community. In 5 of the 6 communities, the author relied upon the local Peace Corps volunteer as a guide to find each of the latrines in the community. In the case of Nance de Risco, the author visited the first latrine and relied upon the guidance of the owners to direct him to the next latrines.

At each household that had a VIP or pit latrine the author introduced himself in Spanish and asked to speak with the owner of the latrine. The author spoke with the latrine owner, or a person designated by the latrine owner who lived in the house, and he read them the IRB approved script for informed consent found in Appendix B. After receiving consent, he then proceeded to conduct an informal interview with the respondent using the interview questions found in Appendix C. Interviews were conducted in Spanish, thus inclusion criteria for the respondents were 1) the respondent could communicate in Spanish, 2) the respondent was the owner of the latrine, or designated by the owner of the latrine and lived in the same household as the latrine owner. This may have affected results slightly, as the chosen respondent was usually an immediate family member of the owner who had a higher level of Spanish ability. However, the owner remained present throughout the interview, so results were consistent with the owner's beliefs.

Table 3 Characteristics of the VIP and Pit Latrine Condition to be Evaluated

Characteristic Evaluated	Reason for Evaluation
Origin of latrine project	Determine date and background of the project
Rate of use and disuse	Metric of project success
Cleansing mechanism	Determine effect of traditional water-washing on latrine use
What will be done once latrine fills	Determine long-term sustainability of project
Latrine maintenance responsibility	Determine gender-based responsibility in latrine maintenance
Training efficacy	Determine if latrine users remembered the original training
Distance to water sources	Determine possibility of contamination

3.1.3 Process of Latrine Observations

The observation process of pit and VIP latrines was obtained and then adapted from Kaiser (2006), Mehl (2008), and Wilbur (2014). The following steps were followed for the observation portion of the data collection:

1) After interviewing the larine owner or designated respondent, the author asked for consent to enter the household latrine and make observation. Once consent was granted, the author proceeded to the latrine and entered.

2) Once inside the latrine, the author noted the presence of anal cleansing materials. If present, the author noted what type of material they were (e.g., Paper, water)

3) The author then checked if the latrine was covered properly. Pit latrine holes should be covered between use, VIP latrine holes should not.

4) The author then judged the level of odor within the latrine on a 1-5 scale. The test was taken upon immediately entering the latrine, standing upright. A value of 1 was chosen if there was no odor, whereas a value of 5 corresponded to an intense odor of raw sewage.

5) The overall cleanliness of the latrine was then observed and recorded on a scale of 1-5. A value of 1 indicated a well swept floor and a clean seat. A value of 5 indicated a dirty floor with a dirty seat, insects, or an observation that the latrine was fouled by urine and/or excrement.

6) The latrine was then evaluated if it was in working condition. The author noted if it was structurally completed, provided privacy to the user, and the pit was not full. A full pit was determined if feces could be seen within one foot of the latrine hole or seat.

7) Finally, an approximation of the distance from the latrine to the household was recorded. This was determined by standing at the latrine and looking back at the house and visually estimating the distance.

3.2 Informal Interviews on the Likes and Dislikes of VIP Latrines, Pit Latrines and Composting Latrines

Upon completion of the observations and questions with the latrine owner/ designated respondent, informal interviews were conducted with the same person. The complete questions with translations can be found in Appendix C. These questions are presented in Table 4 and focused on the likes and dislikes of the latrine owner to investigate the attitudes of VIP and pit latrine owners towards composting latrines. Questions 11 and 12 were developed from Simha et al. (2017). These questions were added to questions used in Wilbur (2014) to get a better understanding of how respondents' friends, family, and neighbors would perceive a composting latrine.

Table 4 Informal Interview Questions

Question
1. What do you think of your pit latrine?
2. Why did you want your latrine in the beginning?
3. Why do some people in the community have pit latrines and not others?
4. What are the advantages of your pit latrine? What do you like about your pit latrine?
5. What are the disadvantages of your pit latrine? What do you not like about your pit latrine?
6. Knowing what you know now, would you still get a pit latrine?
7. How would you improve the design of your pit latrine?
8. Would you prefer a different sanitation technology? Like what? Why?
9. Would you be interested in constructing a composting latrine? Why?
10. What would you think of your neighbor if…
a. He/she constructed a composting latrine?
b. if they used composted human feces on their crops/garden?
11. What do you think your neighbors would say if you…
a. Constructed a compost latrine?
b. If you used composted human feces on your crops/garden?

3.3 Assessment of User Perceptions of Feces and the Use of Composted Human Excrement as a Soil Amendment

3.3.1 Surveys

Surveys began immediately after the informal interview ended, with the same respondent. The survey questions with translations can be referenced in Appendix C. Wilbur (2014) developed the surveys

from Mariwah and Drangert's (2011) work in Ghana. The respondents responded to these questions with 1) agree, 2) disagree, or 3) don't know. Table 5 presents the questions used in the perceptions surveys.

Table 5 List of Perceptions Questions Used in Surveys

Survey Questions
1) Human excreta is a waste and should only be for disposal
2) Handling excreta is a great health risk
3) Human excrement should not be handled in any way
4) Human excrement has no benefit to humans
5) It is OK to touch excrement with your hands.
6) It is OK to touch composted excrement.
7) Human excrement is a resource for the soil.
8) Human excrement from a composting latrine can be used as fertilizer.
9) I would use composted human excrement on my crops.
10) Taste of vegetables will change when composted human excrement is used.
11) Smell of vegetables will change when composted human feces is used.
12) Crops can be killed when fertilized with composted human excrement.
13) Crops fertilized with human excrement are good for consumption.
14) I will never consume crops that used composted human excrement.
15) Animal manure can be used as fertilizer.
16) I have used animal manure as fertilizer

Some of the questions were further broken down to more basic Spanish vocabulary but retained the same contextual meaning. This is because although Ngäbe people are able to speak Spanish, they are not always fluent. All respondents were made to understand the question clearly before responding. The questions were asked as written, and if respondents indicated they were confused a standard set of more basic vocabulary was used to help them understand, or a family member fluent the Ngäberi language helped them to understand the question. The more basic vocabulary can be seen in parenthesis in the full set of survey questions in Appendix C.

3.3.2 Socio-demographic Data Collection

The following socio-demographic data was compiled about survey respondents, upon completion of the informal interview and survey: 1) Age, 2) Sex, 3) Education, 4) Household size, 5) Religious affiliation, 6) Martial status, 7) Primary occupation, 8) Length of stay in community.

3.3.3 Data Analysis

Results of all informal interviews, observations, surveys, and socio-demographic information were analyzed using Microsoft Excel. SPSS statistical analysis software (version 24) was used to evaluate the relationship between socio-demographic information and answers to survey questions. This relationship was determined using Cramer's V to test for correlation between variables, and Fisher's exact test to determine significance, with a significant result being $p<0.05$.

CHAPTER 4: RESULTS AND DISCUSSION

The results of this study are organized according to the objectives outlined in Chapter 1. These objectives were to: 1) quantify the number of pit latrines in use, and those not in use 2) to document both the likes and dislikes of pit latrine owners and their perceptions of the use of feces composted human excrement and 3) compare the results of this research to Wilbur (2014). Less than 5 respondents declined to participate in the study, and in multiple but not all instances that respondent could find another family member to participate in the study.

4.1 VIP and Pit Latrine Use

To quantify the use of VIP and pit latrines, the visited latrines were divided into two main categories 1) in use and 2) not in use. “In use” refers to completed latrines that are in use and were identified by the respondent as being in use, were observed to not be full, had a completed privacy structure, and had the presence of feces in the latrine pit. “Not in use” latrines were either identified by the latrine owner as not being in use, were too full for use, lacked a completed privacy structure, or lacked presence of feces in the latrine pit. The completed and “in use” latrines were then divided into “proper” and “improper” based on the seat or hole in the latrine floor. “Proper” pit latrines had a covered seat or hole, and “proper” VIP latrines had an uncovered seat. Table 6 provides basic demographic information about the study sample.

Table 6 Respondent Demographic Information (n=103)

	Bajo Gavilan	Nance de Risco	Punta Peña de Risco	Bajo Cedro	Nueva Estrella	Hato Nube	Total Study Population
Human development Index[A]	0.668	0.668	0.668	0.668	0.499	0.499	
Age							
Range	19-74	20-82	17-74	27-69	21-76	20-54	17-82
Average	42	44.1	40.1	41.7	37.8	35.9	39.9
Sex							
Male	71.4%	66.7%	51.4%	70%	75%	55%	61.2%
Female	28.6%	33.3%	48.6%	30%	25%	45%	38.8%
Education							
No Schooling	28.6%	16.7%	22.9%	30%	33.3%	25%	26%
Grade 1-6	50.0%	50.0%	54.3%	10%	41.7%	55%	49%
Grade 7-12	21.4%	25.0%	22.9%	60%	25%	20%	27%
University	0%	8.3%	0%	0%	0%	0%	1%
Average Years of Schooling	4.64	6.3	5.1	6.6	4	4.6	5.1
Household Size							
1 to 5	35.7%	33.3%	37.1%	55.6%	16.7%	45%	36.9%
6 to 10	35.7%	41.7%	60.0%	33.3%	41.7%	35%	45.6%
11 to 15	21.4%	16.7%	0%	11.1%	25%	20%	12.6%
16 or more	7.1%	8.3%	2.9%	0%	16.7%	0%	4.9%
Average	7.9	8.4	6.3	5.22	11.25	6.9	7.4
Primary Occupation							
Farmer	42.9%	8.3%	48.6%	40%	58.3%	40%	46.6%
Housewife	21.4%	25%	48.6%	20%	25%	35%	34.0%
Store Owner	0%	8.3%	0%	10%	8.3%	5%	3.9%
Unemployed	0%	8.3%	0%	0%	8.3%	5%	2.9%
Other	35.7%	8.3%	2.9%	30%	0%	15%	12.6%
Sanitation Classification							
Basic Pit Latrine	42.9%	83.3%	0%	100%	16.7%	78.9%	42.2%
VIP Latrine	21.4%	8.3%	100%	0%	75%	21.1%	51.0%
Open Defecation	28.6%	0%	0%	0%	8.3%	0%	4.9%
Pour-flush toilet	7.1%	8.3%	0%	0%	0%	0%	2.0%

[A]Human Development Indices were retrieved from UNDP (2014) for the geographic region of each community

Out of 103 total latrines in the study, 93 finished and in use latrines were studied. Forty-two latrines were basic pit latrines, and 51 were VIP latrines. A properly covered VIP latrine has no cover, allowing for increased air-flow, and a properly covered basic pit latrine has a lid over the hole to stop insects from entering and leaving the latrine pit. Just over 35 percent of latrines were covered properly, with 29.4 percent of VIP latrines being properly covered and 40.5% of basic pit latrines properly covered. These results were obtained by entering and observing latrines, a VIP latrine is not supposed to be covered while a pit latrine must be covered to be sanitary.

Table 7 Numbers and Percentages of Latrines Visited and their Respective Use Status

Community	Number of Latrines Studied	Completed Latrines in Use	Properly Used Completed Latrines [A]	Unfinished, Unused, or Full Latrines
Bajo Gavilán	14	57.1%	50%	42.9%
Nance de Risco	12	91.7%	18.2%	8.3%
Punta Peña de Risco	35	100%	20%	0%
Bajo Cedro	10	100%	30%	0%
Nueva Estrella	12	91.7%	33.3%	8.3%
Hato Nube	20	90%	72%	10%
Total	103	88.3%	35.2%	11.7%

[A] A Properly used latrine means that it was properly covered.

4.2 Attitudes and Perceptions

4.2.1 Likes and Dislikes of VIP and Pit Latrines

VIP and Pit latrine users answered informal interviews, which were then recorded and used to quantify the number of likes and dislikes of their latrine technologies. Answers from questions 1, 3, 5 and 6 of phase 2 were used to compile these results (questions provided in Appendix C). These questions include 1) what do you think of your pit latrine, 3) why did you want a pit latrine in the beginning, 5) what are the advantages of your pit latrine, and 6) what are the disadvantages of your pit latrine. Table 8 presents the likes of VIP and Pit latrines, while Table 9 presents the dislikes of VIP and Pit latrines. Results

indicate that there were five more associated advantages of latrines than disadvantages, with the majority of advantages offered in comparison to open defecation. Disadvantages were more often noted about the characteristics of VIP and Pit latrines, and problems that arise with maintenance of the latrines.

Table 8 Responses to the Informal Interviews about Basic Pit and VIP Latrine Users' Likes Regarding the Sanitation Technology n=103.

Likes Regarding Latrines	Frequency
1) Close to house	50
2) No longer using creek	19
3) Privacy	17
4) Safety	15
5) Latrine doesn't contaminate creek or environment	12
6) Good for health	11
7) Clean	8
8) Comfortable	8
9) Convenient	5
10) Cheap	3
11) Animals don't eat feces	1
12)Can plant crops over filled latrine	1
13) In compliance with law	1
14) no longer feces around community	1
15) all feces in one place	1
16) good for mosquitoes	1
17) good for visitors[A]	1
18) good ventilation in latrine	1
19) higher standard of living[A]	1
20) long lasting	1
21) made of cement	1

[A]- These can also be considered together

The primary advantage of a pit or VIP latrine according to respondents is the proximity to the home. This is followed by the importance that they are no longer open defecating in the creeks, and that latrines are both private and safe. This reflects the literature, as convenience, privacy, and safety are key drivers in social marketing (Jenkins and Curtis, 2005, Geest, 1998, Wilbur, 2014). Health was a motivator, but not as strongly linked as the other factors, as stated in the literature (O'Reilly and Louis, 2014). The primary associated disadvantages of pit latrines identified by users were flies, mosquitoes, and insects, followed by the smell. This can be attributed to the fact that only 35.2% of completed and in use latrines were covered properly. Most respondents use water to clean themselves after using the latrine, another

reason for the proliferation of insects in their latrines. The water can also be associated with the foul smell, as dry latrines usually smell much less than a wet latrine. Seventy of 103 respondents identified water as their anal cleansing material, and of 54 latrines found to have anal cleansing materials present, 39 had water available, while only 10 had toilet paper available. Ninety-four-point eight percent of survey respondents also reported that their sometimes smells bad which can be attributed to the poor covering of latrine holes and use of water for anal washing.

Table 9 Responses to the Informal Interviews about Basic Pit and VIP Latrine User's Dislikes Regarding the Sanitation Technology n=103.

Dislikes Regarding Latrines	Frequency
1) insects[A]	36
2) smell	20
3) fills with water	8
4) dirty	3
5) lots of work	3
6) far	2
7) fills up	2
8) can't water wash inside latrine	1
9) gives kids diarrhea	1
10) inconsistent water for self-cleaning	1
11) no roof	1
12) rats	1
13) there are better technologies	1
14) too close	1
15) very shallow	1
16) wood rots and damages	1

[A]It was common for participants to refer to both mosquitoes and flies simply as insects

4.2.2 Perceptions of Feces and its Use as a Soil Amendment

Table 10 presents information obtained from the survey found in part 2 of phase 3 (Appendix C). The table shows the percentage of overall responses, "agree," "doesn't know," and "disagree," for the 16 statements about feces and their reuse. Defining a high level of consensus as ≥ 75%, the participants showed a high level of consensus in statements 5, 7, 8, 9, 14 and 15. Respondents agreed it is not ok to touch fresh excrement with the hand, with 97.1% of respondents in agreement. Regarding the use of composted human excreta as a soil amendment, the clear majority of respondents agreed that human

excrement is a resource for the soil (89.3%), composted excrement can be used as a fertilizer (87.4%), and that they would use composted human excrement as a soil amendment (82.5%). Additionally, respondents agreed that they would be open to the idea of eating crops fertilized with human excrement (80.6%) and that animal manure can be used as a fertilizer (83.5%).

Table 10 Responses to Statements Regarding Perceptions of Excreta and its Use as Fertilizer n=103

Survey Questions	Agree (%)	Doesn't Know (%)	Disagree (%)
1) Human excreta are a waste and should only be for disposal	38.8	4.9	56.3
2) Handling excreta is a great health risk	68.9	2.9	28.2
3) Human excrement should not be handled in any way	42.7	4.9	52.4
4) Human excrement has no benefit to humans	29.1	3.9	67.0
5) It is OK to touch excrement with your hands.	2.9	0	97.1
6) It is OK to touch composted excrement.	25.2	3.9	70.9
7) Human excrement is a resource for the soil.	89.3	2.9	7.8
8) Human excrement from a composting latrine can be used as fertilizer.	87.4	2.9	9.7
9) I would use composted human excrement on my crops.	82.5	1.0	16.5
10) Taste of vegetables will change when composted human excrement is used.	51.5	10.7	37.9
11) Smell of vegetables will change when composted human feces is used.	40.8	10.7	48.5
12) Crops can be killed when fertilized with composted human excrement.	20.4	6.8	72.8
13) Crops fertilized with human excrement are good for consumption.	72.8	2.9	24.3
14) I will never consume crops that used composted human excrement.	19.4	0	80.6
15) Animal manure can be used as fertilizer.	83.5	1.9	14.6
16) I have used animal manure as fertilizer	71.8	0	28.2

Responses with percentages ranging from 60-75% reflect moderately high levels of consensus. Statements 2, 4, 6, 12, 13, 16 showed moderate agreement in responses. Sixty-nine-point nine percent of respondents expressed moderate agreement with statement 2, 67.0% of respondents disagreed with statement 4, 89.3% of respondents agreed with statement 6, 72.8% of respondents disagreed with statement 12, 72.8% of respondents agreed with statement 13, and 71.8% agreed with statement 16. In turn, the 50-60% range represents low levels of consensus. The low-level consensus statements include

1, 3, 10. Only small majorities of respondents with statement 1 (56.3%), statement 2 (52.4%) and statement 3 (51.5%). No consensus was reached for question 11, that the smell of vegetables will change with the addition of composted human excrement as a fertilizer. Questions 10 and 11 included the highest number of respondents who answered that they didn't know, with 10.7% of respondents not knowing.

Most respondents responded favorably to the use of composting latrines and the use of composted excrement as a soil amendment. This could be because of the difficulty of access for several of the communities, and because of the perceived value of compost as a "free" soil amendment. It was a surprising result with the high level of consensus on questions 7-9, because many of the farmers had not been previously exposed to the idea of reusing composted excrement as a soil amendment. It was also surprising that nearly 73% of respondents expressed that crops fertilized with composted excrement were fit for consumption. These questions also came after asking if the respondent was asked if they would be interested in a composting latrine project in the community, which could have skewed the results. The author tried to be very clear that he would not be building or bringing funding any projects in the community, and that the questions were purely a study, but participants may have still been inclined to answer favorably towards these questions.

4.2.3 Perceptions of Composting Latrines

When asked about preferred sanitation technologies, most respondents (n=77) stated they would prefer either a pour flush or a septic system. A small number of respondents stated that they would prefer composting latrines (n=15 of 103). Sixty percent of those respondents cited the compost as the main motivation for preferring a composting latrine over their current latrine. After asking about preferred sanitation technology, respondents were described a composting latrine by the interviewer, and asked if they would be interested in constructing a composting latrine, and of 103 respondents 63 (61.1%) responded that they would have interest, while 37 (35.9%) responded that they would not. Forty-seven

of the respondents responded that they would be interested in the latrine for the use of the fertilizer, with an additional three expressing a desire for better harvests.

Table 11 Responses to Informal Interviews About Latrine Users' Likes Regarding Composting Latrines When Asked About Preferred Sanitation Technology n=15

Likes Regarding Compost Latrines	Frequency
1) Compost	9
2) Less smell	3
3) Always Dry	1
4) better than a pit latrine	1
5) Past experience with technology	1

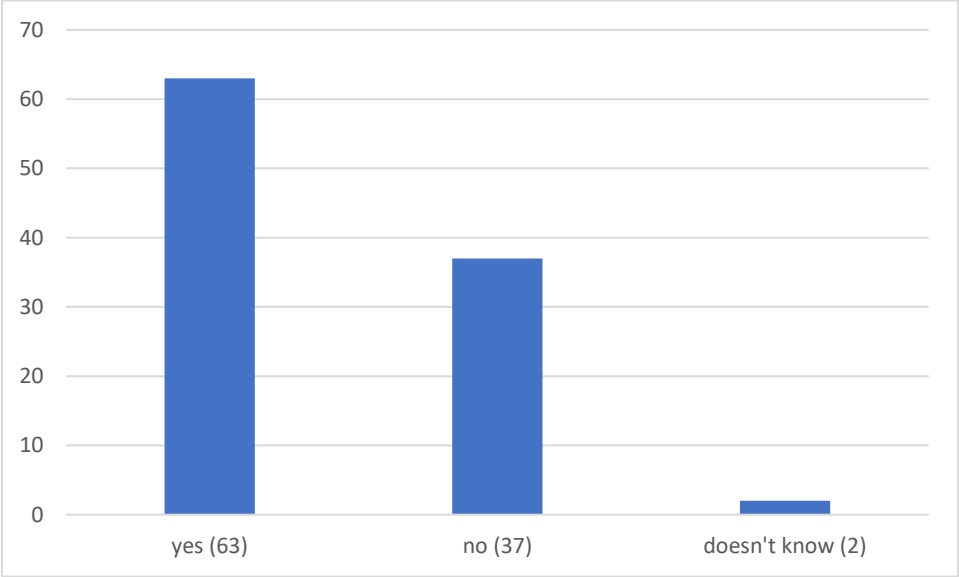

Figure 6 Respondent Preferences When Asked if they Would be Interested in a Composting Latrine for Their Home n=103

Table 12 Responses to Interviews about Latrine Users' Likes Regarding Composting Latrines, When Asked Specifically About Composting Latrines n=63

Reasons for Desiring a Compost Latrine	Frequency
1) Compost	47
2) Better Harvests	3
3) Less smell	3
4) To gain experience	3
5) Prior experience	2
6) Better than a pit latrine	2
7) No insects	1
8) More comfortable	1
9) Easier than digging a new hole	1
10) Convenient	1
11) Always dry	1
12) Two Rooms in Compost Latrine	1

The number of positive responses may have been skewed because of the nature of the question. The question immediately followed an explanation of what exactly a compost latrine is. The author explained that it was a double-vault system that required a large amount of work from the user, requiring compost removal from the latrine, and the addition of desiccants like ash and sawdust. It was then explained that if maintained properly, the odor levels in the latrine were much lower, and that compost can be harvested from the latrine for use on crops and plants after allowing for pathogen destruction. It was also explained urine would be diverted from the excrement to maintain dryness within the latrine chamber. The author tried to be as clear as possible that he would not bring this project to the community, but it is still possible respondents answered favorably for the possibility of a future composting latrine project. Some respondents may have been disillusioned by the perceived amount of fertilizer the composting latrine would give them, and by the quality of the compost. The word *abono* in Spanish can mean both compost and fertilizer, which may have led to respondents over-valuing the compost produced by the latrine.

Table 13 Responses to Informal Interviews About Latrine Users' Reasons for Not Desiring Composting Latrines, When Asked Specifically About Composting Latrines n=37

Reasons for Not Desiring a Compost Latrine	Frequency
1) No prior experience	13
2) Disgust	9
3) Too much work	8
4) it'd stink	2
5) Several have failed in nearby community	2
6) not interested	1
7) Goats already eat all his crops	1
8) Prefer pour flush	1
9) they can make compost out of other things	1
10) Family could get sick	1
11) Too Old	1

The main reason for not being interested in a composting latrine was lack of prior experience (35.1%) n=37. Other main reasons include disgust (24.3%) and the amount of work required to operate the latrine (21.6%).

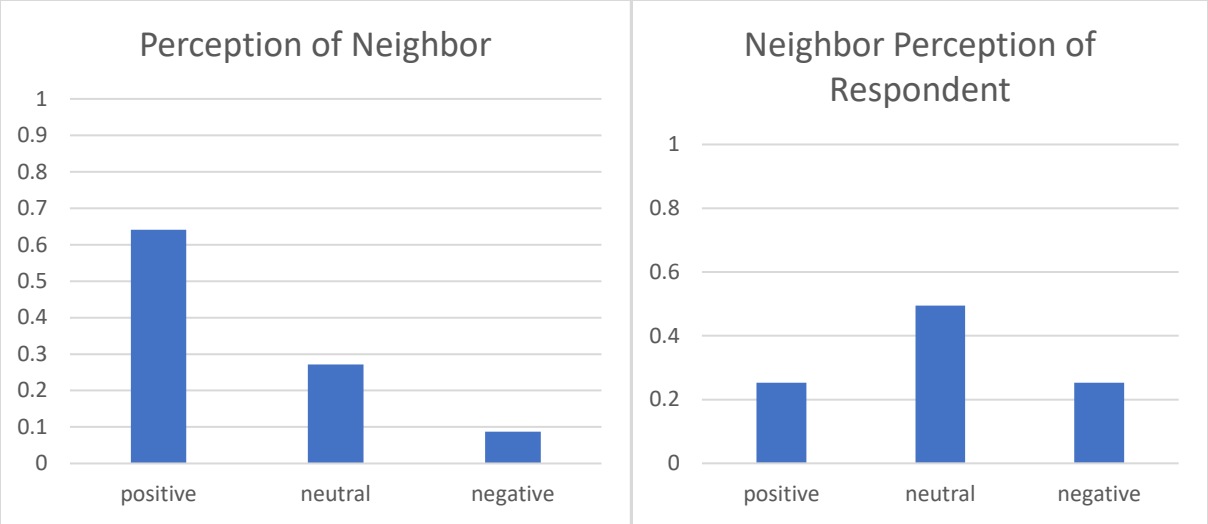

Figure 7 How Would You Feel if Your Neighbor Built and Began Using a Composting Latrine (n=103)

The last questions of phase 2 were developed from Simha et al. (2017) and were asked to obtain a better perspective of what interview participants' perceptions were of composting latrines and using composted excrement. Question 11 asked what the participant would think of their neighbor if they built a composting latrine, and then what they would think if that neighbor began using composted excrement on their crops. Question 12 asked what the respondent's neighbor would think of the respondent should they build a composting latrine, and then what they would think should they begin using composted human excrement on their crops. Most respondents responded favorably if to question 11 (64.1%), with much smaller numbers responding neutral (27.1%) and negative (8.7%). In question 12, the highest percentage of respondents had a neutral response (49.5%), with equal numbers responding positive and negative (25.2%). It was interesting how the respondents answered differently to the two questions, indicating that they would react more positively to their neighbor adopting a composting latrine than they felt their neighbor would react if the respondent adopted one. This may be attributable to the close-knit nature of indigenous communities; respondents may not want to be seen as different than the rest of the community for fear of alienation, even though they view composting latrines and excrement reuse in a positive light.

4.3 Statistical Analysis of Feces and Resource Recovery Perceptions

The significance (p-values) results from Pearson's Chi-Squared Test for Independence and the different demographics of the population from Table 6 are included in Table 14. The numbered statements in the table refer to information provided previously in Table 5. The statistically significant associations are highlighted in bold. The null hypothesis was that the demographic factor and the response to the perception statements was not associated. However, if the p-value is less than 0.050, the null hypothesis is rejected indicating there is an association between the demographic variable and the survey statement response. Knowing which demographics respond favorably to resource recovery can aid in future interventions by identifying which people are more likely to react favorably to the technologies. They could also help evaluate success, training, and future use of EcoSan technologies as our research group has been investigating in another project. Bar charts which relate statements, response numbers, and statistical significance can be found in Appendix D.

Table 14 Correlation and Significance of the Relationship Between Survey Responses and Selected Demographic Indicators from Participants in the Perceptions Survey (n=103).

Survey Responses	Community	Sanitation Classification	Gender	Primary Occupation	Age	Education	Household Size
Statement 1							
Correlation[A]	0.287	0.096	0.173	0.232	0.099	0.186	0.162
Significance[B]	0.154	0.409	0.097	0.269	0.616	0.324	0.490
Statement 2							
Correlation	0.194	0.050	0.031	0.136	0.152	0.181	0.127
Significance	0.603	0.661	0.823	0.818	0.357	0.375	0.713
Statement 3							
Correlation	0.308	0.063	0.021	0.126	0.157	0.184	0.183
Significance	0.098	0.547	0.839	0.838	0.391	0.341	0.373
Statement 4							
Correlation	0.147	0.141	0.143	0.215	0.153	0.125	0.159
Significance	0.846	0.189	0.183	0.325	0.329	0.710	0.466
Statement 5							
Correlation							
Significance	0.197	0.075	0.138	0.299	0.071	0.054	0.109
Statement 6	0.520	0.587	0.280	0.130	1.000	1.000	0.766
Correlation							
Significance	0.348	0.100	0.046	0.238	0.117	0.200	0.203
	0.032	0.363	0.815	0.218	0.564	0.281	0.266

Table 14 (Continued)

Statement 7							
Correlation	0.243	0.114	0.073	0.261	0.070	0.160	0.155
Significance	0.303	0.289	0.707	0.135	1.000	0.443	0.508
Statement 8							
Correlation	0.336	0.247	0.280	0.305	0.060	0.060	0.107
Significance	**0.040**	**0.019**	**0.007**	0.070	1.000	1.000	0.873
Statement 9							
Correlation	0.299	0.182	0.233	0.260	0.201	0.190	0.147
Significance	0.099	0.107	**0.028**	0.144	0.149	0.331	0.536
Statement 10							
Correlation	0.175	0.117	0.149	0.256	0.035	0.154	0.269
Significance	0.743	0.287	0.198	0.188	1.000	0.543	0.079
Statement 11							
Correlation	0.165	0.118	0.154	0.347	0.058	0.167	0.230
Significance	0.787	0.289	0.198	**0.015**	0.912	0.479	0.198
Statement 12							
Correlation	0.413	0.043	0.242	0.331	0.088	0.081	0.164
Significance	**0.005**	0.804	**0.024**	**0.034**	0.807	0.885	0.468
Statement 13							
Correlation	0.248	0.007	0.141	0.220	0.160	0.142	0.143
Significance	0.300	1.000	0.238	0.297	0.318	0.640	0.653
Statement 14							
Correlation	0.167	0.001	0.163	0.211	0.114	0.124	0.221
Significance	0.740	1.000	0.127	0.330	0.505	0.643	0.152
Statement 15							
Correlation	0.178	0.023	0.183	0.283	0.104	0.117	0.142
Significance	0.703	1.000	0.086	0.091	0.593	0.680	0.554
Statement 16							
Correlation	0.265	0.040	0.121	0.241	0.161	0.066	0.107
Significance	0.210	0.826	0.263	0.189	0.253	1.000	0.801

[A]Correlation was calculated using Cramer's V.
[B]Significance was calculated using Fisher's exact test
[C]Numbers in bold type are significant at $p<0.05$

The community in which the respondent lived was found to be statistically associated with 3 statements: statement 6 (It is ok to touch treated excrement), 8 (human excrement from a composting latrine can be used as fertilizer), and 12 (crops can be killed when fertilized with composted human excrement). Nueva Estrella was the only community to respond favorably to question 6, perhaps because of the proximity to Silico Creek, a community documented in Wilbur (2014) to have had success with composting latrine projects. Residents of Nueva Estrella must wait for public transportation in the

community of Silico Creek. Bajo Gavilán was the only community that responded 100% positively towards the reuse of composted excrement (question 8), which may be due to the fact that the author of this study talked about composting latrines regularly during his Peace Corps service, and he lived in Bajo Gavilán. Bajo Cedro and Nueva Estrella were the only communities to respond 100% negatively to question 12.

Sanitation Classification was found to be associated with question 8. People who own a Basic Pit latrine were mostly found in Hato Nube, and Nance de Risco. Gender was associated with statements 8, 9 and 12. Primary occupation was associated with 11 and 12.

Table 15 Logistic Regression Analysis of Latrine Type on Perceptions Statements

Survey Responses	B	S.E.	Wald	Degrees of Freedom	Significance	Exp(B)	95% C.I. for Exp(B) Lower	Upper
Statement 1	0.223	0.724	0.095	1	0.758	1.25	0.302	5.171
Statement 2	0.071	0.735	0.009	1	0.323	1.073	0.254	4.530
Statement 3	-0.757	0.747	1.028	1	0.311	0.469	0.108	2.028
Statement 4	0.867	0.737	1.183	1	0.277	2.38	0.499	11.361
Statement 5	1.503	1.608	0.0874	1	0.350	4.496	0.192	105.035
Statement 6	0.101	0.690	0.021	1	0.884	1.106	0.286	4.276
Statement 7	-0.386	1.556	0.062	1	0.804	0.680	0.032	14.334
Statement 8	-3.129	1.733	3.259	1	0.071	0.044	0.001	1.308
Statement 9	0.386	1.526	0.064	1	0.800	1.471	0.074	29.298
Statement 10	-0.357	0.715	0.249	1	0.618	0.700	0.172	2.843
Statement 11	-1.506	0.783	3.695	1	0.055	0.222	0.048	1.03
Statement 12	-1.495	1.002	2.229	1	0.135	0.224	0.031	1.597
Statement 13	-0.504	1.158	0.189	1	0.663	0.604	0.062	5.848
Statement 14	-1.013	1.191	0.724	1	0.395	0.363	0.035	3.748
Statement 15	0.653	1.584	0.170	1	0.680	1.921	0.086	42.82
Statement 16	1.084	1.202	0.814	1	0.367	2.958	0.28	31.21

Nagelkerke R Square value is 0.346

The number in the Exp(B) column of Table 15 represents the odds ratio of someone with a basic pit latrine responding favorably to the corresponding statement as opposed to someone with a VIP Latrine. Thus statements 4, 5, 15, and 16 show someone who responds positively to those statements is 2.380x, 4.496x, 1.921x, and 2.958x more likely to own a basic pit latrine. While this regression describes the dataset presented, the large ranges in the confidence intervals indicate that these results may not be indicative of the entire population.

4.4 Comparison to Results of Wilbur (2014)

Wilbur (2014) noted that the primary disadvantage associated with composting latrines was the lack of provision within the latrine for water used for anal cleansing. This is because the composting latrine needs to retain a low moisture content, 25% or less (Mehl, 2008), to promote pathogen destruction within the latrine. The current study found that most respondents use water for anal washing after latrine use, but respondents cite smell and insects as the main disadvantage of VIP and basic pit latrines. These problems are more prevalent because of the use of water for anal cleansing. Water is the preferred method to clean oneself in these communities, and selection of appropriate technologies, and the success of sanitation projects will ultimately rely on a culturally appropriate solution that allows the user to wash them self in this way.

The most cited advantage of composting latrines in Wilbur (2014) was the production of compost, which matched the results of this study. Only three respondents in this research cited reduction of odors as an advantage of composting latrines, and only one respondent cited reduction of insects as an advantage. The primary associated advantage of compost latrines in Wilbur (2014), aside from the production of compost, is the lack of mosquitoes and flies, and the lack of smell. These identified advantages are because the latrine remains dry, and water washing is not possible as it is in pit latrines. Other advantages of composting latrines match the advantages associated with pit and VIP latrines, which include privacy, proximity, and lack of contamination of the environment. Education and familiarization of composting latrine technologies can help these users understand the advantages of composting latrines better.

Respondents had a higher level of consensus in more questions of their perceptions of reusing human composted excrement than in Wilbur (2014). Table 5 presents the yes or no questions used in this analysis. In 12 of 16 questions respondents had at least a moderate level of consensus, as opposed to 10 in the Wilbur study. The Wilbur study found high levels of consensus in statements 5, 6, 7, 8, 12, 13, 14,

and 15, moderate consensus in 3 and 9, and low levels of consensus in 1, 2, 4, 10, 11, and 16. This study found high level of consensus in statements 5, 7, 8, 9, 14 and 15, moderate consensus in statements 2, 4, 6, 12, 13, 16, low-level consensus in statements 1, 3, 10. No consensus was reached for question 11.

The study population in Wilbur (2014) was made up of those who owned a composting latrine, and there was a low level of consensus that human excrement has a benefit to humans (54.0%); but in this study 67.0% of respondents agreed that it had a benefit. More respondents also agreed in this study that handling human excrement is a great health risk (68.9%) than Wilbur (56.5%). This probably has to do with the fact that composting latrine owners must work with compost, whereas most pit latrine users are only trained about the dangers of open defecation.

The only statement found to be statistically significant and in common between this thesis research and Wilbur (2014) was the link between primary occupation and statement 11: the smell of vegetables will change when composted human feces is used. More research needs to be done to test the strength of this relationship.

4.5 Supplemental Information from this Study which may be of use in Future Research

4.5.1 Additional Qualitative Information

The information in this section was part of the survey, interview, and observation process, but did not apply to the objectives of the thesis. Table 14 presents the information from a question asking, “would you prefer a different sanitation technology, and why.” Seventy seven of 103 respondents replied that they preferred either a pour-flush or a septic system, while only 15 preferred composting latrines, and the rest (n=11) either preferring their current technology or having no preference. The most cited reason for preferring a septic or pour flush system was that the excrement leaves the toilet one the user flushes it, so the user does not have to deal with the unpleasantness of excrement. Others (n=16) cited that these systems are cleaner, didn’t smell (n=15), and that they were closer or inside the home (n=11). These results suggest that while users are open to composting latrines, they still prefer the smallest interaction

with their latrine and contents as possible. Pour flush systems also give one a sense of status, as they are seen as having more wealth as they can afford the installation. Many Panamanians have a strong preference for them, even if they can give no reason why, as presented below when respondents said, "it's better" (n=4) or they simply didn't know why they preferred a pour flush system (n=4).

Table 16 Responses to Informal Interviews About Latrine Users' Likes Regarding Pour-flush Systems, When Asked About Preferred Sanitation Technology n=77

Likes Regarding Pour Flush Systems	Frequency
1) Excrement leaves with flush	18
2) Cleaner	16
3) No smell	15
4) Closer to house	11
5) No insects	5
6) It's better	4
7) Doesn't know	4
8) More convenient	3
9) Safer	3
10) Permanent	3
11) More Comfortable	3
12) Doesn't fill with water	2
13) Random people can't use it	2
14) Government will make it for me	1
15) No longer wants a latrine	1
16) Fills more slowly	1
17) More private	1
18) Everyone else has one	1
19) Emptiable	1
20) Better for kids	1

Another survey question asked about who cleaned the latrine, how the latrine is cleaned, and how often. This question aimed to document the gender-related burden of labor of cleaning the latrine. Women are the most likely group to clean the latrine, with 82 of 93 latrine owners saying that the women helped clean the latrine, and 46 respondents saying only women clean the latrine. Men were only involved half as often, with 42 responses saying the men helped clean the latrine, and 8 responding that only men clean the latrine. Children were the least likely to help clean the latrine, with 21 respondents saying that their children help clean the latrine, and none saying that children do it alone.

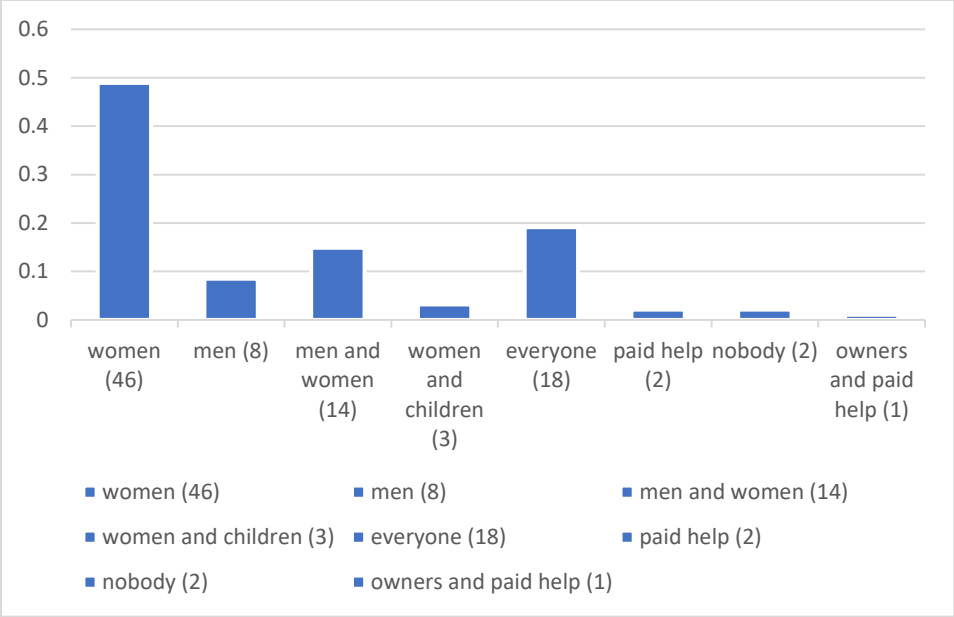

Figure 8 The Gender-Based Burden of Latrine Cleaning (n=93)

Respondents were also found to clean their latrine less than once a week more than two thirds of the time (69%); however, some respondents cleaned it as often as three times per week. Latrine owners also reported using soap and water more often than any other method of cleaning, and often used the disinfectant bleach as well. Machetes were reported being used to cut the grass outside of the latrine. Figure 8 presents the rate at which respondent households clean their latrines annually, while Figure 9 presents latrine what tools and materials respondent households use to clean their latrine. Fifteen of 51 VIP latrines were properly covered, and 17 of 42 basic pit latrines were properly covered. These results suggest the current implementation scheme can be improved with better education outreach about how to properly maintain the latrine once it is built. Properly covering a latrine can lead to much less proliferation of insects within the latrine, which then would increase satisfaction with the latrine. Properly covering a VIP latrine promotes airflow within the latrine as well, which can reduce odors and improve user satisfaction as well.

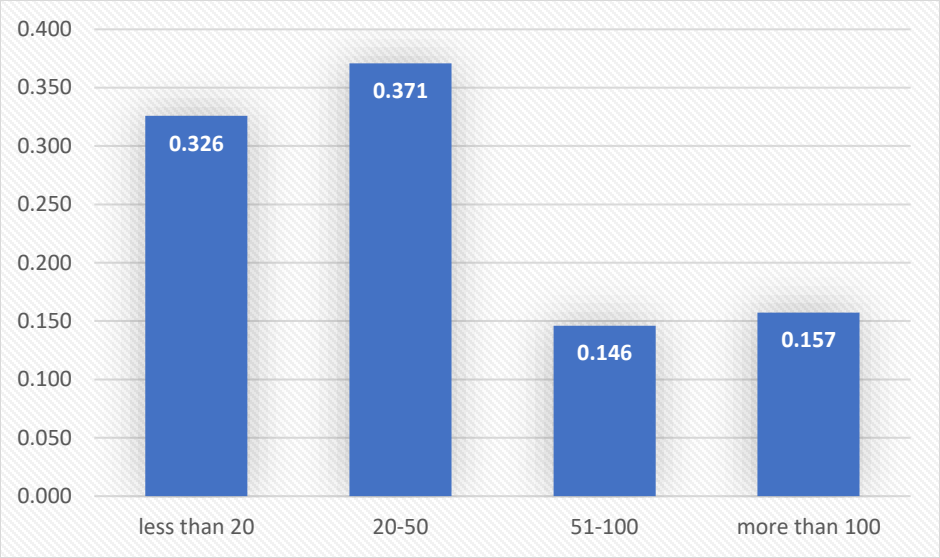

Figure 9 How Many Times Latrines are Cleaned Annually (n=93)

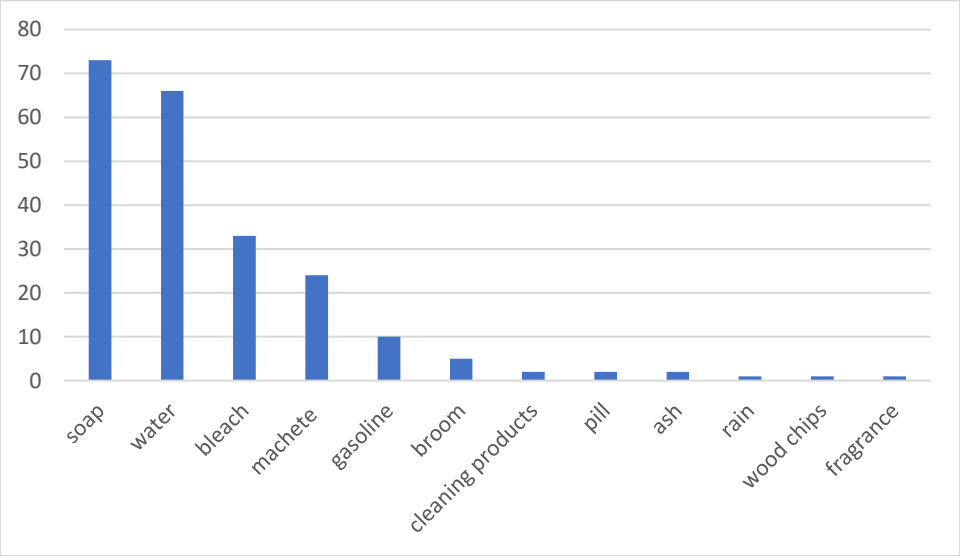

Figure 10 What Materials are Used to Clean Latrines

Note: Latrine pills are sold at hardware stores in Panama and are dropped in the latrine to reduce insects and odor. Cleaning products refer to commercially available sanitizing products that aren't soap.

4.5.2 Additional Logistic Regression

The logistic regression analysis presented in Tables 17 and 18 was the result of changing education and primary occupation to binary variables. The numbered statements in the table refer to information provided previously in Table 5. Table 17 presents education as either formally educated or formally

uneducated, where uneducated is having no schooling whatsoever. Twenty-six respondents in the survey did not have any education, while 77 had some formal schooling. Someone who responded positively to statements 1,2, and 9 were 3.888x, 5.279x, and 13.147x more like to have at least a small amount of education.

Table 17 Education vs 16 Perceptions Statements

Survey Responses	B	S.E.	Wald	Degrees of Freedom	Significance	Exp(B)	95% C.I. for Exp(B) Lower	Upper
Statement 1	1.358	.969	1.965	1	.161	3.888	.582	.582
Statement 2	1.664	.858	3.761	1	.052	5.279	.982	.982
Statement 3	-.575	.907	.402	1	.526	.563	.095	.095
Statement 4	-.732	.969	.571	1	.450	.481	.072	.072
Statement 5	-1.315	1.710	.592	1	.442	.268	.009	.009
Statement 6	.136	.883	.024	1	.878	1.145	.203	.203
Statement 7	-21.12	15812	.000	1	.999	.000	.000	.000
Statement 8	-.697	1.559	.200	1	.655	.498	.023	.023
Statement 9	2.576	1.584	2.645	1	.104	13.147	.590	.590
Statement 10	.056	.868	.004	1	.948	1.058	.193	.193
Statement 11	-1.599	.920	3.018	1	.082	.202	.033	.033
Statement 12	-.133	.898	.022	1	.882	.876	.151	.151
Statement 13	.467	1.144	.166	1	.683	1.595	.169	.169
Statement 14	-.928	1.183	.616	1	.433	.395	.039	.039
Statement 15	-1.218	1.661	.538	1	.463	.296	.011	.011
Statement 16	.499	1.092	.209	1	.648	1.647	.194	.194

Nagelkerke R Square 0.389

Table 18 presents Primary occupation as a binary input, either a famer or non-farmer. Forty eight of 103 respondents identified as farmers in the study, the largest occupation group. It was followed by housewife, which accounted for 35 responses. These housewives were often the wives of farmers, but spouse's occupation was not recorded. The data in Table 18 shows that a positive response to statements 1, 5, 12, and 13 were 3.047x, 1.992x, 4.196x, and 4.838x more likely to be stated by a non-farmer.

Table 18 Primary Occupation vs 16 Perceptions Statements

Survey Responses	B	S.E.	Wald	Degrees of Freedom	Significance	Exp(B)	95% C.I. for Exp(B) Lower	Upper
Statement 1	1.114	.657	2.872	1	.090	3.047	.840	11.052
Statement 2	.074	.647	.013	1	.910	1.076	.303	3.828
Statement 3	-.401	.684	.344	1	.558	.670	.175	2.558

Table 18 (Continued)

Statement 4	.550	.767	.514	1	.474	1.733	.385	7.790
Statement 5	.689	1.561	.195	1	.659	1.992	.093	42.484
Statement 6	-.365	.610	.358	1	.550	.694	.210	2.294
Statement 7	-.090	1.763	.003	1	.959	.914	.029	28.944
Statement 8	-1.241	1.675	.549	1	.459	.289	.011	7.700
Statement 9	.182	1.482	.015	1	.902	1.200	.066	21.899
Statement 10	-.376	.673	.313	1	.576	.686	.183	2.568
Statement 11	-.809	.629	1.653	1	.199	.445	.130	1.528
Statement 12	1.434	.845	2.883	1	.090	4.196	.802	21.966
Statement 13	1.576	1.087	2.104	1	.147	4.838	.575	40.711
Statement 14	-.205	.967	.045	1	.832	.815	.123	5.419
Statement 15	-1.684	1.360	1.533	1	.216	.186	.013	2.667
Statement 16	.285	.909	.098	1	.754	1.329	.224	7.899

Nagelkerke R Square 0.272

CHAPTER 5: CONCLUSIONS, RECOMMENDATIONS FOR ACTION, AND AREAS FOR FUTURE RESEARCH

5.1 Major Findings

The objectives of this thesis were to quantify the use of VIP and basic pit latrines, evaluate the attitudes and perceptions of feces and its reuse as a soil amendment in Ngäbe populations, and to the compare the results of those objectives to Wilbur (2014). Six communities were included in the study with a total population of 103, and 93 latrines were determined to be completed and in use. Only 35.2% of the completed and in use latrines were properly covered, properly covered meaning the latrine hole was left uncovered for VIP latrines and the hole was covered for basic pit latrines.

There were two hypotheses at the onset of the study. 1) The type of latrine a family owns is highly indicative of their perceptions of the use of composted excrement. 2) Pit latrine owners will be averse to the adoption of composting latrines and the use of human compost. The logistic regression previously presented in Table 15 revealed that a VIP latrine owner was much more likely to respond positively to perception statement 8, that human excrement from a composting latrine can be used as a fertilizer than a basic pit latrine owner. A basic pit latrine owner was also found to be 2.380x more likely to respond positively to statement 4, that human excrement has no benefit to humans. The statistical analysis presented in Table 14 shows that sanitation classification had a statistically significant effect on statement 8, but not statement 4. These results suggest that there is a link between sanitation classification and one's perceptions of the use of composted human excrement, but more research needs to be done to test the strength of this relationship. The second hypothesis was rejected. As previously presented in Table 10, 87.4 percent of respondents said human compost can be used as a fertilizer and 82.5 percent

reported that they would use human compost on their crops. Sixty-three of 103 respondents reported that they would be interested in constructing a composting latrine for their home.

The primary associated advantage of owning a VIP or pit latrine was the proximity to the home, with 48.5% or respondents citing it as a primary advantage. The other most frequent responses were satisfaction to no longer being open defecating in the creek, safety, and privacy. The primary associated disadvantages of owning the same technologies were the high incidence of mosquitoes and flies inside the latrine, and the foul smell.

The most significant perceived benefit of a composting latrine to these populations was the value of compost. The most cited barriers to composting latrines was lack of previous experience, followed by disgust with working with feces, and the amount of labor it takes to operate a composting latrine. Composting latrine advantages were cited in 47 of 63 responses where the respondent indicated they would be interested in owning a composting a latrine. The primary cited disadvantage, inexperience, was cited in 13 of 37 responses where the respondent had no interest in owning a composting latrine, followed by disgust (n=9) and the amount of labor (n=8). These results indicate the importance of familiarity with the technology. They suggest if successful pilot projects can be demonstrated to the communities, paired with relevant education and training, these populations would likely be receptive to using composting latrine sanitation infrastructure.

Respondents also answered positively about human compost reuse. When asked what they would think if their neighbor built a composting latrine and began using the compost on their crops, 64.1% of respondents answered that they would perceive this positively, 27.1% would perceive it neutrally, and only 8.8% would perceive it negatively. When asked what their neighbor would think if they built a composting latrine and began spreading composted excrement on their crops 25.2% responded that their neighbor would respond positively and 49.5% responded their neighbor would respond neutrally, and 25.2% of them would perceive it negatively. These results show most respondents feel positively about

the concept of reusing human compost, but a perceived barrier may be the perceptions of the people living near them. Ngäbes live in tight communities, often very close to their immediate family (Wilbur, 2014, Bletzer, 1991). The perceived alienation from family and friends could prevent first adopters from trying a composting latrine. These results further suggest the importance of pilot projects and proper education for composting latrines.

5.2 Recommendations for Action

The findings of this thesis suggest the importance of composting latrine pilot-projects. The most cited reason for not wanting a compost latrine was lack of experience, but willingness to learn was also documented in survey and interview responses (Appendix D). Training follow-ups need to be part of the pilot project, to ensure that composting latrines are being operated appropriately and to familiarize the rest of the community with composting latrines. These pilot projects and trainings will help development workers and government agencies better gauge the interest in particular sanitation technologies.

Additionally, follow up trainings should be conducted for pit and VIP latrine users. Only 29.4% of VIP and 40.5% of pit latrines in this study were covered. A VIP latrine needs to be left uncovered to help promote airflow from the latrine hole up and out of the ventilation pipe, as was previously presented in figure 1. A basic pit latrine hole needs to be kept covered so that flies and insects cannot get into and out of the latrine hole. Latrine users across Bocas del Toro and the Comarca Ngäbe- Buglé should be retrained in regular intervals to ensure the public health benefits that latrines provide. These trainings should also reinforce personal hygiene behaviors to ensure users are washing their hands properly after leaving the latrine.

5.3 Recommendations for Future Research

Future research related to this thesis will be mainly directed towards the use of composting latrines and their sustainability in Panama and around the world but will include other sanitation technologies like pit and VIP latrines as well. More research will be done on the covering of basic pit and

VIP latrines. The geographical and cultural scope of this study should be broadened to include more domestic ethnic groups including the Kuna, Emberá-Wounaan, Naso, Buglé, and Latino. The results can be compared to other Panamanians, indigenous groups located in Central and South America, indigenous groups around the world, and to other water washing communities around the world.

The methods of this research could also be reapplied to populations that exclusively open defecate. Perceptions of the populations could then be compared in the same manner as presented in the results section above and compared to both this study and the Wilbur (2014) study. The perceived barriers and incentives of the open defecating populations towards latrine use could be documented, and preferences for VIP, pit, and composting latrines could be documented as well.

Another research effort could conduct small pilot composting latrine projects in indigenous communities with motivated first adopters. These latrines could use design innovations like a bidet inside of the latrine, carefully placed so the water from the bidet would not mix with the solids below. This could involve a separate bidet inside of the latrine, or a sliding door inside of the seat which leads to a separate chamber where liquids can be held for a later safe disposal. The interviews and surveys found in this study could be used before the project began, and after 2-3 years of successful composting latrine use and compost spreading in the farms of the community. The results of the study suggest that Ngäbes have very favorable perceptions of composting latrines but wish to see them successfully implemented before being willing to try them themselves. The willingness to participate in a new composting latrine project should be documented after the 2-3-year period of successful composting latrine implementation, and willingness to help pay for a composting latrine project should also be documented. Projects such as these are often sponsored by the Panamanian government or the Peace Corps, and user buy in could be measured by that willingness to pay, as many may only wish to build a composting latrine because it is free.

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APPENDIX A: USF IRB APPROVAL

USF
UNIVERSITY OF
SOUTH FLORIDA

RESEARCH INTEGRITY AND COMPLIANCE
Institutional Review Boards, FWA No. 00001669
12901 Bruce B. Downs Blvd., MDC035 • Tampa, FL 33612-4799
(813) 974-5638 • FAX (813) 974-7091

7/18/2017

James Libby
Civil and Environmental Engineering
Tampa, FL 33620

RE: **Exempt Certification**
IRB#: Pro00031389
Title: An Evaluation of Pit Latrines and User Perception of Excrement in Ngäbe Communities in Panama

Dear Mr. Libby:

On 7/18/2017, the Institutional Review Board (IRB) determined that your research meets criteria for exemption from the federal regulations as outlined by 45CFR46.101(b):

(2) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless:
(i) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, or reputation.

As the principal investigator for this study, it is your responsibility to ensure that this research is conducted as outlined in your application and consistent with the ethical principles outlined in the Belmont Report and with USF HRPP policies and procedures.

Please note, as per USF HRPP Policy, once the Exempt determination is made, the application is closed in ARC. Any proposed or anticipated changes to the study design that was previously declared exempt from IRB review must be submitted to the IRB as a new study prior to initiation of the change. However, administrative changes, including changes in research personnel, do not warrant an amendment or new application.

Given the determination of exemption, this application is being closed in ARC. This does not limit your ability to conduct your research project.

We appreciate your dedication to the ethical conduct of human subject research at the University of South Florida and your continued commitment to human research protections. If you have

any questions regarding this matter, please call 813-974-5638.

Sincerely,

John Schinka, Ph.D., Chairperson
USF Institutional Review Board

APPENDIX B: SCRIPTS USED TO OBTAIN VERBAL CONSENT FROM STUDY PARTICIPANTS

USF
UNIVERSITY OF
SOUTH FLORIDA

Script for Obtaining Verbal Informed Consent

Researchers at the University of South Florida (USF) study many topics. To do this, we need the help of people who agree to take part in a research study. We are asking you to take part in a research study that is called: An Evaluation of Pit Latrines and User Perception of Excrement in Ngabe Communities in Panama.

The person who is in charge of this research study is James Libby. This person is called the Principal Investigator.

You are being asked to participate because you are an owner of a pit latrine. The purpose of this study is to assess your pit latrine and then learn how you feel about using compost on crops and plants.

If you take part in this study, you will be asked to participate in two surveys and a questionnaire.

You have the alternative to choose not to participate in this research study

You should only take part in this study if you want to volunteer and should not feel that there is any pressure to take part in the study. You are free to participate in this research or withdraw at any time. There will be no penalty or loss of benefits you are entitled to receive if you stop taking part in this study.

You will receive no benefit from this study.

This research is considered to be minimal risk.

We will not pay you for the time you volunteer while being in this study

We must keep your study records as confidential as possible. We may publish what we learn from this study. If we do, we will not let anyone know your name. We will not publish anything else that would let people know who you are. However, certain people may need to see your study records. By law, anyone who looks at your records must keep them completely confidential. The only people who will be allowed to see these records are:

• The research team, including the Principal Investigator, the Advising Professor, and all other research staff.
• Certain government and university people who need to know more about the study. For example, individuals who provide oversight on this study may need to look at your records. This is done to make sure that we are doing the study in the right way. They also need to make sure that we are protecting your rights and your safety.) These include:

- The University of South Florida Institutional Review Board (IRB) and the staff that work for the IRB. Other individuals who work for USF that provide other kinds of oversight may also need to look at your records.
- The Department of Health and Human Services (DHHS).

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If you have any questions about this study, you can contact the investigator James Libby at (507)6890-3534 or libbyj@mail.usf.edu. If you have question about your rights as a research participant please contact the USF IRB at (813) 974-5638 or contact by email at RSCH-IRB@usf.edu.

Would you like to participate in this study?

APPENDIX C: QUSTIONS FOR INTERVIEWS, OBSERVATIONS, AND SURVEYS FOR STUDY PHASES 1, 2, AND 3

Phase 1. Pit Latrine Use Interviews and Observations Adapted from Mehl (2008), Kaiser (2006), and Wilbur (2014).

Community Surveyed: Date:
Surveyed by:
Community Statistics:

1. Population in the community:
2. Total number of houses in the community:
3. Number of houses with a fully constructed pit latrine:
4. Number of houses with a partially constructed pit latrine:
5. Number of houses with another type of latrine/septic system:
6. Type of sanitation technology used at the school:
7. Identified ethnicity:
8. Running water available? (Y/N) Reliability?

Observations:

1. Is the latrine a basic pit latrine or a VIP latrine?
2. Is there anal cleansing materials present? (Y/N)
a. If yes, what type is it (e.g. toilet paper, corn cobs, water, etc.)?
3. Do the contents of the latrine appear? (1 dry… 5 very wet)
4. Is the latrine seat covered properly? (Y/N)
5. Is there a bad odor? (1 no odor… 5 bad odor)
6. Is the latrine clean? (1 clean… 5 dirty)
7. Are there a lot of flies? (1 no to 5 lots of maggots and flies)
8. Is the latrine in working condition (seats in place, pipes in place, too full, etc.)? (Y/N)
a. If not, describe the problem below.
9. How close is the latrine to the household? To the kitchen?

Questions for Latrine Owner/Operator:

Latrine Number: Role of Interviewee in the house:

1. ¿Cuando recibió su letrina? (en cual año) (When did you receive your latrine?)
a. ¿Quién la construyó? Who built it?
b. ¿Usted recibió ayuda de algun ONG? Did you receive NGO Assistance?
c. ¿Por qué la hizó? Why did you build it?
2. ¿Quién usa la letrina? (Who uses the latrine?)
a. ¿Los niños también? Kids too?
b. ¿Los mayores de edad? Elderly?
c. ¿Hombres? Men?
d. ¿Mujeres? Women?
e. ¿Durante el día? During the day?
f. ¿Durante la noche? At night?
3. ¿Hay gente que vive aqui que defeca afuera de la letrina? Do people in your household open defecate? (Never, sometimes, all the time)?
a. ¿Por qué? If they open defecate, why do they do this instead of using the latrine?
4. ¿Que usa usted para limpiarse? (What type of anal cleansing material do you use?)
5. ¿A veces tiene su letrina mal olor? (Does your latrine ever smell bad?)
6. ¿Que va a hacer cuando se llene la letrina? (What will you do when the latrine is full?)

7. ¿Usa papel higiénico? Si no, ¿qué usa para lavarse? (Do you use toilet paper? If not, what do you use to clean yourself?)
8. ¿Quien limpia la letrina? ¿Como? ¿Cuantos veces al año? Who cleans the latrine? How do they clean it? How many times a year?
9. ¿Recibió capacitación sobre el uso y mantenimiento de la letrina? ¿Quién se la dio? (Did you receive training over the operation and maintenance of the latrine? Who was the trainer?)
10. ¿Qué enseñaron en la capacitación? (What did they teach in the training?)
11. ¿Hay muchos casos de diarrea en la casa? ¿Por cuantos días han tenido diarrea en el mes pasado? ¿Los niños? (Are there many cases of diarrhea in the house? How many days have you had diarrhea in the past month? And the children?)
12. ¿Había más casos de diarrea cuando no tenía su letrina? (Were there more cases of diarrhea before you had your latrine?
13. En el caso que no se usa la letrina, ¿Cuándo terminó de usar la letrina? (When did you stop using the latrine?)
14. ¿Cuantos pies por abajo esta su nivel freático? How low/high is your water table?
15. ¿De que profundidad es su letrina? ¿está forrado con algo? How deep is the latrine pit? Is it lined or unlined?
16. ¿De que distancia esta su letrina de un fuente de agua? How far is the latrine from a water source? (well/spring?)
17. ¿Hay algo mas que usted quiere decir sobre letrinas, saneamiento, o este invesitgación? Anything else you would like to say/add in regards to pit latrines, sanitation, or this research?

Phase 2. Informal Interviews about Likes/Dislikes of Composting Latrines
1. ¿Qué piensas de su letrina? What do you think of your pit latrine?
2. ¿Como se empezó un proyecto de letrinas por acá? How did a latrine project get started here?
3. ¿Por qué quisó usted una letrina? Why did you want a latrine in the beginning?
4. ¿Por qué algunos en la comunidad tienen letrinas y otros no? Why do some people in the community have pit latrines and not others?
5. ¿Cuales son las ventajas de su letrina? ¿Qué te gusta de su letrina? What are the advantages of your pit latrine? What do you like about your pit latrine?
6. ¿Cuales son las desventajas de su letrina? ¿Qué no te gusta de su letrina? What are the disadvantages of your pit latrine? What do you not like about your pit latrine?
7. ¿Sabiendo lo que sabes ahora, todavía conseguirías una letrina de hueco? Knowing what you know now, would you still get a pit latrine?
8. ¿Qué harías para mejorar el diseño de su letrina? How would you improve the design of your pit latrine?
9. ¿Preferirías una otra tenología? ¿Qué? ¿Por qué? Would you prefer a different sanitation technology? Like what? Why?
a. ¿Un servicio con tanque séptico? Pour-flush latrine and septic system?
b. ¿Letrina abonera? Composting latrine
c. ¿Letrina con ventilacion? VIP latrine
10. ¿Tendrías interés en construyendo una letrina abonera? ¿En usando una letrina abonera? ¿Piensas que toda su familia tendría interés? ¿Por qué sí o no? Describe a compost latrine and ask if the respondent would be interested in constructing one? In using one? Would all members of the family be interested? Why or why not?

11. ¿Qué pensaría usted sobre su vecino si el/ella…? What would you think of your neighbor if…
a. ¿…construyo una letrina abonera?…He/she constructed a composting latrine?
b. ¿Usó excremento para sus plantas en su finca?…if they used composted human feces on their crops/garden?
12. ¿Qué dirían sus vecinos si usted…? What do you think your neighbors would say if you…
a. ¿Construyó una letrina abonera? constructed a compost latrine?
b. ¿Usó excremento para sus plantas en su finca? If you used composted human feces on your crops/garden?
13. ¿Qué dirían sus amigos y familia si usted…? What do you think your friends/family would say if you…
a. ¿Construyó una letrina abonera? if you constructed a compost latrine?
b. ¿Usó excremento para sus plantas en su finca? If you used composted human feces on your crops/garden?
14. ¿Hay algo mas que usted quiere decir sobre letrinas aboneras, saneamiento, o este invesitgación? Anything else you would like to say/add in regards to composting latrines, sanitation, or this research?

Phase 3. Survey Regarding Perceptions of Excreta and Composted Excreta Used as Fertilizer
Part 1: Socio-demographic Information
1. ¿Usa usted tu letrina? (Do you use your pit latrine?)
a. No latrine (no tiene letrina)
b. Sometimes uses (a veces)
c. Used it until it filled up and have not constructed a different one (la usó pero se llenó, y no han hecho una otra)
d. Used it in the past but have "upgraded" (la usó, pero ya tiene algo major)
3. ¿Cuándo recibió usted tu letrina? (When did you receive your latrine?)
4. Edad (Age)
5. Sexo (Sex)
6. Educación (Education)
7. Número de Personas Viviendo en la Casa (Household size)
8. Religión (Religious affiliation)
9. Estado civil (Marital status)
10. Ocupación principal (Primary occupation)
11. Periodo de estadía (Length of stay (5, 10, 15, 20, 30 years))]

Part 2: Agree, Disagree, or Don't Know Survey – wording in parentheses would be used to clarify potentially difficult words or concepts for the participants
1. Excremento humano es un desecho y solo debe ser desechado (no puede ser usado para otra cosa). (Human excrement is a waste and should be only for disposal (cannot be used for something else).)
2. El manejo de excremento humano es un gran riesgo a la salud (es malo para la salud). (Handling human excrement is a great health risk (bad for one's health).)
3. Excremento humano no debe ser manejado en ninguna manera (Human excrement should not be handled in any way.)
4. Excremento humano no da ningun beneficio (algo bueno) a humanos (Human excrement

has no benefit (something good) to humans.)
5. Está bien tocar el excremento con la mano. (It is OK to touch excrement with your hands.)
6. Está bien tocar el excremento convertido en abono. (It is OK to touch composted excrement.)
7. Excremento humano es un recurso para (da algo bueno a) la tierra (Human excrement is a resource for (gives something good to) the soil.)
8. Excremento humano de una letrina abonera puede ser usado como abono (Human excrement from a composting latrine can be used as fertilizer)
9. Yo usaría excremento humano convertido en abono en mis cultivos. (I would use composted human excrement on my crops.)
10. El sabor de vegetales va a cambiar cuando se use excremento humano convertido en abono (Taste of vegetables will change when composted human excrement is used.)
11. El olor de vegetales va a cambiar cuando se use excremento humano convertido en abono (Smell of vegetables will change when composted human feces is used.)
12. Los cultivos pueden morir cuando se use excremento humano convertido en abono (Crops can be killed when fertilized with composted human excrement.)
13. Los cultivos usando excremento humano convertido en abono están bien para consumir (Crops fertilized with human excrement are good for consumption.)
14. Yo nunca voy a consumir cultivos que usaron excremento humano convertido en abono (I will never consume crops that used composted human excrement.)
15. El estiércol de animales puede ser usado como abono (Animal manure can be used as fertilizer.)
16. Yo he usado estiércol de animales como abono en el pasado (Ever used animal manure as fertilizer)

APPENDIX D: BAR CHARTS WHICH CORRESPOND TO STATISTICALLY RELEVANT RESULTS

These bar charts present the response rates to the survey statements presented in Table 5, which are also shown in the charts. These charts were chosen because of their statistical relevance shown in table 14 using Fisher's exact test, and the later graphs were for relevant logistic regression results.

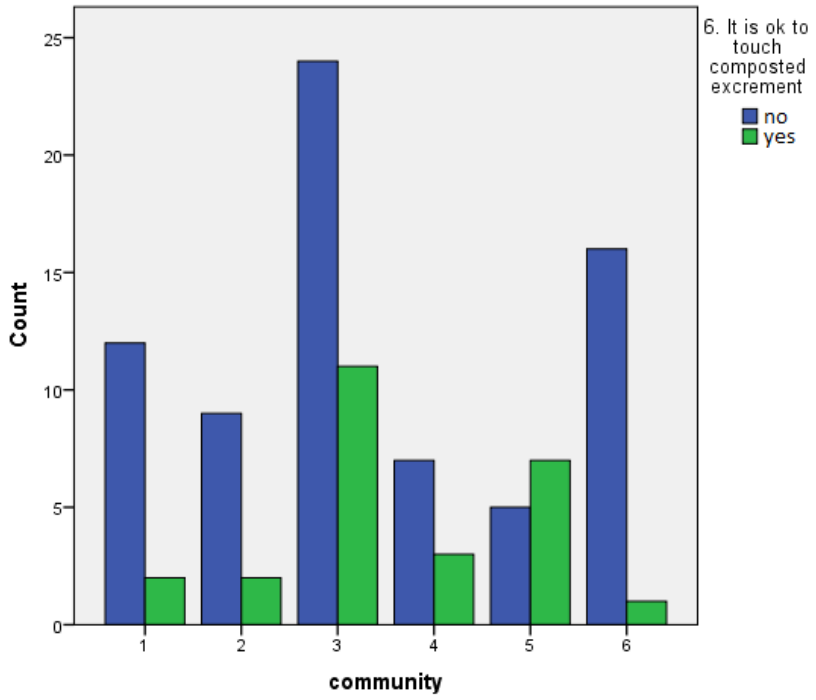

Figure D1 Graph of Results of Survey Statement 6 vs Community

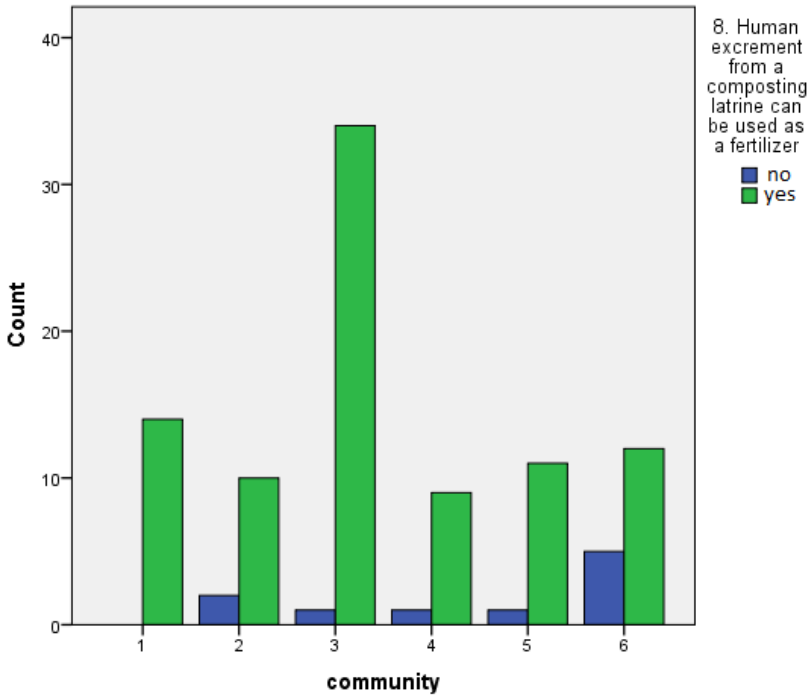

Figure D2 Graph of Results of Survey Statement 8 vs Community

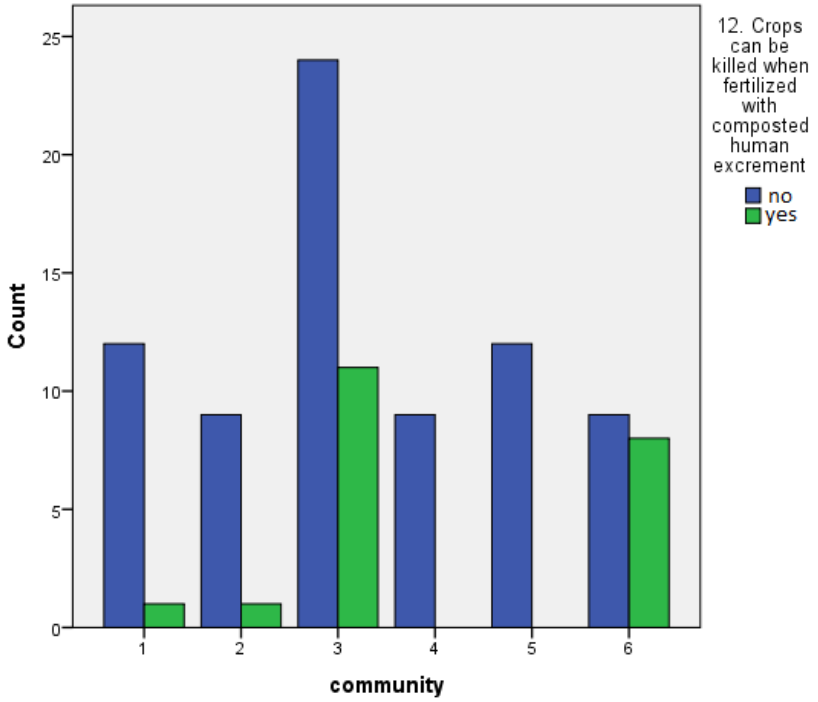

Figure D3 Graph of Results of Survey Statement 12 vs Community

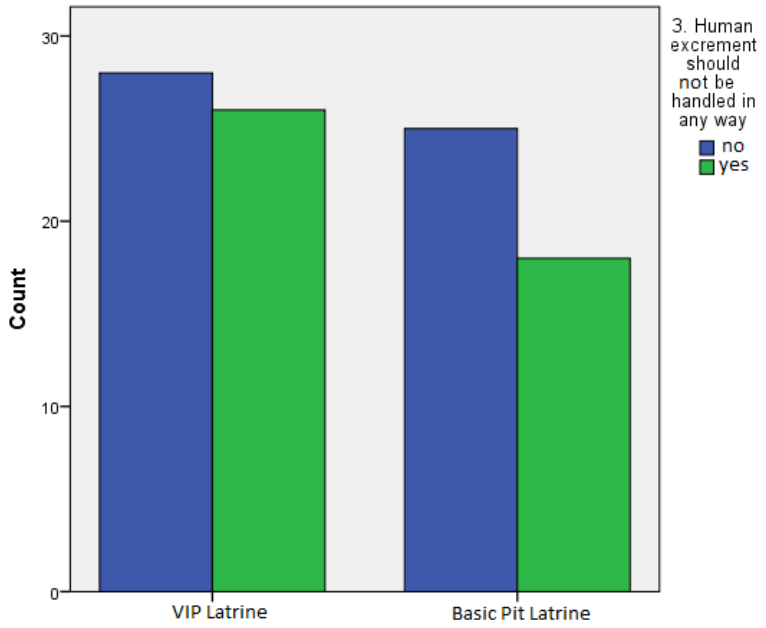

Figure D4 Graph of Results of Survey Statement 3 vs Sanitation Classification

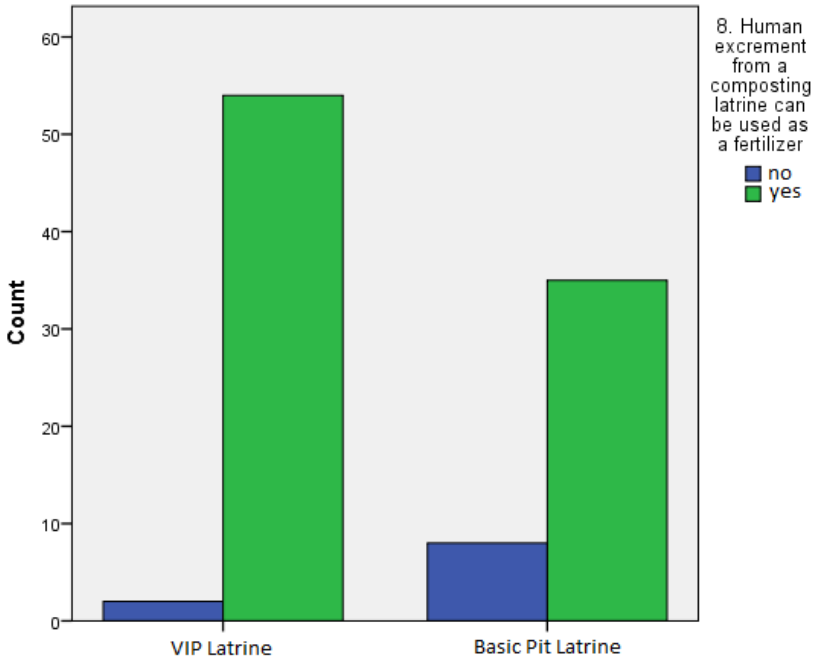

Figure D5 Graph of Results of Survey Statement 8 vs Sanitation Classification

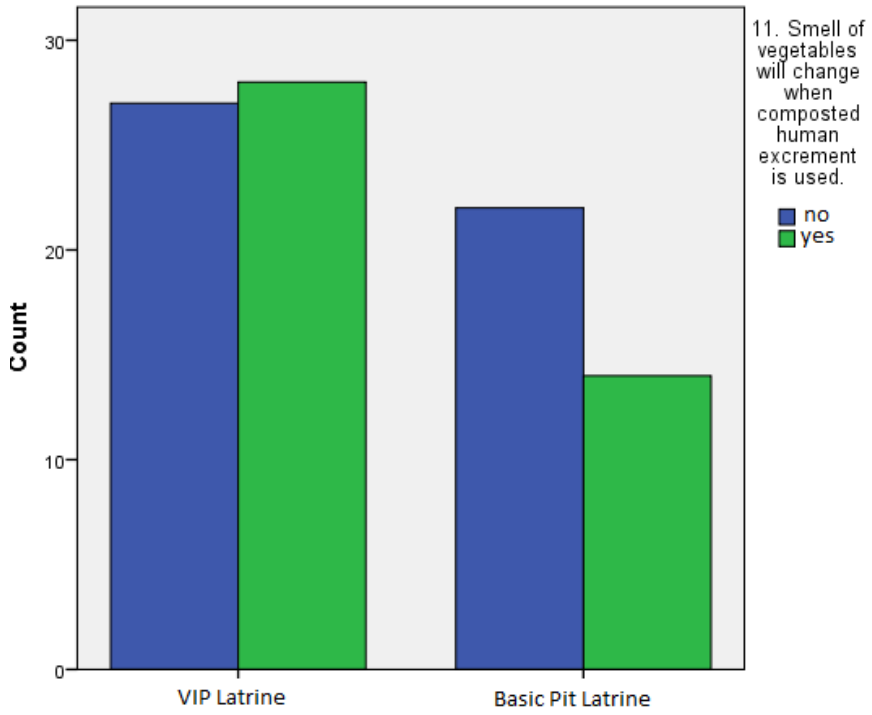

Figure D6 Graph of Results of Survey Statement 11 vs Sanitation Classification

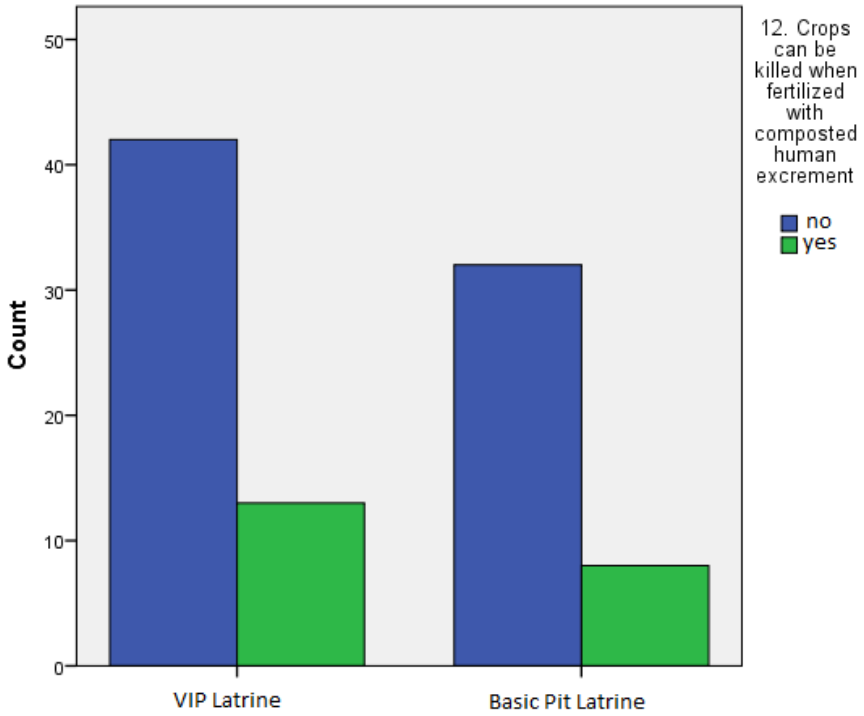

Figure D7 Graph of Results of Survey Statement 12 vs Sanitation Classification

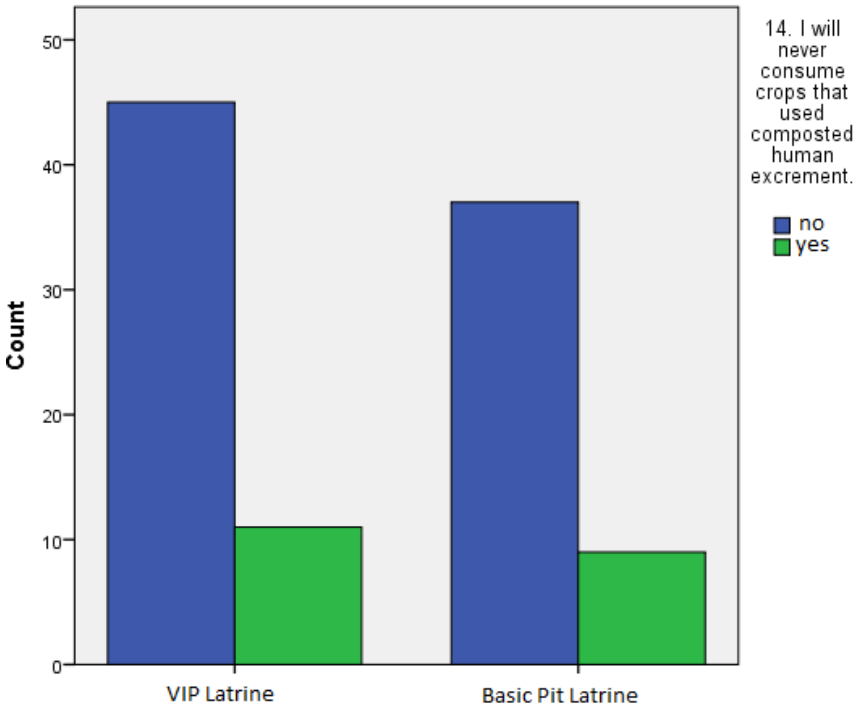

Figure D8 Graph of Results of Survey Statement 14 vs Sanitation Classification

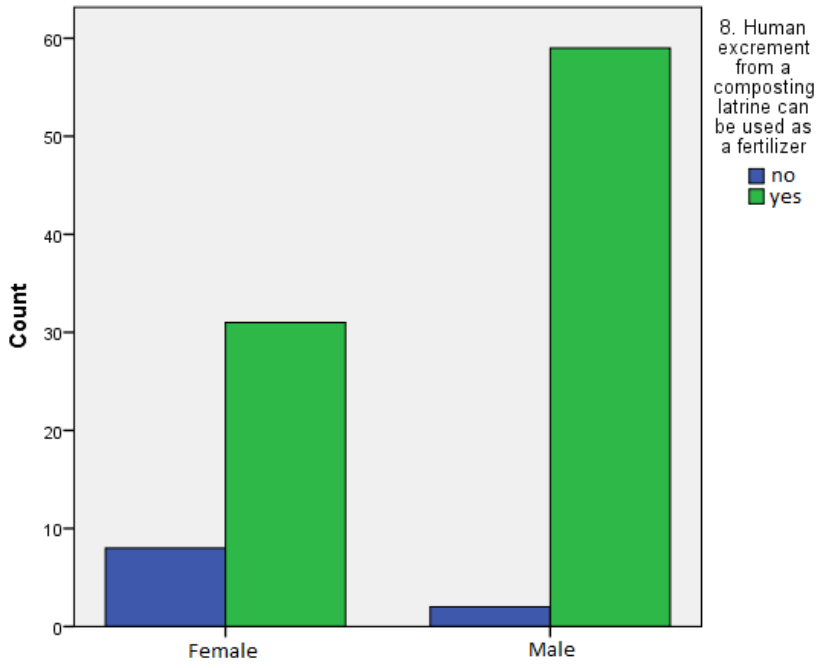

Figure D9 Graph of Results of Survey Statement 8 vs Gender

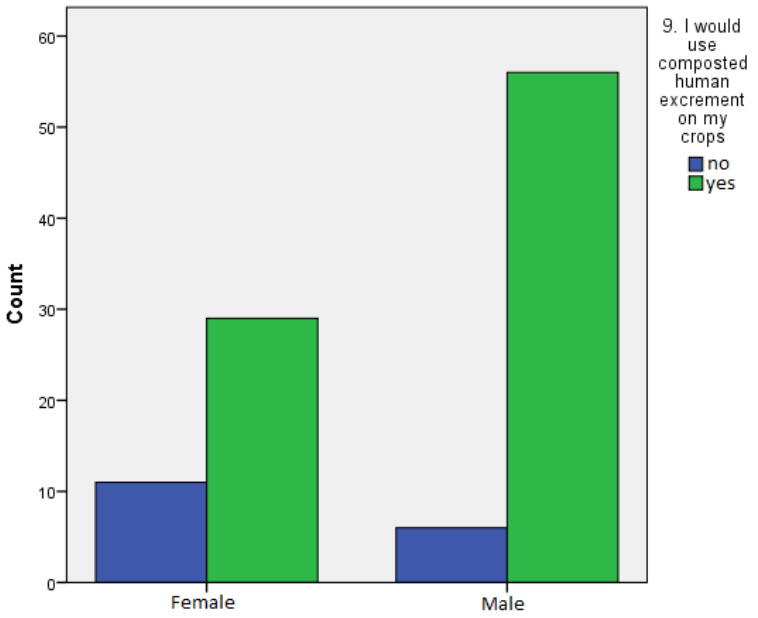

Figure D10 Graph of Results of Survey Statement 9 vs Gender

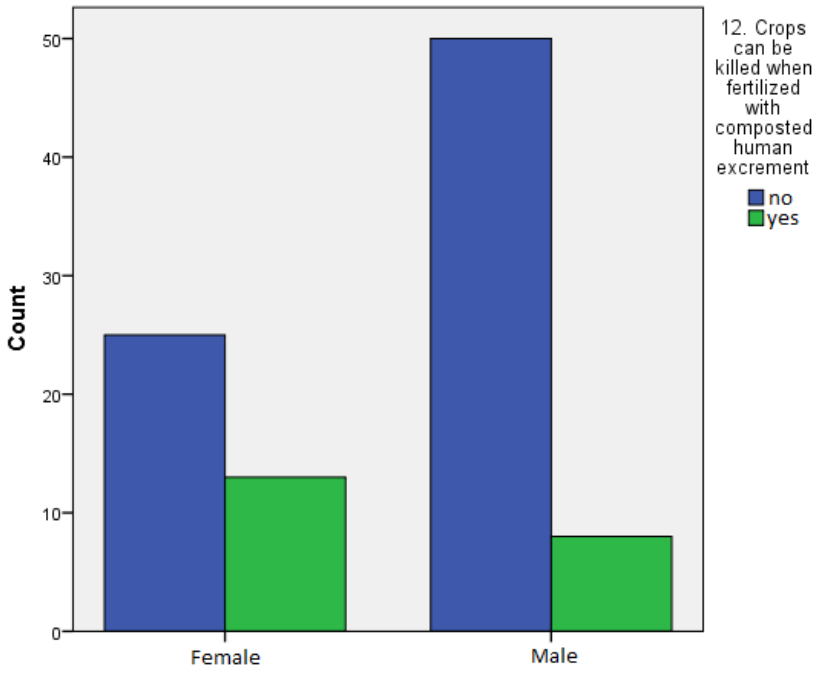

Figure D11 Graph of Results of Survey Statement 12 vs Gender

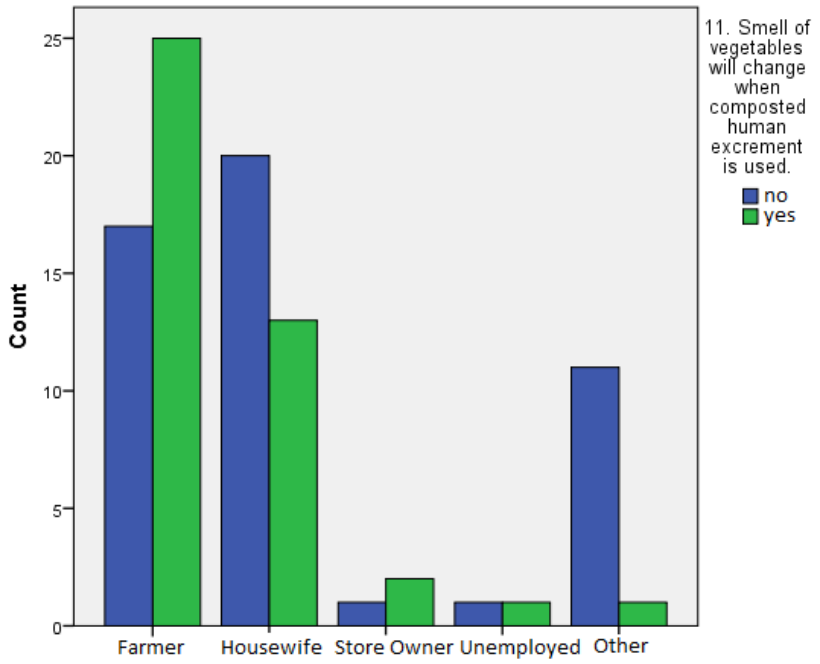

Figure D12 Graph of Results of Survey Statement 11 vs Primary Occupation

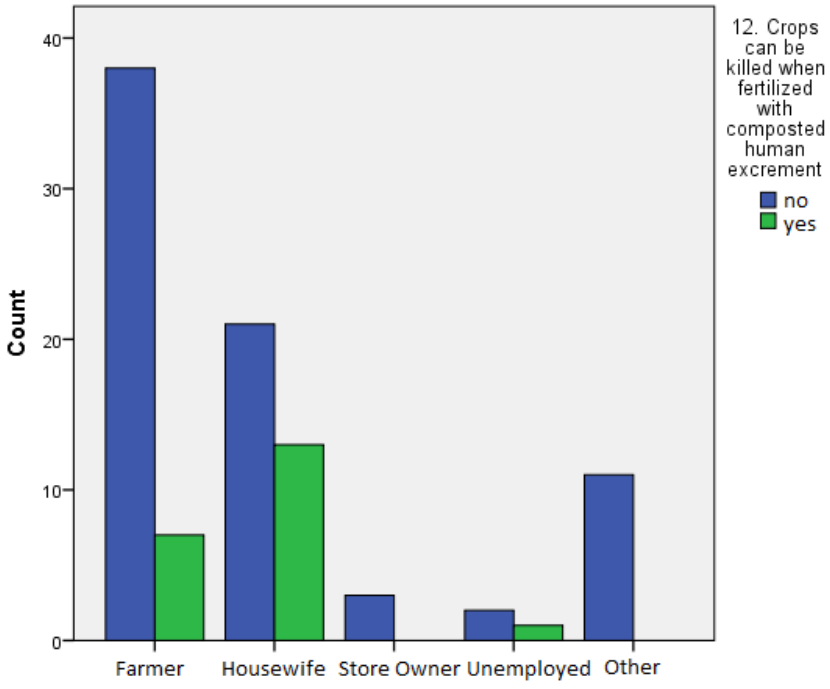

Figure D13 Graph of Results of Survey Statement 12 vs Primary Occupation

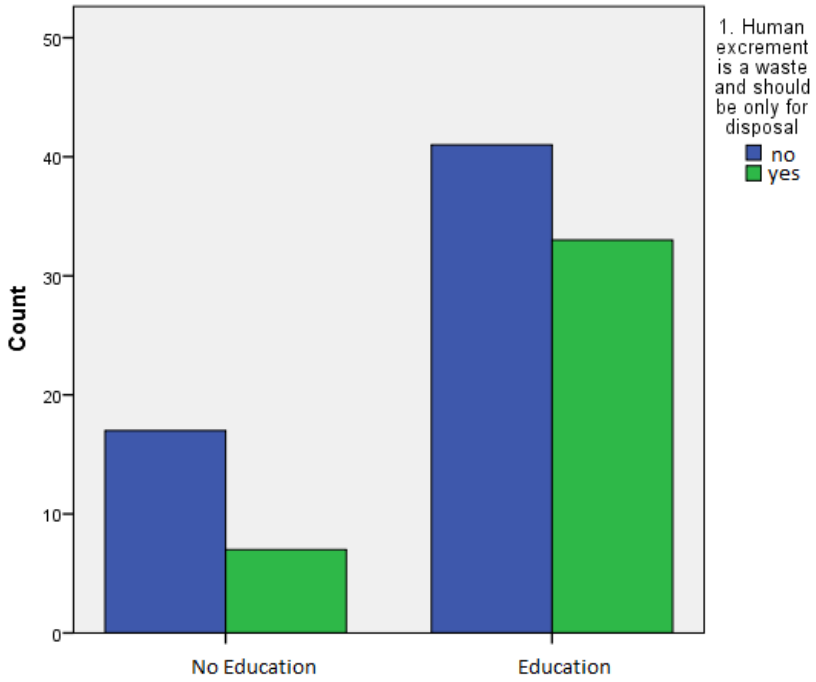

Figure D14 Graph of Results of Survey Statement 1 vs Education/No Education

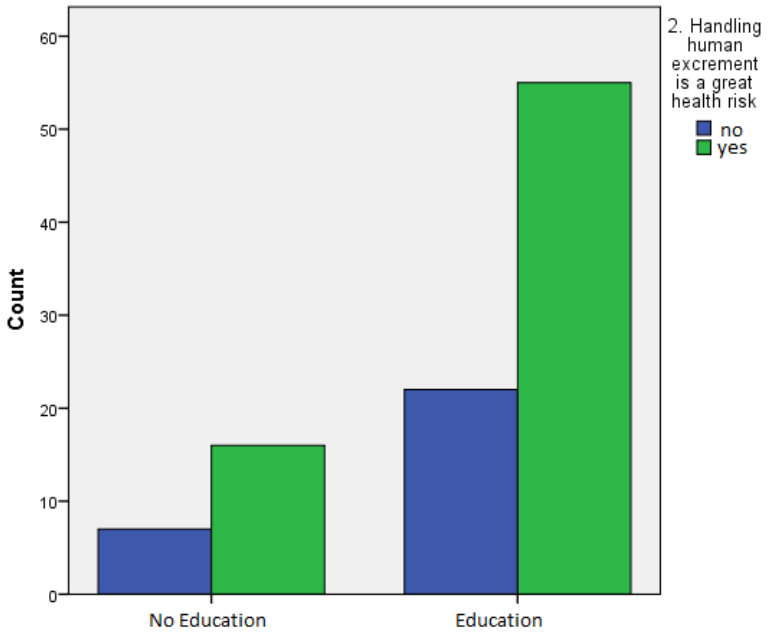

Figure D15 Graph of Results of Survey Statement 2 vs Education/No Education

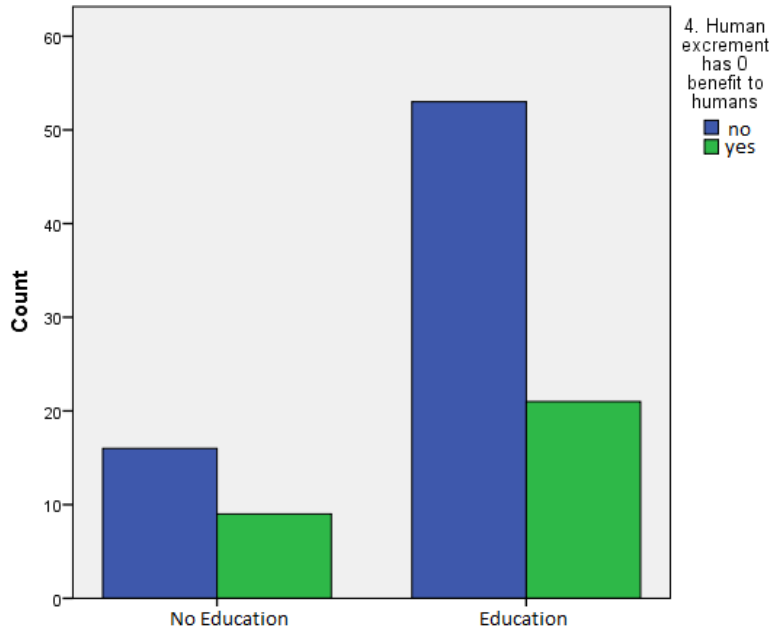

Figure D16 Graph of Results of Survey Statement 4 vs Education/No Education

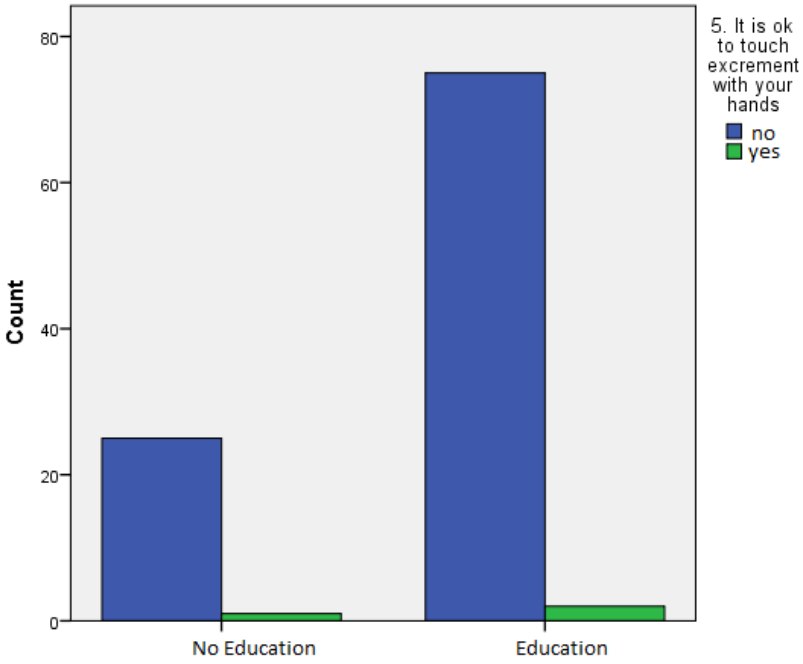

Figure D17 Graph of Results of Survey Statement 5 vs Education/No Education

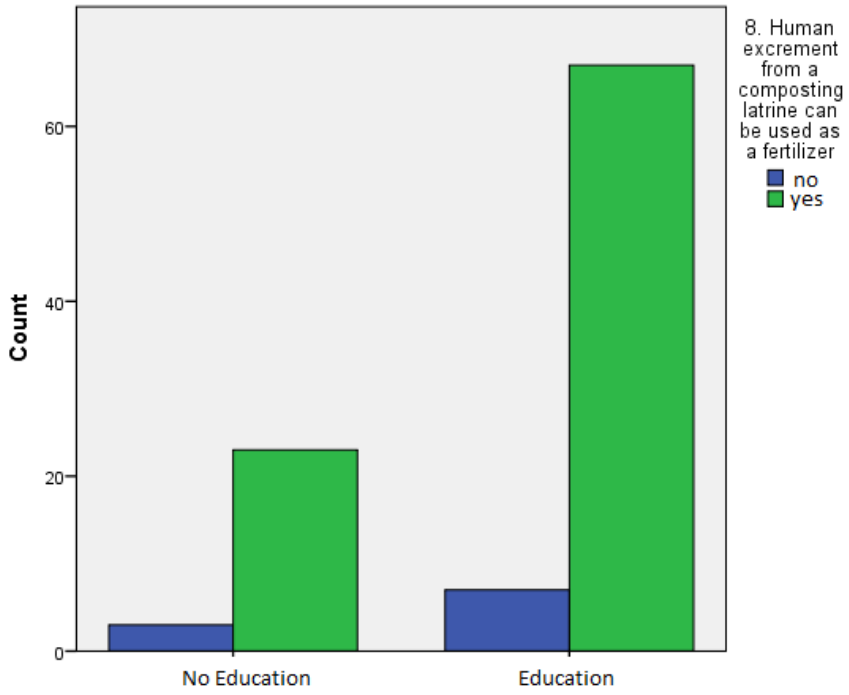

Figure D18 Graph of Results of Survey Statement 8 vs Education/No Education

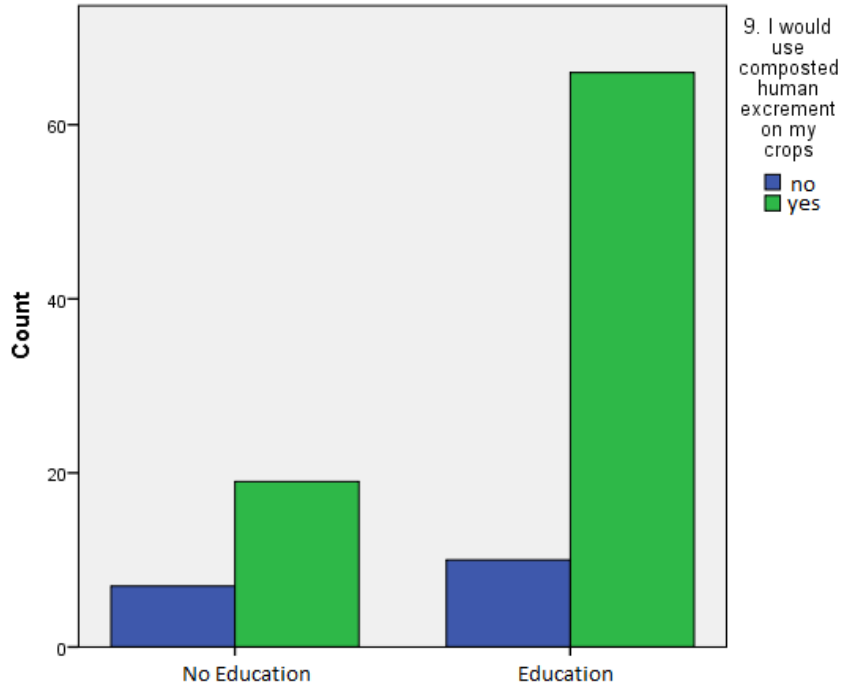

Figure D19 Graph of Results of Survey Statement 9 vs Education/No Education

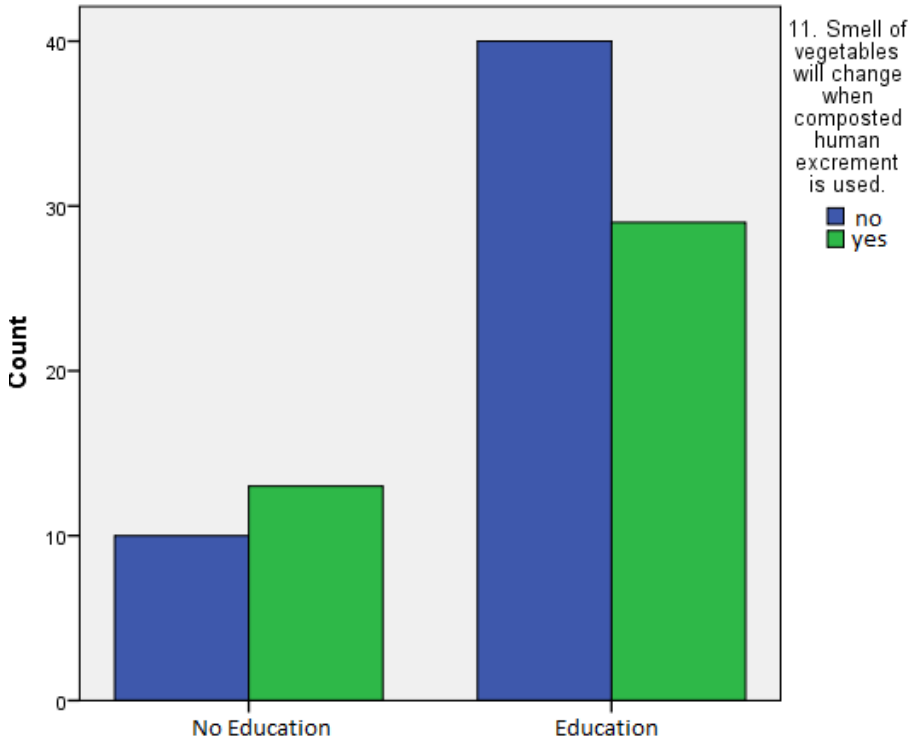

Figure D20 Graph of Results of Survey Statement 11 vs Education/No Education

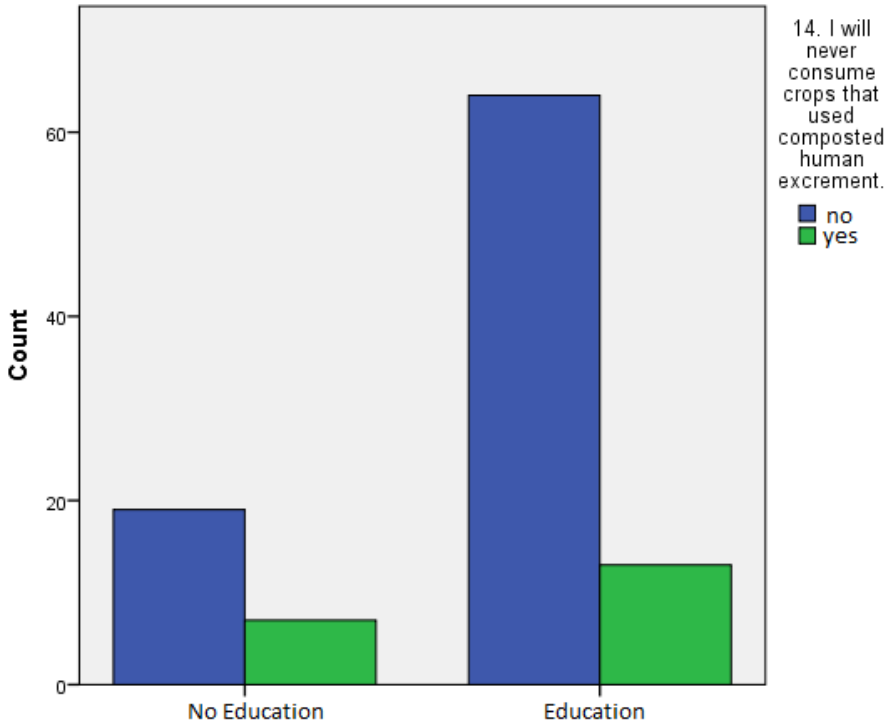

Figure D21 Graph of Results of Survey Statement 14 vs Education/No Education

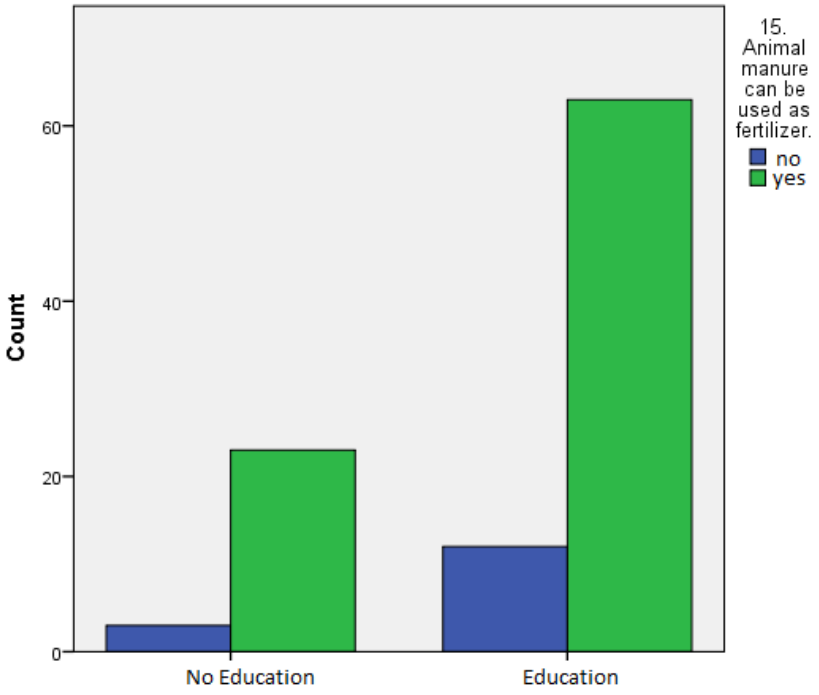

Figure D22 Graph of Results of Survey Statement 15 vs Education/No Education

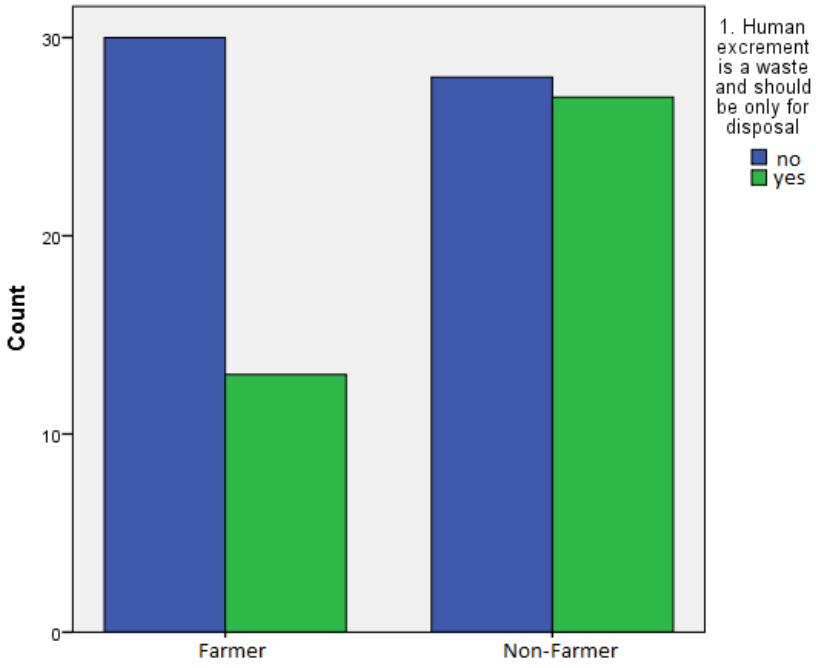

Figure D23 Graph of Results of Survey Statement 1 vs Farmer/Non-Farmer

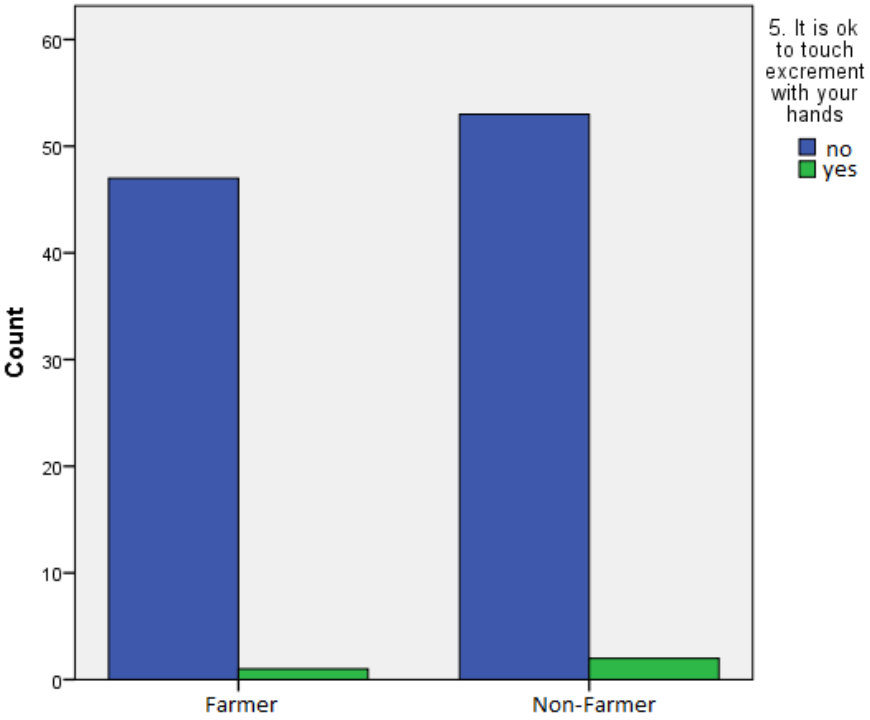

Figure D24 Graph of Results of Survey Statement 5 vs Farmer/Non-Farmer

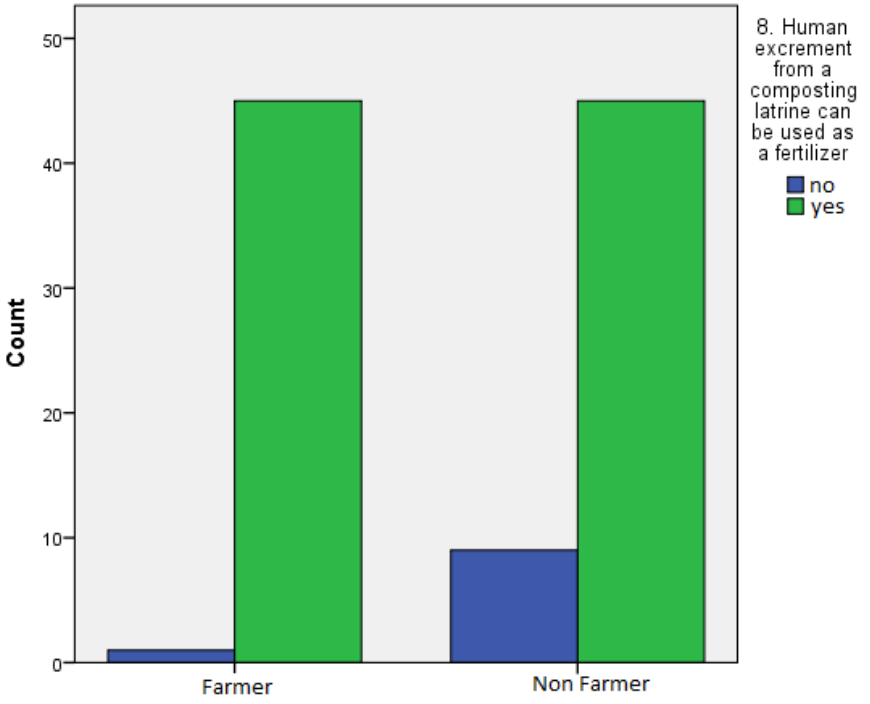

Figure D25 Graph of Results of Survey Statement 8 vs Farmer/Non-Farmer

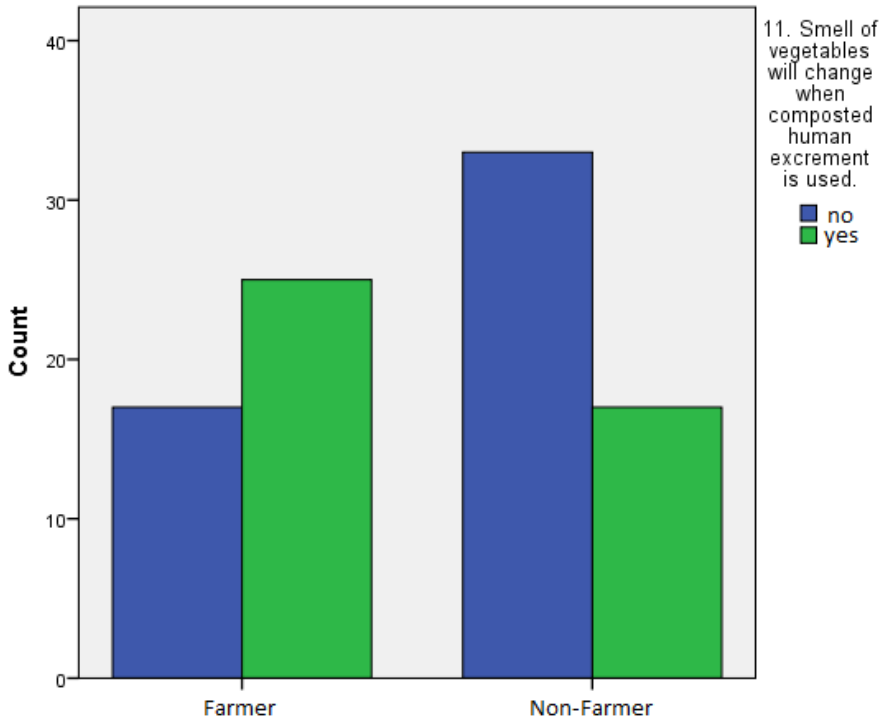

Figure D26 Graph of Results of Survey Statement 11 vs Farmer/Non-Farmer

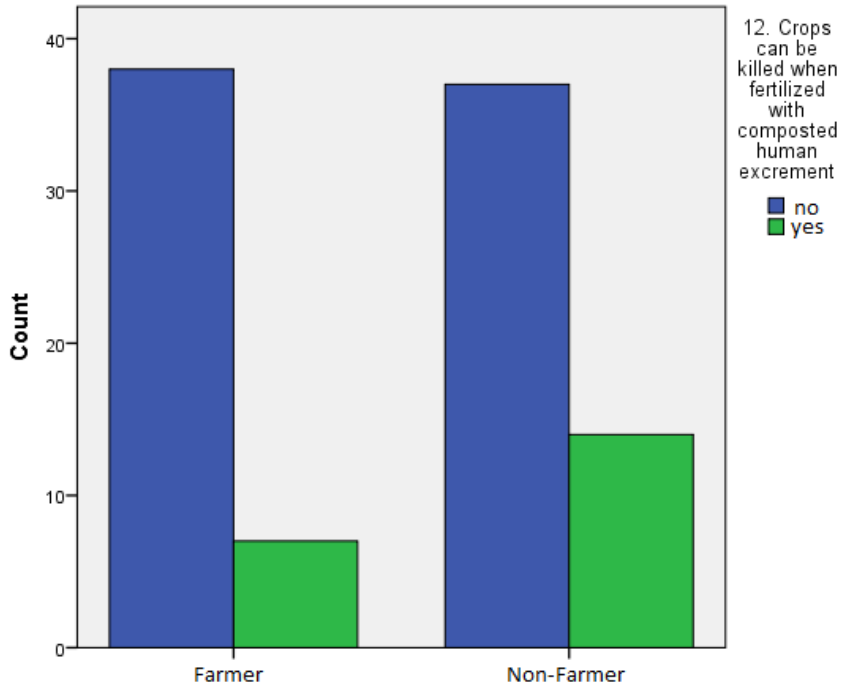

Figure D27 Graph of Results of Survey Statement 12 vs Farmer/Non-Farmer

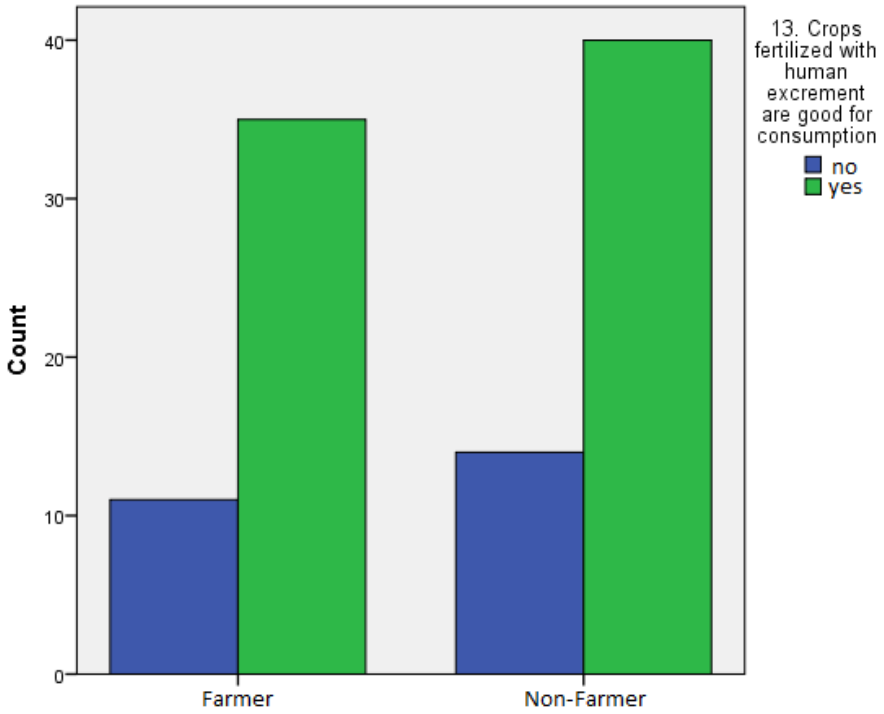

Figure D28 Graph of Results of Survey Statement 13 vs Farmer/Non-Farmer

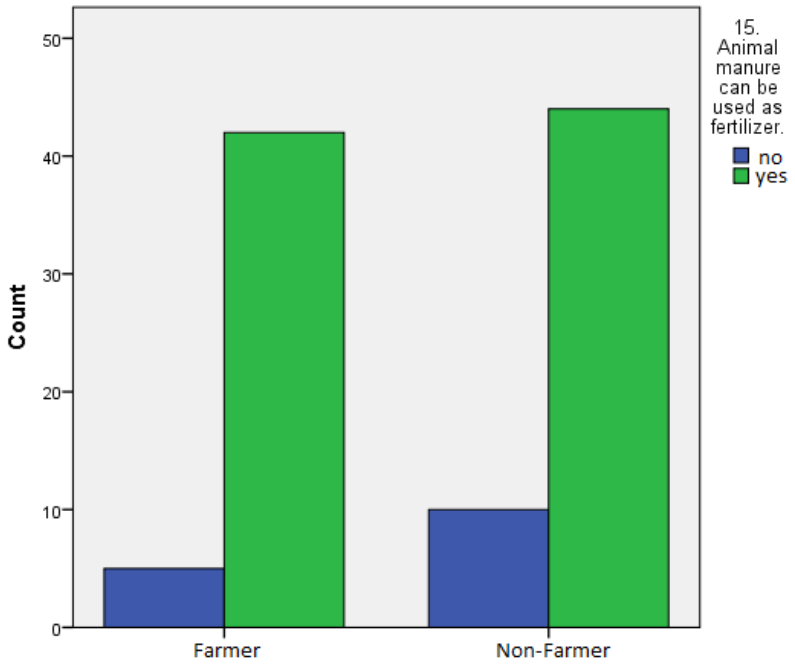

Figure D29 Graph of Results of Survey Statement 15 vs Farmer/Non-Farmer