INDIVIDUAL'S PERCEPTION AND THE POTENTIAL OF URINE AS A FERTILISER IN ETHEKWINI, SOUTH AFRICA

By

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As the candidate's supervisor I have/have not approved this thesis/dissertation for submission.

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ABSTRACT

Climate change, environmental degradation and unsustainable consumption of resources are increasingly putting a strain on the Earth's natural wealth. More sustainable sanitation behaviour such as maximising the use of urine diversion dry toilets (UDDT) can help alleviate the strain on water resources. Urine could be used as a fertiliser as it contains nitrogen and phosphorus, important components required for the soil. Furthermore, with urine as a fertiliser, it would now be free, accessible to all and decrease the need to mine phosphate.

This research explores the perceptions and knowledge of farmers in the eThekwini municipality about urine and its use in agriculture. It seeks to understand if this practice is socially acceptable in order to contribute to the debate of food security. To investigate the attitudes towards urine, 12 interviews were conducted with farmers who consult with the Umbumbulu Agri-Hub and at the Newlands Mashu Permaculture Learning Centre (NMPLC). These interviews were done in order to find out their views of urine and its possibility on integrating ecological sanitation, more specifically urine reuse in their programmes.

According to Ajzen's (1991) theory of planned behaviour as a framework the findings suggest that: individuals' and others self-perception and non-motivational factors such as smell and lack of training remain barriers to usage as well as lack of knowledge about its potential for fertilising capabilities. In Zulu culture urine is utilised in various ways and is deemed acceptable for medicinal and spiritual purposes. Nonetheless, there seems to be a negative perception of urine amongst most respondents. However, many farmers expressed curiosity towards the use of urine in agriculture if not for themselves then for future generations. This would allow an important role for organisations such as the Agri-Hub and NMPLC to aid in disseminating the knowledge concerning urine reuse in agriculture.

DECLARATION - PLAGIARISM

I, Natalie Benoit declare that

1. The research reported in this thesis, except where otherwise indicated, is my original research under the supervision of Professor Dianne Scott.

2. This thesis has not been submitted for any degree or examination at any other university.

3. This thesis does not contain other persons' data, pictures, graphs or other information, unless specifically acknowledged as being sourced from other persons.

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    a) Their words have been re-written but the general information attributed to them has been referenced
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5. This thesis does not contain text, graphics or tables copied and pasted from the Internet, unless specifically acknowledged, and the source being detailed in the thesis and in the References sections.

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ACRONYMNS AND ABBREVIATIONS

AIDS	Acquired Immunodeficiency Syndrome
CBD	Central Business District
EcoSan	Ecological Sanitation
EWS	eThekwini Water and Sanitation
FAO	Food and Agriculture Organization
HIV	Human Immunodeficiency Virus
IMS	Infrastructure Management & Socioeconomic
KZN	KwaZulu-Natal
LDC	Less Developed Country
MDC	More Developed Country
NGO	Non-Governmental Organisation
NMPLC	Newlands Mashu Permaculture Learning Centre
NPK	Nitrogen, Potassium, Phosphorus
TB	Tuberculosis
TPB	Theory of Planned Behaviour
UDDT	Urine Diversion Dry Toilets
WHO	World Health Organisation

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CHAPTER I: BACKGROUND OF ECOLOGICAL SANITATION

> *What is done with this golden manure? It is swept into the abyss. Fleets of vessels are despatched, at great expense, to collect the dung of petrels and penguins at the South Pole, and the incalculable element of opulence which we have on hand, we send to sea. All the human and animal manure which the world wastes, restored to the land instead of being cast into the water, would suffice to nourish the world (Les Misérables by Victor Hugo, 1862).*

1.1. Introduction: Closing the Loop on Sanitation

Sanitation remains a pressing issue across the world. It is estimated that in 2010, 2.5 billion individuals did not have access to improved sanitation (JMP, 2012). In 2004 South Africa, it was reported that approximately 18 million people, mostly living in rural areas, did not have adequate sanitation (Republic of South Africa, 2004). Unimproved sanitation often means open defecation. The number of which has increased in absolute numbers in Sub-Saharan Africa by 33 million since 1990 (JMP, 2012). The lack of sanitation may result in contamination of water bodies which would then negatively affect the environment and the health of surrounding communities. Considering the earth's finite resources, the concept of 'adequate sanitation' may have to be redefined in order to utilise resources sustainably. It would not be environmentally sustainable to provide flush toilets to all 18 million South Africans. Many areas in South Africa, which have non-renewable groundwater reserves, are already experiencing seasonal water shortages (FAO, 2003). This study aims to understand the perceptions people have of urine as a potential resource for use in agriculture. In the long run, using potable water to flush human waste will become unsustainable even in water rich countries such as Canada, Gabon, Guyana, New Zealand and Norway (FAO, 2003). It is important that alternative technologies be developed and mainstreamed in order to decrease water consumption.

There are some sanitation systems that have been created to suit different physical environments, gender differences and cultural preferences. Many sanitation systems have been developed for households who have yet to have access to perceived modern or dignified sanitation. Less Developed Countries (LDC) have been a prime site of research and development in ecological sanitation (EcoSan) systems (Esrey et al., 2001; Morgan, 2004).

EcoSan systems have a number of advantages. Firstly, EcoSan adopts an ecosystem approach where urine and faeces are seen as resources rather than as waste to be disposed of.

Both urine and faeces contain nutrients which can be recycled to improve the fertility of the soil which can result in an increase in crop production and food security. Secondly, the concept of EcoSan entails a decentralised approach which allows households to have control over their own resource. They can use sanitised (free of pathogens) urine and faeces if they wish to do so, whereas if they are using a flush system, this system does not offer the choice to retain nutrients. Moreover, sanitation systems which require water for flushing have adverse effects on water bodies such as pollution and the over-consumption of a finite resource, namely, potable water. Lastly, EcoSan systems are hygienic when used properly. They are often less costly than conventional flush toilets and the related wastewater treatment required (Esrey et al., 2001; Mihelcic et al., 2011).

The concept of a 'closed-loop' system relates to the idea to EcoSan. However, this concept goes beyond an alternative sanitation system. 'Closing the loop' in a sanitation system seeks to have zero discharge, where water bodies are kept nutrient and pathogen free and limit the consumption of water for sanitation purposes (Esrey et al., 2001).

Alternative sanitation technologies can have multiple benefits: not only they decrease water consumption, but also they allow the transformation of waste into fertiliser (Esrey et al., 2001). However, as with any innovation, people are not always very receptive to new ideas (Rogers, 2010). It is important to explore people's perceptions in order to understand their reactions to new concepts and technologies if a concept such as EcoSan is to be mainstreamed. The literature shows that there are some uses of urine that are acceptable, such as for medicinal, Cultural and aesthetic purposes whereas with urine in agriculture it is reported that there is a feeling of disgust (Rozin & Fallon, 1987). Knowledge can influence and encourage change. If people who have positive perceptions of urine and are willing to make use of it in agriculture on a grand scale it could potentially alleviate concerns about sanitation, water, the environment and agriculture.

The aim of this research is to understand the perceptions and knowledge held of key stakeholders (local government, private sector organisation and farmers) in relation to the use of fertiliser in the form of urine for agriculture. The objectives are:

1) To explore farmers' general and cultural perceptions of urine and its potential use for fertilising crops.

2) To explore farmers' knowledge and understanding of urine as a fertiliser and its potential impact on their crops.

3) To understand the key informants' (those who transmit agricultural knowledge to the farmers) perceptions and knowledge of urine, in general, and as a fertiliser.

4) To assess the possibility of incorporating the method of using urine as a fertiliser into the one of the methods of fertilising in the training programmes and among farmers.

This study is guided by the constructivist paradigm. The constructivist paradigm is based in transactional knowledge, where understanding and meaning is acquired by experience and social interaction. It does not acknowledge one truth but recognises that all truths are partial and incomplete. Then it is important to explore the multiple truths that may exist to better understand the general reality that is constructed (Lincoln et al., 2011). This study focuses on the eThekwini municipality to understand how in the two case studies selected realities' are locally constructed in relation to urine reuse. In this way it seeks to determine the social acceptability of this practice. As such, the knowledge produced here will contribute to the debate on food security, and also open up the possibility of incorporating skills related to urine reuse in agriculture into gardening training programmes.

1.2. How UDDT have been Integrated in the Context of the eThekwini Municipality[1]

There exists an overarching national water and sanitation plan in South Africa (Republic of South Africa, 2004). The National Sanitation Strategy incorporated many principles into the White Paper on Sanitation, such as community participation, financial sustainability of sanitation services. Moreover, sanitation is acknowledged as a human right which concerns human and environmental health (Republic of South Africa, 2004).

In 2002, the eThekwini municipality had a backlog of 175000 households with poor or no sanitation (Roma et al., 2011). The urine diversion dehydration toilet (UDDT) was chosen as the sanitation system for those without an improved sanitation system. The reasoning was that households would be able to maintain their sanitation system with little or no municipal intervention required after installation (Gounden et al., 2006). The installation of UDDT had as a primary goal to prevent water borne diseases, following the cholera outbreak in August

[1] eThekwini is located by the Indian ocean in the province of KwaZulu-Natal, South Africa. Its population is approximately three million inhabitants.

2000, where over 4000 cases were recorded and 22 individuals died (Erasmus, 2001). This event added pressure on the municipal government to provide improved sanitation for its residents and as a means to decrease the likelihood of cholera (Erasmus, 2001; Roma et al., 2011). A project started in 2003 by the eThekwini Water and Sanitation (EWS) aimed to provide UDDTs, 200 litres tanks for water storage, education and training for each household where a UDDT had been installed. The municipality has set up over 75000 UDDT across eThekwini, mostly in peri-urban and rural areas (Roma et al., 2011). There are multiple benefits to the efficient use of this type of sanitation system. Though there is no direct use of urine as fertiliser at this time, the benefit of the UDDT system is the separation of faeces and urine which allows for faeces to dry faster than in a ventilated improved pit (VIP) latrine, and results fewer odours. UDDT are built closer to homes as they smell less than VIP latrines. The UDDT is a decentralised option and is less costly. It is more practical than a VIP toilet as it is easier to empty and the waste is easier to manage (Roma et al., 2011). The aim to provide free basic sanitation has been well intentioned. However, the UDDT acceptance on behalf of the households has been mixed (Duncker, 2006).

1.3. Guidelines to Urine Reuse for Agricultural Application

To recycle human waste is a concept that has been explored for some time. Human waste has been unintentionally and purposely incorporated into the earth for millennia. However, separating urine and faeces at the source is a new idea (Drangert, 1998; Esrey et al., 2001). The separation helps to manipulate the resource more easily. Urine compared to faeces contains 80 percent of the nutrients and has much less pathogens. Urine contains nitrogen (N), phosphorus (P) and potassium (K) which are the same elements that are found in many fertilisers (i.e. NPK fertiliser) (Karak & Bhattacharyya, 2011). Nitrogen is usually more dominant than potassium and phosphorus at a NPK ratio of 11:1:2 (Morgan, 2004; Karak & Bhattacharyya, 2011). Thus, urine can be used as a fertiliser and to improve the quality of compost (WHO, 2006). Each of these elements benefits plant growth in different ways. Nitrogen helps in promoting leaf growth, becoming fleshier, larger and greener. Phosphorus helps to germinate seeds and ripen fruit. Finally, potassium is good for the flowering and fruit development (Morgan, 2004). Yearly, a person can produce between 30 to 70kg of nitrogen which is sufficient to support over 300m^2 of crops.

Urine in the bladder is sterile, yet as it passes through the urinary tract it collects pathogens. The possibility of pathogens in urine increases if cross-contamination occurs with faeces (Hoko et al., 2010). However, most pathogens will die off after storage. Ideally above 20 degrees centigrade for at least one month, in a sealed container to accelerate the killing of the bacteria due to the ammonia and high pH levels (WHO, 2006; EcoSanRes, 2008b). The potential spread of disease is low, though the risks are higher in crops that are eaten raw, root crops and those grown close to the surface. Urine must be utilised with caution like any other fertiliser. It should not be overused to preserve the soil's productivity and its ecosystem (Zimbelmann & Lehn, 2006). The practical application of urine in agriculture would involve diluting the urine in water. The ratio depends on the nutrient requirements of the plant and the soil (Jönsson et al., 2004; WHO, 2006). An added benefit of dilution is to decrease the smell of the urine during application (Jönsson et al., 2004). Ideally the urine would be applied before sowing or directly in the soil during early plant growth to minimise ammonia loss (WHO, 2006; EcoSanRes, 2008b). For the purpose of this research urine, compost, manure and such will be referred to as a fertiliser. Even though the respondents themselves do not use the word 'fertiliser' as it is associated with chemicals. As with any inputs or chemicals utilised in agriculture, the use of protective gear and hygienic practices such as cleaning of hands after application is highly recommended for hygienic and sanitary purposes (EcoSanRes, 2008b).

1.4. How Urine would Influence Phosphorus & Water consumption

Phosphorus (P) is an essential nutrient to sustain life. It is found in all living organisms, plant and animal (EcoSanRes, 2008b; Rosemarin et al., 2009; Cordell, 2010). Urine contains P, which adds to the fertilising capabilities of urine. Naturally, P is integrated into the soil through weathering and flooding. The sediments are deposited in the lowlands when rivers flood (Vaccari, 2009). However, these natural processes have been hindered by the construction of dams, which have prevented floods from occurring (Vaccari, 2009). Purposefully, adding P to the soil has been occurring for centuries as demand for food crops exceeds the soil's production capabilities. Historically, sources of P have come from human waste, ash, leftovers from slaughter houses and bones (Cordell et al., 2009). Guano, avian excrement, was sourced from the coast of Peru and the South Pacific until the late XIXth century as a source of P until it became scarcer (Childers et al., 2011).

Phosphate rock, from which phosphorus is derived, is a non-renewable resource. It is estimated that 'peak phosphorus' will be reached by 2030, when its demand will exceed its supply (Rosemarin et al., 2009). Others estimate that the reserves will last from 50 to 130 years (EcoSanRes, 2008a; Cordell et al., 2009; Von Münch & Dahm, 2009). The production of biofuels, increasing population; urbanisation and increasing meat consumption are accelerating the consumption of phosphorus (Mihelcic et al., 2011; Rosemarin et al., 2009). From 2007 to 2008, phosphate prices increased up to 700 percent. This affected access to fertiliser especially for poor farmers, which amplified inequalities. This resulted in devastating impacts on food production, consumption and food security (Rosemarin et al., 2009; Childers et al., 2011; Elser & Bennett, 2011). The cost of fertilisers was already too high for most farmers. Sub-Saharan African farmers pay two to six times more than European farmers due to transport and storage costs (Cordell et al., 2009; Childers et al., 2011). Not only is the cost of phosphate increasing but also the environmental impacts of mining it is degrading the environment through leaching and the generation of radioactive by-products (EcoSanRes, 2008a). In the future, the increasing price and value of phosphate may entice governments and companies to mine areas which have been previously protected environments. The exploitation would result in a great ecological loss (Vaccari, 2009; Childers et al., 2011). There needs to be precautions taken as 'peak phosphorus' is approaching. The exploitation of the Earth's resources may continue at an accelerated rate with little or no consideration for the future well-being of ecosystems and humanity.

Yearly the amount of phosphorus produced by human beings is about three million tonnes which represents one fifth of what is mined annually (Dagerskog & Bonzi, 2010; Elser & Bennett, 2011). There are various estimates on the amount of human waste being recycled back into the earth (Childers et al., 2011). For example, in Burkina Faso it is estimated that the entire population excretes 125 million US dollars worth of fertiliser on a yearly basis (Dagerskog & Bonzi, 2010). If EcoSan was practiced globally it could have multiple benefits. It would alleviate the degradation of water sources, increase food security and production, decrease the amount spent on fertiliser and keep phosphate reserves from being mined and depleted. Natural fertilisers should be encouraged over chemical fertilisers to decrease the environmental degradation of natural resources.

Phosphorus and water quality are linked, whereby much of the surplus P finds itself in waterways. A significant amount of the P that is used in agriculture is not fully utilised. The

amount of fertiliser applied to one hectare of land varies from 3 to 25kg and only 30 percent of it is absorbed (Childers et al., 2011). The rest is runoff which causes eutrophication, blocking the oxygen and killing the living organisms below, deteriorating water quality (EcoSanRes, 2008a; Vaccari, 2009; Childers et al., 2011). The use of conventional flush systems uses a significant amount of water and contaminates important water resources as well. Many households in LDC do not have the luxury of following the same growth path that the more developed countries (MDC) have followed with conventional flush toilets that consume up to 12 litres per flush (Bond & Dugard, 2010). It is estimated that annually one person who uses a flush system will use 15000 litres of potable water to dispose of 35 kg of faeces and 500 litres of urine (Esrey et al., 2001). Not only is potable water scarce but issues such as efficiently distributing water to households and the cost of maintaining sewage treatment facilities, also make a decentralised approach a suitable option logistically and environmentally (Zimbelmann & Lehn, 2006). The planet will not be able to sustain billions of flushing toilets. In LDC and MDC alike all individuals need to modify their behaviour.

1.5. Structure of the Thesis

This thesis is composed of six chapters. The first chapter outlines the general idea of ecological sanitation and how it can affect agricultural practices in developing countries. It further discusses the UDDT, an alternative sanitation system and how it is linked with nutrient reuse. Finally, it examines the potential of ecological sanitation in alleviating the overconsumption of natural resources such as phosphate and water.

Chapter II reviews some of the significant literature on dry sanitation and the reuse of human waste, providing an overview of the historical and actual uses of urine. Furthermore, it reports on the integration and reception of UDDT in South Africa and in eThekwini more specifically. A short focus on Durban's sanitation and waste management strategy is provided. Moreover, case studies are described to illustrate the range of perceptions in relation to EcoSan and urine reuse. Lastly, the theoretical framework based on Ajzen's theory of planned behaviour (TPB) (1991) is used to understand the perceptions, knowledge, norms and pragmatic issues concerning urine reuse. The TPB is used as an overarching framework and not as a predictive tool to determine behaviour.

The third chapter illustrates the methodology used to conduct this research. The study follows a qualitative approach instead of the usual positivist when using the TPB. Moreover,

this chapter discusses sample selection, the process of data collection, the analysis and the limitations of the research process.

Chapter IV reports the results of the interviews conducted with farmers on their perceptions and knowledge of urine. Moreover, it discusses themes which relate to the literature in chapter two and theoretical framework. Similarly, the fifth chapter presents the analysis and discussion of the interviews conducted with key informants with whom the farmers work in partnership with.

Finally, the last chapter provides a discussion of the main themes in accordance to Ajzen's TPB. It provides an overview of the research objectives and how they have been answered. It seeks to assess the feasibility of introducing the concept of ecological sanitation and the reuse of urine in agriculture among farmers and the two organisations with whom they are associated. Lastly, the chapter demonstrates how this study has contributed to the literature on urine perception. It takes some of the limitations of the study and finally makes recommendations for potential avenues which could be undertaken in order to introduce urine in their agricultural practices.

CHAPTER II: LITERATURE REVIEW: URINE AND SANITATION

> *This liquid, which is generally ranked amongst vile and disgust, which become, in the hands of the chemist, a source of important discoveries, and is an object in the history of which we find the most singular disparity between the ideas which are generally formed of it in the world, and the valuable nothing which the study of it affords to the physiologist, the physician, and the philosopher (Smith, 1954: 902).*

2.1. Introduction

The literature review will broadly cover the topic urine, sanitation and contemporary views on the topic of ecological sanitation. Section 2.2 examines the various uses urine had in the course of history. Section 2.3 follows more precisely with its use in agriculture. Section 2.4 presents the sanitation and human waste reuse situation in colonial Durban. Sections 2.5 and 2.6 describe some of the alternative sanitation systems that have been recently developed in Europe, Africa and Asia and how they function. As well as the receptivity issues which have arisen as a result of this technology. In Sections 2.7 and 2.8 a range of different perceptions to the reuse of human waste will be covered in seven different countries including South Africa. Lastly, Section 2.9 will briefly review the theoretical framework used for this study, Ajzen's theory of planned behaviour (1991). The theory is used as a guide to understand the respondents' attitudes, how they perceive others' opinions and external factors which may affect their willingness to adopt certain behaviour or not.

2.2. The Urine Market through History

Throughout history, many cultures have used human urine and faeces for medical, aesthetic and agricultural purposes, without repulsiveness (Drangert, 1998). In the course of history urine has had many functional qualities. It has been used as a diagnostic tool, for therapeutic purposes, for cleansing and other practical uses. Presently urine is used for diagnosing conditions such as diabetes and pregnancy. This practice dates back to millennia. Urine was utilised for diagnostic purposes in Ancient Egypt, Sumer and Babylon (Smith, 1954). For example, the urine of a woman was used to determine if she was pregnant and the sex of the foetus. It was believed that if either the barley or the wheat grain germinated the woman was pregnant, if only the barley germinated it would be a boy and if only the wheat grain did, it would be a girl (Lefebvre, 1956).

Urine was also employed in an intimate manner. In many areas urine was believed to soften skin. French women would bathe in urine to revitalise their skin (Smith, 1954). It was also used to treat various skin ailments. In Sweden urine was applied on wounds and to help with dry skin. Among Swedes and Mayans, urine was also incorporated into special drinks for medicinal purposes (Drangert, 1998; Sawyer, 2003).

The Romans knew the importance of urine to the point that they taxed urine collected from public sources (Smith, 1954). The urea contained in urine gives it detergent like properties (Smith, 1954). Greek and Roman civilisations (as well as in French and Danish) urine was used as a cleaner and a detergent (van Vuuren, 2008; Jewitt, 2011). Urine was also used to dye cloth, soften wool, and to tan animal hides due to the uric acid and even in the manufacturing of gunpowder (Esrey et al., 2001; Höglund, 2001; Jewitt, 2011). Other products which make use of urine as part of their production process include: Harris Tweed, tobacco and cheese (Smith, 1954).

Current views and uses of human waste have changed through time, space and with globalisation. For centuries, human waste was used for different purposes. Some religious texts mention human waste, and the manner in which it should be expelled and disposed of. According to Islamic tradition, contact with human waste should be avoided and its use in agriculture can only occur once faeces have been modified beyond recognition and odour (Avvannavar & Mani, 2008). In the Bible, according to Deuteronomy 12-14, it states that a person should choose an area on the outskirts of where one is staying "thou shalt dig therewith, and shalt turn back and cover that which cometh from thee". The area must be kept clean so that God does not see anything unclean, for if he does he may turn away and leave (Warner, no date). The manner in which human waste is dealt with encourages a detachment from it. In the Hindu tradition, defecation is surrounded by ritual and depending on caste stipulates the use of water. Conversely, Buddhism promotes the recycling of both urine and faeces (Avvannavar & Mani, 2008). This may explain the long history and extensive use of human waste in many Asian countries (Avvannavar & Mani, 2008).

A person's relationship with his or her waste is partly mandated by religion. Culture may also affect how people deal with their excreta (Esrey et al, 1998; Drangert, 2004). There are cultures that are not bothered by the handling human waste while there are those which find it repulsive and cultures who find themselves holding a view in the middle. Many cultures have taboos associated with sanitation. This highlights the importance of exploring

the cultural beliefs associated with urine and sanitation in order to implement programmes in a sustainable manner and make EcoSan part of local culture (Esrey, 1998; Duncker et al, 2007). In Kenya, it is considered witchcraft if crops are grown with another person's faeces or urine. However, there are no cultural taboos concerning infants' excreta (Mugure & Mutua, 2009). There are multiple cultural practices which involve human waste. Thus, when trying to inculcate new sanitation systems in communities, cultural practices must be taken into consideration.

Yet, there are some exceptions where human waste does still have some use but they do not seem as widespread as they might have once been. Urine as it was in the past, is still used by certain individuals', for medical purposes. In Eastern Africa, Zimbabwe and South Africa it is used to treat eye infections. When applied directly on the skin it soothes burns and neutralises poison from snakes (Kassa et al., 2010). In other Eastern African communities, urine is not viewed negatively but as a harmless even beneficial product. It is commonly put on abrasions to stop bleeding, to treat athlete's foot, and drank by individuals who are inebriated (Kassa et al., 2010). Guzha and Muduma's (2001) reported in a small fraction of a community in Zimbabwe believe that urine has medicinal functions for impotence and as a love potion (Guzha & Muduma, 2001). Urine in some context may be perceived as a waste. Yet in many cultures there is recognition that urine has multiple uses.

2.3. Urine in Agriculture: Past and Present

In the past, another function for urine was in agriculture as a fertiliser. Possibly since the advent of sedentary living, agricultural societies have applied the 'night soil', human waste collected in a container over night, back into the earth (Bracken et al., 2007). Night soil is the practice of reusing human waste for fertilising purposes from a household into fields (Esrey et al., 2001; Sawyer, 2003). Asia was the first documented region to use human waste in agriculture. The Chinese have been composting human waste for millennia, and until the 1950s, approximately 90 percent of it was composted and reused as fertiliser (Drangert, 1998; Jewitt, 2011). Similarly in Japan, urine and faeces have been marketed since the XIIth century, when building concierges supplemented their income by selling tenants' waste to farmers who would then use it in their fields (Avvannavar & Mani, 2008). In the early XXth century the Japanese were spreading millions of tons of human waste on fields (van Vuuren, 2008). This tradition continued until the Second World War, when commercial fertilisers became popular

and widely available (Drangert, 1998). In Southeast Asia, human waste was used in aquaculture, where fish would feed on it (Furedy, 1988). In the XVIIth century, urine was suggested as an inexpensive source of phosphorus in households (Smith, 1954). In Europe, there was a tradition in Switzerland and Denmark where urine was used as a fertiliser as it constituted a good source of nitrogen and potassium (Smith, 1954). In Sweden and Germany, urine was separated from the faeces so that the urine would be easier to handle and a more efficient fertiliser (Höglund, 2001).

The continent with the widest utilisation of human waste in agriculture is Asia. China has and today still recycles human waste for agricultural purposes especially in rural areas (Tanner, 2001). Japan on the other hand, also with a long history of human waste reuse, has incorporated EcoSan in an urban context. There are over 1800 facilities that treat night soil transported from homes to the treatment facilities (Tanner, 2001). Presently, approximately 50 percent of human waste is collected by city services and used as agricultural fertiliser (Drangert, 1998). In Vietnam, human waste was and continues to be spread in the rice paddies as fertiliser (Jewitt, 2011). It is believed that the amount of human waste that is recycled in Vietnam is comparable to an expense of 83 million US$ per year on fertiliser (Mackie Jensen et al., 2008). Although human perceptions and attitudes towards reusing urine and faeces as fertilisers still conceal stigma and taboos, it is encouraging to see that people are recycling their waste in a sustainable manner (Drangert, 1998). There is hope that the long tradition of human reuse can be again re-integrated into agricultural practices in LDC and MDC alike. In many LDC, there are efforts being made to introduce ecological sanitation. The responses have been mixed, from positive, uncertain to completely against the idea.

2.4. A Short History of Sanitation and Human Waste in Durban

Historically, in the colonial town of Durban, individuals were in charge of the disposal of their personal household waste. However, as population density increased, sewage and sanitation infrastructure were put in place (Bracken et al., 2007). In 1867 Durban, inspectors were assigned to safeguard the public health of the city by dealing with ‘nuisance’ which was the practice of open defecation (Kearney, 2012). In order to deal with the issue, public urinals were provided in certain areas. These urinals were dry systems that did not require water. However, in 1887, the urinals were converted into systems that use water. The soiled water was then pumped into the ocean, where it was believed that when discharged appropriately,

purification of the wastewater would occur from the natural organisms found in the ocean (Kearney, 2012).

In the span of 20 years, Durban's sewage went from the collection, manufacturing and selling of night soil for agricultural purposes to a waterborne sewage system. The transition was partly due to mounting apprehension of disease in a growing and denser urban environment (Kearney, 2012). Night soil collection was done with carts going from street to street taking it out of sight. Kearney (2012) reports that:

> A population of 3 000 produced 200 full pails which arrived daily at the depot each weighing 31 lbs, totalling 891 tons per year. [Excluding] the slopwater, the valuable part is 700 tons, made up of 75 tons of solid faeces giving 20 tons of solid; 25 tons of paper and 600 tons of urine all providing 85 tons of valuable fertiliser, each pail takes 50 lb absorbent ... a total of 1 397 per annum; blood from slaughter houses would provide 100 lbs daily which added to absorbant would give 55 tons; total 85 + 1397+ 55 + 63 bags and rags provides 1 600 tons of manure (Kearney, 2012: 62).

The human waste was then dried to be more adequately transported to farms located on the outskirts of the city. Night soil collection continued up to 1936 in the Umbilo and Umgeni areas (Kearney, 2012). Therefore it should not seem foreign for Durban residents to make use of 'humanure' (human manure) as it was used in the past (Jenkins, 2005). Yet, it appears that matters of bodily waste have been conveniently flushed away and easily forgotten.

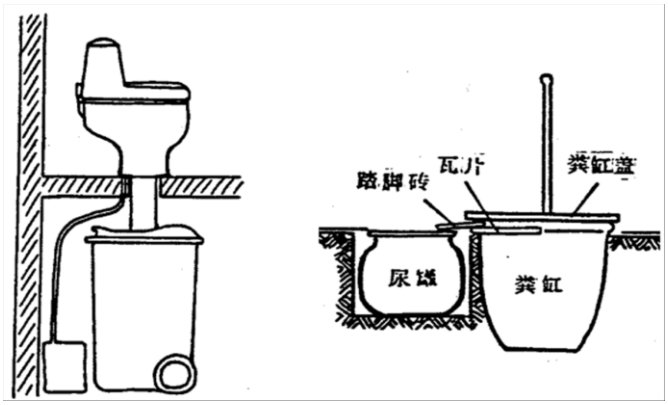
2.5. Alternative Sanitation Systems and How They Function

The disposal human waste out of sight and out of mind has created the idea that once the waste is out of sight, it is no longer a concern. The financial and environmental costs of disposing and treating human waste are significant (Bracken et al., 2007). The transformation from 'urine-blindness', a negative view of urine, to an acceptance of urine as a resource is a difficult battle (Drangert, 1998). There are some efforts being made to lessen the financial and environmental costs incurred by complex sanitation systems while still being hygienic and environmentally sustainable (Drangert, 1998; Duncker et al., 2007). To flush away human waste seems to be the solution that people strive for, though not the most sustainable as it requires large volumes of water. The world's water-stressed regions are looking for

alternatives to decrease water consumption and potentially recycle some of the beneficial nutrients found in urine and faeces (Drangert, 1998).

This section synthesises existing evidence of ecological sanitation options that have been utilised. The Arborloo, which has been promoted in many areas of Southern Africa, is a shallow pit used as a toilet. When the pit is full and has been periodically covered with ash, soil, leaves and covered with a layer of topsoil, a tree is planted in the pit (Morgan, 2004). Another alternative is the Fossa alterna, similar to the Arborloo, it has two structures in place, instead of one. One is used until it is full then the other is utilised. Once the content of the Fossa alterna has been decomposed and transformed into rich humus, the content is removed and used in the fields (Morgan, 2004). UDDT or No-Mix toilets are dry systems that have been widely utilised in Europe and Asia. They have separate compartments (see Figure 2.1. for examples) where the urine is connected to a pipe and the faeces are dropped and collected separately (Drangert, 1998). The separation of urine and faeces accelerate the drying of the faeces. The UDDT compartments are easier to handle in the hilly areas of eThekwini (Von Münch & Dahm, 2009).

Figure 2.1. Models of No-Mix Toilets



(Drangert, 1998: 158).

Increasingly, because of its lower water consumption, EcoSan systems have been promoted in LDC, as alternatives to pit latrines (Morgan, 2004). The Skyloo is another type of urine diversion toilet. The urine and faeces are emptied once or twice a year depending on the frequency of use. The faeces are then moved to an area where the composting process can continue. Ash, soil and leaves are also added to the faeces to help in the drying process and decrease the likelihood of pathogens (Jackson, 2005).

2.6. Receptivity Issues with Alternative Sanitation Technology

The toilet individuals' use is much more than just a technological fix to sanitation. To encourage the use of certain systems several aspects should be considered: norms, perception and culture of both the users and those professionals who are promoting the sanitation systems. Sanitation systems represent a sense of pride, status, convenience, improved health and hygiene (Drangert, 1998). The conventional flush solution seems to be technological fix that has been normalised and is strived for. Although, it is not a sustainable fix. In water stressed areas individuals and local governments are also realising its unsustainable nature.

The world over, sanitation preferences vary according to culture, religion, geography, environmental constraints and socio-economic situation. The alternative types of sanitation are not unanimously accepted. The modern No-Mix technology made its way in Scandinavia in the early 1980s' (Lienert & Larsen, 2006). According to an evaluation study by Lienert and Larsen (2006) user acceptance was high, over 75 percent of respondents had favourable attitudes toward the No-Mix toilets. On the African continent, the no-mix toilets are aesthetically more rudimentary than their European counterparts which look like conventional ceramic flush toilets. The less modern look does in part influence in acceptance of the toilet.

In an EcoSan pilot study based in Kisumu, Kenya, Arborloo and Fossa alterna were preferred to Skyloos' reflecting cultural taboos in manipulating urine and faeces (Jackson, 2005). In Mozambique the 'humanure' generated from the Fossa alterna was the prime motivator to installing the sanitation system, not the structure itself. The crops that had been grown using the 'humanure' were much more resilient than those crops that were not fertilised with humanure (Jackson, 2005; Jenkins, 2005). It is pertinent to incorporate the holistic use of alternative sanitation systems not only for its primary purpose of improving sanitation conditions but its reduced environmental impact and fertilising potential.

South Africa has the widest coverage of UDDT in Southern Africa (Uddin et al., 2012). While UDDT have been integrated as a method of sanitation in eThekwini and KwaZulu-Natal (KZN) more widely, the toilets have not been well received. Duncker et al. (2006) reported that in different regions where UDDT were installed it was found that following installation, two thirds of respondents liked the UDDT and the rest did not. Later, as time passed, half of respondents did not like the UDDT and 30 percent did not know. Many of the toilets remained unused and only 20 percent liked them. There were several reasons for their low receptivity. The elderly found the toilets were difficult to access, as the steps were

too high. Overweight people had issues with the small seats and insufficient room to manoeuvre within the toilet space (Matsebe & Duncker, 2005). Instead people used the toilet space, as storage or as animal pens. Moreover, emptying of the vaults was perceived as unhealthy and unpleasant. Even if respondents felt more comfortable handling urine to faeces, no education or training was properly given on the beneficial properties of urine in agriculture (Matsebe & Duncker, 2005). Many recipients of the UDDTs hope that they are a temporary solution to the eventual installation of flush toilets (van Vuuren, 2008).

Like any new technology introduced to a consumer, there needs to be consideration of the population for whom the technology is intended for. The implementation, training, monitoring and follow-up of the UDDT project are considered substandard, especially in KZN. It was a top-down approach, where community members were only consulted once the decision of installing UDDT had been taken. More importantly, training was insufficient on operational information and the added benefits such as using urine in agriculture were not incorporated into the workshops (Matsebe & Duncker, 2005). Perhaps the UDDTs would have been better received if the community members would have been aware of the economic and sanitary benefits of urine reuse the UDDT from the onset.

2.7. Contemporary Introduction to Ecological Sanitation

The use of human waste has been documented for centuries. However, the latest resurgence dates back to the 1990s. Since then many projects have been put in place to install EcoSan systems in order to provide sanitation for those without. There have been many attempts to ‘close the loop’ to preserve water sources and trying to recycle nutrients back into the soil. Perceptions towards urine in agriculture vary. The following sections review a few case studies with diverging views from the ‘enthusiast’, the ‘ambivalent’ and the ‘pessimist’ in light of urine reuse for agricultural purposes

2.7.1. The Enthusiast

Among certain individuals, there are those who view human waste in a positive light. They do not feel repulsed by its use as a fertiliser for edible crops. Swedish farmers who were using urine as a fertiliser did not notice any unpleasant odour and did not inform their customers about the type of fertiliser they used (Lienert & Larsen, 2009). Materials from No-mix toilets used in Sweden are commonly used in household gardens. Some housing projects

rely on farmers who collect the urine from the housing complex to then spread it in their fields (Drangert, 1998). Similarly, it was observed in some areas of Nigeria, septic tank contents were often spread in fields (Ilesanmi, 2006). Crops were also grown in areas were open defecation occurred and there are no objections to consuming those vegetables (Ilesanmi, 2006). In certain areas of Southern Tanzania human waste has been used in agriculture for years. However, this practice was promoted by coincidence. Initially there was resistance to using human waste but after digging up an old latrine pit, residents discovered that the decomposed material was harmless and would be a great fertiliser. Trees were then planted in abandoned pit latrines (Drangert, 2004; Jackson, 2005). The following sections included three cases where the concept of urine reuse in agriculture has been well received through workshops and demonstrations.

Burkina Faso & Niger

Dagerskog and Bonzi (2010) undertook two projects based in Kourittenga, Burkina Faso and the other in Aguié, Niger. Urine was applied to crops as part of a baseline project. Prior to the application of urine, farmers were informed about results from other projects, where urine was applied to crops. Additionally, training was provided for the safe and efficient collection of the urine (Dagerskog & Bonzi, 2010). The new knowledge and behaviour from farmers was based on experience stemming from their practical application of urine. Other methods used included: training, educational sessions, construction of sanitation systems that divide urine from faeces, participative tests plots, sensitisation to the manipulation of human waste and participants evaluation of test plots (Dagerskog & Bonzi, 2010).

There were some barriers to accepting urine. The farmers wanted to witness the results. In order to make it simpler to discuss, urine was referred as ‘liquid fertiliser’. In a study in Arba Minch in Ethiopia, Kassa et al. (2010) observed among the respondents that odour was an issue. The strong smell was not appreciated. In contrast to Arba Minch, in both Aguié and Kourrittenga the odour of the urine was perceived as being a positive contribution to the fertilising process where the more potent the smell, the better it was for fertilising (Dagerskog & Bonzi, 2010). In a taste test of urine fertilised crops, the outcome showed that the urine fertilised crops were sweeter and better looking. The Aguié project has been well received. An individual even purchased 140 containers of urine from his neighbours’ in order to enrich

his compost (Dagerskog & Bonzi 2010). Not only is urine a cheap fertiliser for farmers but is a resource that households can sell as they are individual manufacturers of their own potential source of income.

Nepal

In Nepal, two separate studies were undertaken to evaluate knowledge and acceptability of urine in agriculture. From the questionnaires administered there was no explicit acceptability or knowledge of urine as a fertiliser. However, many were receptive to the idea without strong taboos dictating that the use of urine was to be avoided (Pradhan & Heinonen-Tanski, 2010). Pradhan et al. (2011) surveyed Nepalese villagers; most of whom thought that urine reuse was a good option and wanted to use it. All those surveyed were wholly reliant on agriculture to feed their households. Moreover, the high cost of fertiliser in Nepal may be a factor that influenced the enthusiasm of respondents towards urine reuse (Pradhan et al., 2011). Only four percent of respondents preferred urine be utilised exclusively on non-edible plants whereas the rest stated it could be used on any plant. However, it should be noted that these households have not yet made use of urine directly on their land but only on the demonstration plots set up by the study (Pradhan et al., 2011).

Tilley et al. (2009) undertook a study that examined the social and economic feasibility of struvite in central Nepal. The research showed an acceptance of both urine and struvite. Struvite is a powdered fertiliser which is a source of phosphorus derived from urine. It has many benefits such as being easily transportable, odourless and it has a constant nutrient content (Cordell et al., 2009; Tilley et al., 2009). Urine was collected from households with UDDTs' in Siddihipur, averaging at 155 litres per person per year which was below the numbers typically found. The daily per person collection of urine varied from one litre per person daily to one seventh of that portion (Tilley et al., 2009). It was found that the difference in urine collection was affected by the households' uses of the urine. It was being used in gardens, added to compost heaps or given to others so that they could use it for farming purposes (Tilley et al., 2009).

These are examples of successes for 'closing the loop' in the application of urine in agriculture. Through the successful practices and demonstrations, perceptions have been altered from initially hesitant individuals to positive and fervent attitudes towards EcoSan.

The aforementioned cases demonstrate promise for those communities that may be initially ambivalent to the idea of urine in agriculture to becoming proponents of ecological sanitation.

2.7.2. The Ambivalent

No matter how much education, workshops and training are carried out, this will not necessarily change the mind set of some individuals' to become more favourable to the use of urine in agriculture. In many countries various methods have been used to introduce the concept of EcoSan. Yet, uncertainties remain, which make individuals' hesitant as to whether or not to adopt EcoSan methods. The following examples are based in two countries, Ghana and Turkey, where different levels of ambivalence were observed.

Ghana

Many studies have been done in Ghana to assess the potential use of urine in agriculture. Several municipalities in the country take approximately 50 percent or more of their municipal budget to deal with sewage, disposal and other sanitation matters (Danso et al., 2004; Cofie et al., 2011; Mariwah & Drangert, 2011). EcoSan could be a good alternative to alleviate the demands on municipal infrastructures.

In a multi-city study conducted by Danso et al. (2004) respondents showed positive views towards human excreta, where 65 to 82 percent would buy crops grown with human waste. Of those of who had positive views of human excreta, 80 and 60 percent thought dried human faeces and urine could be marketed, although urine specifically for medicinal purposes (Danso et al., 2004). Interestingly, only 17 percent were willing to sell their urine. However, according to a five year demonstration project in the CBD of Accra their percentages relating to willingness to sell were different (Cofie et al., 2011). In this particular study, 19 percent of marketers were willing to sell their urine and over 50 percent of consumers were willing to sell their urine. Those who were not willing to sell their urine stated its uses in ritual purposes as a deterrent (Cofie et al., 2011). In this study, over 80 percent of the farmers were willing to handle urine and its smell, as it contains nutrients and they disagreed with its disposal. However, the farmers were still concerned with issues regarding the nutritional effects on crops, efficient storage of urine, the sufficient availability of urine and the likelihood of rodents attacking their vegetables as urine is used as bait to attract rodents (Cofie et al., 2010; Cofie et al., 2011).

Different groups seem to have different concerns and levels of acceptance. Marketers were the least keen on the reuse of urine. Their worries were around patronage. Their customers may not want to buy vegetables from these marketers if they knew of their provenance (Cofie et al., 2011). Interestingly, customers were not as adverse to the idea of buying urine fertilised vegetables. Arguing that presently consumers have no guarantee on how the vegetables they consume are grown. They may without knowledge currently be eating vegetables grown with urine (Cofie et al., 2011). In this study, those favourable to the use of urine saw it as natural. It was perceived as part of the body, and thus a resource, which was already being used for its medicinal value. They also thought that urine would allow vegetables to have a longer shelf life because it is organic. It would also cut down on production cost, to have a free fertiliser (Cofie et al., 2011).

In contrast to the Cofie et al. (2011) and Danso et al. (2004) studies, Mariwah and Drangert (2011) who surveyed 154 households in Efutu, Ghana found that over 80 percent thought of human waste suitable only for disposal and that handling it, even sanitised, would involve great risk:

> There is a Ghanaian proverb which says that 'a chamber pot will forever remain so even when it is bought new'. This means that faeces will also remain faeces whether treated or not. I don't think it is good to handle it in any way (Mariwah & Drangert, 2011: 4).

Conversely, an infant's waste was seen as having minimal risk to human health (Mariwah & Drangert, 2011). Although, 60 percent agreed human waste could be good for the soil, only 36 percent would use a sanitised version, even less would consume vegetables grown using human waste. The dominant reasons why they would not use urine were mainly because of the smell, the health risks and the lack of consumer support for such crops (Mariwah & Drangert, 2011). Similarly, respondents who were aware of the positive impacts of it would be more likely to use it than those who do not know about it (Mariwah & Drangert, 2011).

A growing issue that is slowing the impetus of the use of urine as a fertiliser is apprehension about the composition of the urine and its possible impurities. Among European farmers and consumers, there are fears concerning micro-pollutants, hormones, pathogens, disease transmission, pharmaceutical residues, and other contaminants (Lienert et al., 2003). Farmers' livelihoods could be put in jeopardy if consumers are unwilling to consume crops

grown with urine. Such was the case in Switzerland where pressures came from consumers. They demanded that wastewater, which often contains human waste, be banned from being used in agriculture (Lienert & Larsen, 2009).

Turkey

In Turkey, Beler Baykal et al. (2011) conducted a survey on the perception of urine as a fertiliser for three different type of plant usage: landscape plants, plants eaten raw, and plants eaten when cooked. In general there was a much higher acceptance of natural rather than artificial fertiliser. There was however, a discrepancy between the approval and acceptance to consume crops produced with urine. Considering the trends, there was a higher approval and acceptance of urine for growing landscape plants. Approval and acceptance decreased for cooked crops and were even lower in uncooked crops. Approval rates for all three crop categories were higher than acceptance to consume those products (Beler Baykal et al., 2011). Knowledge and approval of the use of urine in agriculture can be high but that approval does not necessarily translate in a person being willing to consume the product. Approval does not mean acceptance nor does signify utilisation.

Although there is ambivalence in both Ghana and Turkey, they have learned about the positive and negative impacts of ecological sanitation. They have been able to make a more educated decision. In Ghana, the concerns are higher among marketers than farmers or consumers. In Turkey, the study specified that respondents would rather use urine for non-consumable plants. The introduction of EcoSan is a slow process. The hesitation today does not mean that it will be accepted in the future.

2.7.3. The Pessimist

Many individuals who have been exposed to the concept of EcoSan have seen its benefits and its limitations. In all the aforementioned studies, most people were initially not accepting of the idea. Training, workshops, demonstrations and so on had to occur in order to transform perceptions (Tilley et al., 2009; Dagerskog & Bonzi, 2010; Kassa et al., 2010; Cofie et al., 2011). However, in some instances individuals have remained adamant on their distrust of using urine in agriculture such as in this case study in Pakistan.

Pakistan

In the North West Frontier Province of Pakistan, Nawab et al. (2006) studied the cultural preference in sanitation systems, as well as indirectly exploring individuals' views on human waste in a predominantly Muslim population. The community is water stressed. 90 percent of the population practices open defecation. However, most women prefer to defecate privately because of safety and privacy issues. Open defecation is accepted culturally in contrast to Islamic tradition which encourages strict avoidance of human waste (Nawab et al., 2006).

Many individuals' acknowledged the value of human excreta, often reaping better crops from areas where open defecation had occurred. But the decomposition process occurred naturally, drying in the sun, with the soil's micro-organisms disintegrating the human waste (Nawab et al., 2006). Although farmers were unwilling to use it directly for agricultural purposes, they did encourage open defecation in their fields (Drangert & Nawab, 2010). Individuals believed that plants were capable of absorbing the nutrients and preventing the intake of pathogens. Thus, if grains, fruits and vegetables were grown using wastewater or human waste, they were acceptable as long as the crops were properly cleaned (Drangert & Nawab, 2010).

People's religious beliefs and cultural values impeded the willingness to use human fertilisers rather preferring to die "than eating back our own faeces" (Drangert & Nawab, 2010: 241). Artificial fertilisers were preferred to compost. However, wastewater was greatly prized for irrigation and as a source of nutrients. The villagers were more willing to use sewage water as it was seen as dirty water not human waste. However, urine is seen as less pure than wastewater because urine is not mixed with water (Nawab et al., 2006). This reinforces the urine-blindness common in the area, where the farmers' are unaware of the nutrient content of urine (Drangert & Nawab, 2010).

There were varying degrees of acceptance of human waste. An infant's waste is perceived as purer than an adult's waste. Women were willing to handle children's and the sick's' waste as it was expected of them (Drangert & Nawab, 2010). Even some animal dung were considered purer (cow and goat) than others (horse and dog) (Drangert & Nawab, 2010). In Pakistan, the main issue with EcoSan was the direct contact with the human waste more than the fact that it would be recycled into the soil. Similarly in Zimbabwe Hoko et al. (2010) found that individuals were concerned with the risk human waste had when it was

manipulated. The influence of culture, religion and psychological factors on the rationale of contact with what is perceived as impure is a significant factor to be dealt with.

Many farmers need to sell their produce thus need customers. If consumers were willing to consume EcoSan fertilised crops it would possible to entice farmers to take up the practice as it would be one less barrier (negative consumer views) to deal with. EcoSan could be mainstreamed through the process of diffusion. The idea is perceived as new, the knowledge of it would be spread by various communication channels over time and among different social systems (Rogers, 2010). At the moment EcoSan is poorly received in many countries for cultural, hygienic and normative reasons as seen in the case studies mentioned above. EcoSan is mostly being promoted in LDC without much focus in MDC which have just as an important to play a role in promoting environmentally equitable methods of dealing with environmental degradation.

2.8. Where does South Africa's Perception of Urine compare?

South Africa has enough food to feed its inhabitants. Due to poverty, 14 million inhabitants are at risk of food insecurity. For some crop producers, lack of access to fertile land and fertiliser hinder their food security (WRC, 2007; Wilkinson et al., 2010). Food security defined in the South African context refers to availability, access and utilisation of nutritious, safe and sufficient quantities of food in order for all to achieve their dietary needs and a healthy life (Wilkinson et al., 2010). In South Africa, ways that food insecurity is dealt with include: food fortification programmes, nutrition education and promoting the production of personal food supply through gardens (Wilkinson et al., 2010). Access to fertiliser remains a challenge for many and the increase price of artificial fertilisers in the past five years have made it more difficult for farmers to produce sufficient crops. The incorporation of urine in agriculture could increase production and access to food while making extra income selling surplus crops being produced (Wilkinson et al., 2010).

In most areas of the country, UDDT have not been wholly accepted, which also affects the possible acceptance of urine in agriculture. For example in Kanniesberg, out of approximately one thousand households using the UDDT system 50 were practicing EcoSan, reusing the urine and faeces in agriculture (Jackson, 2005). Mthatha, in the Eastern Cape is one of the areas where there is a high rate of human waste reuse. The community has accepted the UDDT and have received extensive training and support on EcoSan. Though, the

respondents only utilise urine under certain conditions. They do not use it for root or leafy vegetables or any vegetables that have contact with the ground (van Vuuren, 2008). In most other areas of the country, ecological sanitation has not been widely accepted (Duncker et al., 2007). According to a survey conducted in eThekwini, when asked about urine in agriculture, 41.8 percent of respondents thought that urine kills plants, 14.8 percent thought it kills insects, only 9.7 percent thought it would help plants to grow, and 4 percent believed it would pollute the soil (Okem et al., 2012).

The idea of reusing human waste in agriculture is still unknown, generally, "food and human waste should not be uttered in the same breath" (van Vuuren, 2008: 30). A few have some knowledge of the potential of faeces, yet not the fertilising potential of urine (Drangert, et al., 2002; Duncker et al., 2007). Human faeces are what closest resemble manure which is generally more acceptable, whereas the use of a liquid fertiliser, urine in agriculture is unknown (Duncker et al., 2007). In the case of Kimberley, when the UDDTs' were built, the households were not informed about the fertilising potential of urine, only of faeces (Drangert et al., 2002). The hesitation to the use of urine is that it is believed that urine burns plants, it is unhygienic, smelly and individuals' have never heard of it being used (Drangert et al., 2002; Duncker et al., 2007; van Vuuren, 2008). The main concerns among the respondents in various communities in eThekwini were health, smell, perception of others, while religious and the use of urine for magic were the least important of concerns (Okem et al., 2012).

Many fear handling human waste whether in agriculture or not. This may be the result of health and hygiene campaigns promoting hand washing after using the sanitation facilities (Duncker et al., 2007; van Vuuren, 2008). Many worry that handling human waste will cause sickness and potentially contract HIV/AIDS (Drangert et al., 2002; Duncker, 2006; van Vuuren, 2008). Yet, the waste of the sick, elderly and infants are acceptable to handle (Duncker et al., 2007). While not used in agriculture urine has many uses in South Africa as part of traditional medicine. An infant's urine can be used to treat eye infections, treat burns, get rid of spots on skin, help relieve swollen ankles and feet, to get rid of the poison, protect people from bad luck and witchcraft and even help children start walking (Drangert et al., 2002; Duncker et al., 2007; van Vuuren, 2008). However, these uses are not known by all in the community. According to Okem et al. (2012) almost 50 percent knew of no purpose of urine, while approximately 27 percent were aware of medical purposes, 5.5 percent for ritual purposes and only 3.6 percent knew that urine could be used as a fertiliser.

South Africa seems to be an ambivalent country. In Mthatha the receptivity of urine has been high, yet in other areas there is little or no use of it. There is an acceptance of urine as medicine among several South Africans which could possibly be transferred in its utilisation for agricultural purposes. In the case of South Africa, increased training and workshops on ecological sanitation could be highly beneficial to mainstreaming the concept.

2.9. Application of the Theoretical Framework

This section provides theoretical concepts in order to understand the type of behaviour individuals' could have towards the use of urine in agriculture. Ajzen's (1991) theory of planned behaviour (TPB) is the framework utilised to understand the perceptions of the respondents of the study. Ajzen's theory of planned behaviour posits that "the individual's has an intention to perform a given behaviour" (Ajzen, 1991: 181). The theory suggests factors that may affect the possibility of an action being taken. The ability to perform such behaviour depends on cooperation with others to do so, time, finances and skills. Moreover, referring to Figure 2.2., the motivation and intention in performing that said behaviour is reflected by (1) attitude, if an individual's self perception of the behaviour is favourable or not, (2) subjective norm, the perception of others and social pressure to perform the behaviour or not, and finally (3) the perceived behaviour control which refers to the level of difficulty in performing said behaviour.

Figure 2.2. Diagram of the theory of planned behaviour

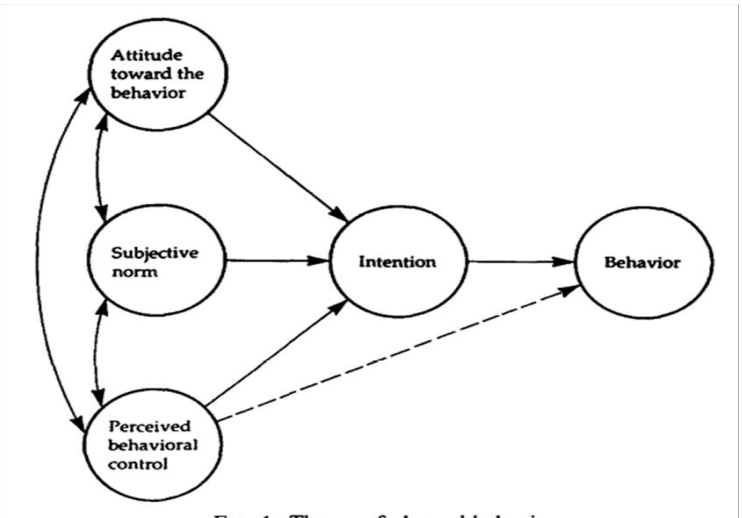


FIG. 1. Theory of planned behavior.

(Ajzen, 1991: 181).

In the context of this research, attitude refers to whether urine is seen as something positive or negative in the eye of the respondent. Which can be deduced from such questions as: "Would you use urine in the vegetable garden?" The subjective norm is how the respondent evaluates and perceives the application of urine in agriculture by others in their household and in their community. Not necessarily how the community actually perceives urine reuse but how respondents think their community would respond. The following question in the interview schedule helped gather this information "Do you think the members of your household would eat food that has been grown with human urine as fertiliser?"

Moreover, personal experiences of using urine in agriculture or witnessing the use of it could mould the subjective norm and influence the respondent's attitude. Finally, in relation to urine perception, perceived behaviour controls are the more pragmatic issues that may affect urine reuse. These include access to the skills and training required to put EcoSan into practice efficiently and sustainably.

The TPB is largely used within the positivist paradigm which seeks to predict individuals' behaviour where individuals are seen as actors who seek to maximise behaviour which results in positive consequences (Bamberg & Schmidt, 2003). Thus, TPB has mostly been used in quantitative research (Terry et al., 1999; Bamberg & Schmidt, 2003). Yet, there are some studies that have used the TPB in a qualitative or mixed method approach (Dietrich, 1996; Powell-Cope et al., 2003). In this study, the TPB is applied to provide a framework in order to understand how various factors could influence an individual's behaviour. Moreover, it assists in the analysis of the qualitative data collected through interviews, not as a predictive tool to determine the behaviour of respondents could have towards urine reuse.

2.10. Conclusion

This literature review has described many different historical uses that urine has had on three different continents. The use of urine in agriculture was a known concept to Durbanites 150 years ago and to many Asians and Northern Europeans. Many sanitation systems have been created to adapt to various demands and environments such as the Fossa alterna and the UDDT, some of which have been more accepted than others.

From the studies reviewed, there was no consensus on what urine represented and how it was perceived by individuals. Some were supporters of urine reuse. Others were quite cynical, while some remained undecided on the topic requiring more information or just time

to witness the results. From the South African case studies, it seemed that the study samples were not homogenous. Some were distrustful of urine in agriculture while others were ambivalent but willing to learn more about it. Finally, Ajzen's theory of planned behaviour (1991) is used to provide a framework to help in understanding the individuals' perception and knowledge of urine and its potential as a fertiliser.

CHAPTER III: METHODOLOGY

3.1. Introduction

This chapter outlines the methodology used in the design of this study which seeks to explore individuals' perception and the potential of urine as a fertiliser in eThekwini, South Africa. Section 3.2 outlines reasons why the constructivist approach was used in this qualitative study. The following sections 3.3 and 3.4, describe the study area, the demographic background of the respondents, the sampling technique and the process data collection. The last two sections 3.5 and 3.6 cover the analysis and limitations component of the study.

This research was conducted in a qualitative manner to collect information for more richness and depth. The research was undertaken with individuals who have been trained at the Newlands Mashu Permaculture Learning Centre (NMPLC) by the eThekwini Municipality Infrastructure Management & Socioeconomic (IMS) Development Department Agroecology Programme. These individuals gardened in Ntuzuma and Inanda. Similarly, farmers from Umbumbulu, a peri-urban area of eThekwini, who are part of the Umbumbulu Agri-Hub, were also interviewed. Additionally, key informants from each organisation were interviewed to provide background information and their perception of urine. Lastly from both organisations their perception and knowledge is assessed to understand the feasibility of the integration an EcoSan component to the support they already provide farmers. The following statements are excerpts of the two organisations overarching goal and underlying principles:

> The Umbumbulu Partner Farmer Agri-Hub […] provides an exemplary example, […] for development agencies and institutions with an interest in grass roots development; people-first development principles; and the much maligned concept of sustainable development. In a context where poverty eradication, the reality of peak oil, general environmental degradation, and concerns over climate change should be informing developmental processes… (IMS, 2011: 4).

> IMS delivery aligns with the eThekwini IDP's focus on poverty and unemployment in 2010/11, and commitment to promote the security of citizens from poverty. Agriculture and processing are broadly addressed in Strategic Plan 2: Economic development & job creation. Support for community farms, emerging farmer development and food security for vulnerable families … (E. Gori and Associates, 2012: 2).

3.2. Constructivist Approach in Qualitative Research

The qualitative approach allows the research to interact with the multiple realities and perceptions of individuals. The research is conducted in a more natural environment compared to its quantitative counterpart whereby the data is collected in a structured and somewhat artificial context (Scheyvens & Storey, 2003). In the constructivist approach it is assumed that everyday social realities are created by individual's experiences and are developed in different social contexts where social interactions take place. Therefore, different meaning will be attributed, by individuals, to these realities (Guba & Lincoln, 1994). This qualitative approach to research allows the researcher to reach more depth in the respondents answers compared to a more positivist approach which uses close ended questions (Guest et al., 2006). Qualitative research in this way allows the researcher, with the respondent, to reveal more information. While other issues will arise if the right questions are asked or if the respondents are allowed to fully divulge their opinion without being restricted by the structure set in place by the researcher (Lincoln et al., 2011). The theoretical framework is based on the theory of planned behaviour (TPB) (Ajzen, 1991). Although mainly applied in positivist studies of human behaviour, the TPB can be applied within the constructivist paradigm. It allows for an understanding of the manner in which individual's realities are built. It also allows for an understanding of how behaviour is influenced by a multitude of subjective realities which individuals combine to construct their perception of social realities (Lincoln et al., 2011).

3.3. Study Area and Sample Selection

For logistical purposes, it was decided that farmers should be interviewed in a specific context. In order to conduct interviews, two study areas were selected as case studies for this research out of convenience and because there was an establish relationship between the researcher and the organisations. First is the Newlands Mashu Permaculture Learning Centre (NMPLC) which was started in 2000 as an NGO and is now run by the Agricultural Management Unit of the eThekwini municipality as one of its Agri-Hub training centres (E. Gori and Associates, 2012). The NMPLC deals with farmers and community gardens from all over eThekwini. For the purpose of this research, members of two community gardens, in Ntuzuma and Inanda, were interviewed.

The second study area is the Umbumbulu Agri-Hub, which is a public-private partnership. It was started in September 2010 by the Newlands Mashu Community Development Foundation for the eThekwini municipality and its focus is to support small-scale growers through the application of permaculture principles (IMS, 2011).

The selection of two different organisations allowed me to interview farmers from different communities in a peri-urban context in Umbumbulu. Plus, in an urban context with the farmers from Inanda and Ntuzuma who deal with the NMPLC. Two study areas were selected so that, if for some reason one of the organisations would be unwilling to participate, the study could continue relying on only one organisation. Half of the respondents would be sampled from each organisation. A scoping stage was undertaken to find out if the research would be relevant and feasible logistically within the context of each organisation. Both organisations were visited in order to confirm their participation in the research.

Similarly, the small sample size of two key informants from each organisation provided a sample of four key stakeholders which is justified as they are not part of the main research aim. A separate interview schedule was created for farmers and for key informants though some questions did overlap. In the key informant's interview schedule, the goal was to find out more about their process of transferring knowledge, as well as their willingness to possibly integrate urine reuse in their programme. This was important as they were the main agents in the transfer of knowledge in the organisations with whom the farmers interacted with. In order to assess the feasibility and their keenness on propagating the idea of EcoSan to other farmers with whom they work with.

3.4. Process of Data Collection & Sample Characteristics

A total of 16 respondents (12 farmers and 4 key informants) were selected to participate in this research. In this qualitative study, a non-probability sampling method was used. The respondents did not have an equal opportunity of being selected. Purposive sampling was used within the two organisations selected to represent the perceptions and understanding of urine of small-scale farmers in different areas of the municipality, among different the genders and ages (Devers & Frankel, 2000a). The respondents were selected on the basis that they were present and willing to be interviewed at the time the researcher was present in the community.

The interviews were conducted between July 5th 2012 and August 29th 2012. The interviews ranged from 20 to 68 minutes in length and were entirely performed by myself. In order to conduct the interviews I went directly to the home and gardens of the farmers. In Umbumbulu, the training coordinator acted as a gatekeeper and a link to the farmers in the community (Devers & Frankel, 2000b). He allowed me to follow him on his rounds as he visited the farmers in the area. The trainer suggested I interview the farmers whom he had already pre-selected on the basis that they could speak sufficient English.

Some of the respondents were aware of the nature of the visit, depending on what the trainer had previously mentioned to them during their telephone communication. None of the interviews were set up in advance, so this gave it a more informal feeling. In some instances, respondents go to great lengths in order to put there best self forward, such as preparing special foods, wearing their nicest clothes and so on which was not the case during this research which was not the case for this research (Warren, 2002).

At the NMPLC, I went to the specific location with some officials from the organisation. There were two visits, one in Ntuzuma where I interviewed two individuals was concurrently during a farmers' cooperative meeting. The other visit was in Inanda where an interview was held with three individuals from a community garden. At a later date, I interviewed the chairperson and two women who belonged to the coop.

Rarely were the interview environments in a fixed location (Warren, 2002). In order to make the respondents feel comfortable, they were asked to choose the location of the interviews. Some took place in gardens; a few in individuals' living rooms; a couple were just standing next to a truck, in a car, sitting in a nursery, and two others were along a building in order to shelter ourselves from others and limit the noise.

The size of the sample was limited due to time, availability and its purpose. The sample size for qualitative research with semi-structured interviews allowed for a small sample size of a total of twelve farmers, approximately half from each organisation. Guest et al. (2006) state that if studying general themes the point of saturation where the data produces little or no new information, is as little as six if respondents. The objective of the research was to describe the potential of urine in agriculture within a relatively homogenous group. In this case, it is proposed that 12 respondents are sufficient (Guest et al., 2006).

Initially there were supposed to be six farmers interviewed in each of the two respective organisations. However, in Umbumbulu, the trainer was not able to find six people

who spoke English and would agree to be interviewed. Nevertheless, an extra interview was conducted with the NMPLC group which resulted in twelve interviews in total. In Umbumbulu, no one refused to be interviewed directly. However, it was the trainer who was contacting the farmers. If any had refused to be interviewed, they would have directly to him. In Ntuzuma, there were people who refused to be interviewed. The individuals stated that they were too busy and did not have time to be interviewed. The following tables display the demographic characteristics of the farmers and key informants (Table 3.1 and Table 3.2).

Table 3.1 List of Key Informants Interviewed

Pseudonym	Date of Interview	Organisation	Age	Educational Background	Job Title	Years in Environmental Field	Knowledge of Urine in Agriculture
Ms.P	20.07.2012	Umbumbulu	45	Diploma theatre & computer animation	Sustainable development practionner	17	yes
Mr.N	09.07.2012	Umbumbulu	29	Matric	Training coordinator	6	yes
Ms.S	11.07.2012	NMPLC	56	Standard 6	Trainer	10	somewhat
Mr.B	08.08.2012	NMPLC	48	Diploma, BSc Equivalent	Horticulturist	26	yes

The ratio of women to men was not mentioned in the sampling strategy. As the composition was the sample, farmers who deal with the Agri-Hub and NMPLC were unknown. Still there were 5 female and 7 male farmers interviewed, a relatively equal ratio. This provided an exploration of perception along gender lines. Among the farmers few had finished secondary school. Only one respondent had a degree relating to agriculture. Most respondents had gained their agricultural knowledge through their parents who themselves practices agriculture. Plus, short training sessions provided by their respective organisations. The age distribution varied from 26 to 73 years old. The more elderly respondents were from Umbumbulu with a mean age of 61.6 years. In NMPLC there farmers were younger with a mean age of 45.3 years. There seems to be a difference in average age between farmers who practice in peri-urban and urban environments.

Table 3.2 List of Farmers Interviewed

Pseudonym	Date of Interview	Organisation	Age	Educational Background	Years of Experience as a farmer
Mr.G	05.07.2012	Umbumbulu	70	Standard 9	9 years, no training
Ms.S	05.07.2012	Umbumbulu	73	Teaching - University	46 years, training from nuns in Marian Hill
Mr.Z	09.07.2012	Umbumbulu	61	Standard 9	Since he was born, training from mother & now the Agri-
Mr.L	19.07.2012	Umbumbulu	74	College	Gardening in primary (1949) & parents were farmers
Mr.M	19.07.2012	Umbumbulu	30	National Diploma in Agriculture	Since he was young, his parents were farmers
Mr.C	29.08.2012	NMPLC	57	Standard 6	Learnt gardening skills in primary school
Mr.I	29.08.2012	NMPLC	59	Standard 9	Since he was young parents were farmers
Ms.T	29.08.2012	NMPLC	36	Standard 5	Since her was young parents were farmers
Mr.Gw	27.07.2012	NMPLC	45	Standard 8 but not finished	10 years & lots of training in permaculture
Ms.B	27.07.2012	NMPLC	42	Grade 12	7 years, gardens at home & training from Dept. of Agriculture
Ms.Z	11.07.2012	NMPLC	52	Standard 9 & finishing Standard 10	Since she was young, her parents were farmers
Ms.M	11.07.2012	NMPLC	26	Matric & 1 year computer certificate	Gardening training at the library & gardens at home.

3.5. Analysis

The data was collected via digital recorder while the interviews were being conducted. The same day, notes were written up on each interview similar to a diary or field notes. Later, each interview was transcribed. The transcription of each interview aided in visualising the data and organising the analysis more efficiently.

All the transcriptions were printed out and coded manually. However, the main coding process occurred with NVIVO 10. Nodes were created in order to organise the data according to the research objectives. Other significant themes arose that were beyond the research objectives but were still incorporated such as reference to manure, blood and the current farming practices. The data for the farmers and key informants were coded separately as the themes were slightly different. Plus, for analytical purposes it was simpler to organise the two groups separately in the coding process.

The overarching themes for farmers and key informants included: ‘manure’, ‘blood’, ‘demographics’, ‘the future of urine in agriculture’, ‘cultural beliefs’, ‘knowledge of human waste in agriculture’, ‘perception of urine in general’ and ‘in agriculture’. The following

nodes were then classified into the three main components of Ajzen's theory of planned behaviour, 'attitude', 'subjective norms' and 'perceived behaviour control' (Ajzen, 1991). In order to support each of the themes, data from the respondents in the form of quotes were incorporated to substantiate the results.

3.6. Limitations

During the interviews with farmers from the NMPLC, some of the interviews were performed in a group setting, where multiple respondents were interviewed at the same time. In two of the three instances, a bond was established more easily, each person gave individualised answers and was not swayed by the comments of the others. However, during the one interview, one of the respondent's barely spoke and when she did her answers were a repetition of the answer of what the other respondents was saying (Arksey & Knight, 1999).

Unfortunately, during all the interviews conducted with farmers there was someone else present. The interviews were thus not conducted on a one on one basis. A reason for this constraint was the lack of time and knowledge of the farmers in the area and of personal transport. The individual assisting me from NMPLC expected the research to be conducted quickly, perhaps more like a questionnaire, even though it was stated multiple times that specific guidelines had to be followed to conduct the interviews. In Umbumbulu, the interviews were conducted with the trainer present. Similarly, this also put pressure on me to complete the interviews quickly as he was working (the interviews were conducted during work hours).

The interviewing process resulted in a co-creation of knowledge, between the respondents and myself (Guba & Lincoln, 1994). Perhaps being asked questions about the utilisation of urine in agriculture affected the respondents' perception and understanding of the topic (Guba & Lincoln, 1994). In Umbumbulu, the trainer's reality may have influenced some of the responses of the farmers as many were told about the research prior to the visit. Moreover, during certain interviews, the trainer commented on the questions and spoke in isiZulu, both of which could easily have affected the responses of the farmers.

My inability to speak or comprehend isiZulu was an inconvenience to the research process. All of the farmers were isiZulu speakers and felt more comfortable conversing in isiZulu. More nuanced information could have been provided if I had been fluent in isiZulu. The ability to probe and dive deeper in language and interaction with the respondents could

have allowed for the collection of richer data (Scheyvens & Storey, 2003). The ability to communicate in isiZulu may have provided for a certain level of familiarity and possibly cultural awareness. No translator was hired due to a concern that a translator could influence the manner in which the questions would be asked or how the answers from the respondents would have been translated. The respondents themselves translated their thoughts in English expressing their perception and knowledge of urine.

No time was taken to neither note body language nor describe the surroundings. Note taking could have been valuable, however, for the level of analysis required it was not necessary (McLellan et al., 2003). Moreover, the process of taking notes in addition to recording could have made the interview feel more impersonal. I preferred maintaining eye contact and efficiently probe than being distracted by note taking (Warren, 2002).

3.7. Conclusion

This study was designed in a qualitative approach to gain more depth into individuals' perception instead of having preconceived answers to the questions asked as in a quantitative approach. The location of the study was in peri-urban Umbumbulu and urban settings of Inanda and Ntuzuma. Farmers and key informants from the Umbumbulu Agri-Hub and the Newlands Mashu Permaculture Learning Centre were interviewed on their views, uses and knowledge of urine. A thematic approach was used to analyse the data, to structure the respondent's understandings, attitudes and views. The design of this study helped provide background on the respondent's perceptions, uses and willingness to use urine in agriculture. It is a hope that further research can be done using the results of this study, and to design a workshop and training on ecological sanitation.

CHAPTER IV: FARMERS ATTITUDES AND EXPERIENCES OF URINE

4.1. Introduction

In order to understand individual's perception of urine and its potential use in agriculture, this chapter will present the evidence collected as to what fertiliser farmers currently use and the cultural uses of urine. Then based on Ajzen's theory of planned behaviour (1991), the results are structured according to the range of 'attitude's that farmers have about urine in general and in agriculture. Next is the concept of 'subjective norms' which deal with the respondents' knowledge of urine and how respondents believe others perceive urine. Then the concept of 'perceived behaviour controls' is presented which refers to the more pragmatic aspects when dealing with urine and finally the feasibility of implementing urine reuse in their community.

The results are presented using a qualitative approach, even though the study is using Ajzen's theory which was originally intended for quantitative purposes (Bamberg & Schmidt, 2003). Though in the context of this research, the planned behaviour framework and its component concepts aid in presenting and understanding the data in a structured fashion in the following chapters.

4.2. Farming Background and Knowledge

Most respondents are practicing farming as their primary method of subsistence. However, Ms.M is practicing gardening as part of her tasks within the NGO she works for. Most of the respondents have been farming since they were in primary school. For the most part, the farmers have gained their experience and training from their parents, many of whom were farmers.

The manner in which the sample was selected in Umbumbulu meant that they work closely with the mentor from the Agri-Hub. They have received and are still getting permaculture training with a strong focus on chemical free farming. The other farmers sampled are involved with the Newlands Mashu Permaculture Learning Centre. The farmers interviewed were part of two different cooperatives located in Ntuzuma and Inanda. They are continuously getting training, support and information from the NMPLC.

The influence of both organisations on the respondents is deduced by the vocabulary that was used during the interviews such as 'fertiliser'. Fertiliser was referred to mean a synthetic input. Yet, fertiliser is defined by Farlex online dictionary (2012) as:

> "…any of a large number of natural and synthetic materials, including manure and nitrogen, phosphorus, and potassium compounds, spread on or worked into soil to increase its capacity to support plant growth" (Farlex, 2012).

In most interviews the respondents told me that they did not use 'fertilisers'. For them, the word 'fertiliser' was associated with something artificial added to the soil that would cause damage in the long run. The most common soil conditioner respondents referred to was:

> *"All manure, not fertiliser. Fertiliser for me means chemical. I use it for sugar cane because I cannot help it. It is the standard way but not for vegetables and cash crops" (Ms.S).*

Manure is an important source of nutrients for crops. The respondents mention that they use cow, chicken, goat and/or horse excreta to make their crops thrive. Interestingly, none of the farmers possess animals. In Umbumbulu, the respondents source the excreta, free of charge, from their neighbours who own animals. The following statement expresses how respondents get their manure:

> *"We put animal shit, compost. Compost is very good. I get the manure from some people who own cow, goat, pig, and sheep. We go get the manure with the wheelbarrow; we do not have any bakkies. We ask them to give us the manolo for free" (Mr.Z).*

In Ntuzuma and Inanda, the farmers are mostly reliant on the municipality for their soil conditioner. A person from NMPLC periodically comes to their garden and provides inputs that are considered beneficial for growing crops such as dry sewage sludge. Initially, the farmers were reticent about using sludge. Three respondents describe their situation as follows:

> *"We do not have to pay for the manure, sludge that Laurence brings. We get it for free. The driver brings it by truck… Even when Laurence told us about the manure from human faeces, we said: Haibo! It took a*

long time for us to try it, maybe a year passed. Laurence came back again and said come see my hub. When we did visit, we saw how the vegetables were luxurious and so nice. And we said bring a little bit [sludge]" (Ms.T/Mr.I/Mr.C).

Poorly informed of the composition of the sludge, the respondents were unfavourable to the idea of applying such waste onto their soil. However, they are now creating their own compost from the sludge, mixing in manure and their food waste to create manageable and well-balanced compost.

At present, all farmers seem to have reliable sources of fertiliser although they do not own the animals that are producing part of their fertiliser. Wilkinson et al. (2010) stated that phosphorus based fertilisers' cost had increased. None of the farmers interviewed referred to a shortage of fertiliser, though they do not rely on purchasing fertilisers. All respondents, with the help of their respective organisations create their own compost with a mix of animal excreta, food scraps, grasses and such. While relationships between farmers and neighbours or with municipality provide good social capital, they may not be sustainable. Many factors could come into play: neighbours may stop raising animals, they may no longer provide the manure for free, a disease may affect the livestock and the municipality may no longer have in its mandate to distribute fertiliser.

Human urine could be spread by farmers as fertiliser at no cost. Presently, the accessibility to fertiliser is currently limited to farms who are able to afford it or who are fortunate enough to have a reliable source of organic fertilisers. This results in increasing inequality among farmers with different levels of capital. Farmers with abundant sources of fertiliser are able to grow more abundant and resistant crops. While poorer farmers rely on the limited land that is available to them that is often less accessible and fertile. It has been observed that plants grow better, stronger, more resistant and sweeter when fertilised with urine (Jackson, 2005; Dagerskog & Bonzi, 2010). Food security could be improved by the availability and effects of urine as a fertiliser. Moreover, it could potentially increase farmers' tendencies to grow gardens as well.

4.3. Traditional Uses of Urine

Urine use is not a foreign concept in Durban among Zulu people. Most respondents are aware of some uses of urine especially for medicinal or traditional purposes, except for two respondents. In all, ten different uses were mentioned during the interviews.

As a traditional medicine, urine is used for various purposes. It is commonly used to neutralise poison, and to treat pink eye. However, there are specifications as stated by one respondent:

> *"When there is a disease like pink eye, you must have a little three year old boy's urine and you rub it in your eye and then it will be healed" (Mr.M).*

A few respondents had first hand medicinal experiences with urine. Ms.M took her child's urine and put it into his ear to get an insect out. Mr.L recalled being given urine when he was young to treat a stomach ailment.

Some cultural practices relating to urine include emptying and spreading the contents of a night bucket (urine collected overnight) around a homestead to protect against evil spirits. Similarly, if there is something in a backyard that seems untrustworthy urine can be poured on it to kill it. Contrastingly, urinating directly on plants, especially plants that have medicinal properties, will take away their special properties. Urine can be used to bring bad luck upon others. Ms.M states that if someone has a bad dream, wiping your face with the first urine of the morning gets rid of nightmares.

Urine has love potion properties. Ms.Z refers to urine being used to keep partners close to you. Mr.M recalls hearing a story in African culture as follows:

> *"We have a belief that if I am married to you and I do not want any man to touch you. So we make our magic and if a man wants to come to touch you and have sex than his penis will just rest. So now if that guy wants to have sex with you he will need to drink your [the woman's urine] in order to have sex with you [to break the spell]. It is just African magic".*

Urine seems to be an integral part of traditional Zulu medicine, whether used by it self or mixed in with herbs. It has multiple uses and many of which have been tried, tested and proven efficient by several of the respondents.

4.4. Attitudes of Farmers

The attitudes of individuals are important to comprehend their behaviours in particular circumstances. There are multiple uses and experiences relating to urine, stated by the

respondents. It could be assumed that respondents who have used urine would have a positive attitude towards it. However, there seems to be a range of attitudes relating to urine irrelevant of previous uses.

4.4.1. Perception of Urine

Most respondents have diverging views of how they perceive urine. Although, there are differences of opinion, all respondents were adamant in their opinions on urine. In the most part, respondents have an overall negative view of urine in general. It is seen as something negative, dirty and smelly. It is viewed as waste, *"it is just rubbish, just chuck it and throw it away" (Mr.Z).*

However, there are respondents who have a more nuanced view of urine. Not necessarily as something negative, nor as positive. Urine is seen as a natural process. It is something neutral that has to happen to humans in order to keep bodies balanced and healthy. A few respondents refer to urine as something that needs to get released, as one respondent states:

> *"…think about, it is just urine, it is just water plus me. It is just me relaxing water that I have drank. Ur-ine that means even me I am in that urine. The passing of that urine also includes me. Somewhere somehow, there's something I am loosing because those things I have been eating, there's something that is not needed by the body is being released" (Ms.Z).*

There are some respondents who have a positive view of urine. Their confident views of urine have to do with their practical experiences with it or knowledge of its multiple uses, such as the personal experience of Ms.S:

> *"I know I can use it for fertiliser, should I drink something bad I can neutralise the poison. I grew up believing that. The different uses I've tested myself" (Ms.S).*

4.4.2. Perception of Urine in Agriculture

Presently in KZN, the use of human waste for fertilising purposes is seldom practiced and relatively unknown (Duncker et al., 2007; Okem et al., 2012). Even those who are aware of its uses do not necessarily make use of human waste.

During the past decade over 75000 UDDT systems have been installed in the eThekwini municipality (Roma et al., 2011). Plate 4.1 and 4.2 illustrate the two different compartments which have not been used to its fullest extent. The intention of the unit is that once one of them is full, then the toilet is moved to the other side. However, according to the farmers in the cooperative in Inanda, they have not used the contents of the toilets. Moreover, the manner in which the toilet was built did not allow for the collection of urine. The piping was built so that the urine seeped into the ground, though Plate 4.2 shows a toilet with a disconnected pipe where the urine is evacuated directly as surface runoff.

Plate 4.1. A view inside the toilet in Inanda

(Benoit, 27/07/2012).

Plate 4.2. The toilet's compartments and its disconnected pipe

(Benoit, 27/07/2012).

Negative Views

Many of the respondents are not keen on the idea of using urine, especially when applied to edible crops. The fear seems to be that urine could stress and burn the plants such as one respondent states:

> *"If you take it as it is, because there's acids. It might burn it because it is strong. Because there's no, you would have to be careful. I'm sure it will burn because of the concentration" (Ms.S).*

Mr.Gw has a negative perception of using urine in agriculture and is ambivalent to the prospect of eating urine fertilised crops. He thinks that it goes against his training in permaculture. He worries that he would be unable to predict the results of his crops. Whereas presently using permaculture he is able to foresee the product of his sowing. Another respondent categorically refuses to use or consume urine fertilised crops. Yet he does not give a reason for his reticence.

> *"I never tasted it [respondent laughs]. I would not be interested in tasting it. As I have said and repeat again, I take urine a waste [as opposed to animal waste being good] but the human one I think is a bad waste" (Mr.G).*

Three respondents specify that urine could potentially destroy the plants if it was applied directly. However, Ms.T thinks that diluting the urine in water may decrease its adverse effects. Similarly, Ms.J and Mr.L think that mixing the urine with the soil could make it potentially acceptable to be used in agriculture.

Unlike a study based in Turkey which had greater acceptance of urine fertilisation if applied to landscaping plants (Beler Baykal et al., 2011), most respondents do not have specifications on the type of plants that could be grown using urine. If it can be used at all, it should be good for all plants. However, a couple of respondents Ms.M and Mr.M do specify that if they are to use urine they would use their own, urine from their family, not of others.

Positive Views

A few respondents expressed enthusiasm to test out urine in agriculture. Ms.J remembers a NMPLC presentation about urine reuse and seeing photographs of plants being fertilised with urine. The presentation did not give specific directions on how to use urine in

gardens. It specified that guidelines existed and should be followed. Their curiosity seems to have been stimulated by my questioning on the topic of urine reuse. One respondent's answer reflects the co-construction of knowledge and the influence of the research on him, and hence refers to urine as:

> *"It's alright, there's no problem, because as you say it makes the plant good. I don't think it will kill me or will do something to my body system. I don't think it would destroy anything… She's [referring to the researcher] convincing me now." (Mr.Z).*

Ms.Z believes that mixing urine and faeces in the soil would be acceptable. She has eaten vegetables that have been grown with the contents of pit latrines and she has never been sick because of it. Another respondent has similar thinking to Ms.Z, she is not so particular about her manure whereby *"as long as it is manure I don't care where it comes from animal or human, it's just the same" (Ms.S).*

There seems to be a divide between the perceptions of the respondents and what they know about urine. This is particularly flagrant when there are asked about the properties of urine where about ten different uses were mentioned. Yet, many of those same respondents believe that urine is something negative or a waste to be disposed of. In traditional uses, urine seems to be seldom used and only when necessary whereas if it were to be utilised as a fertiliser in farmers' fields then the relationship would be constant. The collection of urine would be done on a daily basis and so would the consumption of crops grown with urine. Then perhaps urine would be perceived as something positive, not only in certain circumstances.

Issues of Blood

One of the reservations in the EcoSan literature is the appropriate use of the sanitation system to prevent cross-contamination with faeces (Hoko et al., 2010). However, there are some people who would consider menstrual blood as contamination. This transfer is not preventable if women use the UDDT during their menstruation. Thus, it is important to understand individuals' perception not only of urine but of menstrual blood as well. Interestingly, historically there was a process in order for men to avoid dealing with menstrual blood in traditional Zulu culture which Mr.Z describes in the following:

> *"Even in old day when women have menstruation she doesn't even touch the clothing of the men or cook. In honour and respect, it is your time to be in your [period]… So it might be challenging for men to go and collect that type of urine or anyone's. Even if women collect their own urine and the women are the only one in contact with the women's urine… Through scientific we don't know but cultural it is out" (Mr.Z).*

All the male respondents are unfavourable to the idea of having menstrual blood in the urine. Mr.G is unwilling to discuss the topic. Among older men, discussing menstruation is unheard of. Similarly, Mr.M mentions that to discuss menstruation is bad luck. However, he sees the benefits of cow blood for fertilising, as it is an ideal component of his personalised fertiliser.

There are some respondents who are more willing to accept menstrual blood in urine if they are unable to see it. In Zulu culture, men are not supposed to see it, though they are aware that it exists. For example in Plate 4.3., it is obvious that menstrual blood is a component of the dried sewage sludge, as it contains sanitary napkins. However, the fact that the blood came in a different form which is undistinguishable made it more acceptable.

Plate 4.3. Heap of Dry Sewage Sludge showing the presence of sanitary napkins

(Benoit, 27/07/2012).

Similarly, Ms.Z has her own experience with blood in practicing agriculture:

> *"Honestly, because the blood thickens and blood rotten it's organic. It can be right… Already the soils where we cultivate there are pads, tissues and so on. They are just active and the plants are still right" (Ms.Z).*

Those who have more positive views of menstrual blood are women. According to the female respondents the blood could be beneficial for the plants. One of the respondents' thinks that if urine can be used in the soil then whatever it naturally contains should be assimilated in the soil as well.

The menstrual blood highlighted the issue of the inputs in agriculture being recognisable. Individuals are aware that the contents of the sludge and pit latrines are predominantly human waste. The farmers in Ntuzuma and Inanda are willing to use the sewage sludge made of degraded human waste. Yet, there remains hesitation to using urine on its own. Possibly respondents are less averse to using sludge and pit contents because the substance looks unfamiliar and has been idle for some time.

4.5. Subjective Norms

Subjective norms are how individuals perceive others and the social norms that guide behaviour. The awareness that a behaviour is useful or not is important. Yet perceptions often can affect whether or not the behaviour is put into practice. The evidence presented in the section above reveals that there is no consensus about the use of urine in agriculture. The respondents are divided among those who have a positive outlook of urine in agriculture and those who do not or who are ambivalent.

4.5.1. Knowledge of Urine in Agriculture

Among the respondents, six know of the beneficial properties of human waste through experience in the field, tasting crops that they knew had been grown with human excreta or stories they had heard. The six others (Mr.G, Mr.Z, Mr.L, Mr.Gw, Ms.J and Ms.M) are unaware of its agricultural uses. Urine is perceived as a waste and it is not to be utilised. Yet, the specific benefits of urine for agricultural purposes are known by only one respondent.

Ms.S recalls hearing about using human waste in Marian Hill. Germans nuns told her about it. They recommended that as long as it looked like manure it could be used. They used to empty the pit latrines and spread the contents on the fields. Ms.Z did herself practice EcoSan:

> *"We plough with human urine and excrement and the food has nothing and we do not get sick. We mix both urine and faeces. You know the old toilet, pit. Before there were no transport to pick up the contents.*

> *We used to close them up with soil than on top of that we used to plant. We got fertile soil, so much cabbage…" (Ms.Z).*

She was 'closing the loop' even before the term was coined in the literature. She has eaten crops fertilised with pit latrine contents, although not with urine specifically.

Growing up in Inanda, respondents from the Sesiphapheme garden remember eating vegetables grown by inmates from a nearby prison. They knew that the potatoes were grown with human waste generated from the prison sanitation system. Still they consumed the large potatoes. According to Mr.C, the soil acts as a sieve and the plant takes what is beneficial to it, which coincides with the belief in Pakistan that plants are capable of controlling the intake of nutrients and pathogens (Drangert & Nawab, 2010).

Mr.M is the most knowledgeable respondent about urine's specific use in agriculture. Though he has never used urine in agriculture, he is aware of its nitrogen content and he has his own specifications for its use where:

> *"I know food will be good because I learnt about it… I can use especially if you are dealing with fruit trees or sugar cane. Plants that takes longer to reach harvest. Because I believe maybe all the diseases will be gone. But I won't put it on my mushrooms because I harvest after two weeks" (Mr.M).*

In the past he has used sewage sludge that had been provided by the municipality. Allegedly, chlorine and high temperature are used to kill pathogens, although the effect on the quality of the crops is unknown. There seems to be confidence in the quality of the sludge and in the municipal authority.

4.5.2. Perceived Concerns of the 'Other'

Even if an individual has a positive perception of urine and knowledge that urine is beneficial in agriculture, the individual still may be hesitant to make use of it due to the perception of others'. How will the community perceive the individual if the farmer were to use urine? This question seems to be a prominent issue among respondents.

Mr.M is the prime example of a farmer who has a positive perception of urine, knows multiple traditional uses, as well as its use in agriculture. However, he would not use urine in his garden. He mentioned that:

> *"I would love to do something with it but because the customers they do not understand the value of it. It will have a negative impact. If I tell them, this carrot I grew with my pee, would you like some, they will say no. Unfortunately, I would love to but I cannot do. In a different circumstance I would. If I got a farm and someone takes my vegetables even if I use it [urine] then I would. For the sake of my business I will say no" (Mr.M).*

For him, urine reuse would have negative consequences because of his customers' possible negative perception of it. He fears consumers pressure such as was exerted on Swiss farmers who used wastewater for irrigation (Lienert & Larsen, 2009).

Some Swedish farmers who used urine in their farm did not inform their customers (Lienert & Larsen, 2009). Similarly, many respondents if they were to practice urine reuse, they would keep it to themselves. Ms.Z argues that consumers do not need to know if their vegetables are grown with urine. According to Mr.Z presently most consumers do not know how, who and where their vegetables are grown. One way that he would encourage the consumption of urine fertilised crops without stating that urine is used would be that:

> *"you say it is organic crops, they will buy it. They can't ask how you plant it, what you put in the plant. Then, the consumer would not know about the urine" (Mr.Z).*

During a dual interview, Ms.Z and Ms.M interacted and probed each other during the interview. When asked if Ms.M would use urine in her garden she said: *"I would only use my family's urine, unless he or she is a visitor"*. But then Ms.Z interjected and mentioned that she thought that Ms.M was not afraid of using someone else's urine per se. But the real issue is *"she's afraid of asking them: Please give me your urine".* Then, Ms.M confirmed that if there was a process of collecting and distributing urine she would use it, as long as she was not involved in the process.

Whether in terms of business or a community's perception of a farmer, people worry about their position in their community and how they are perceived by others. Presently, in eThekwini the idea of EcoSan is new and unusual. Thus, if the idea is to gain any momentum there needs to be community support.

4.6. Perceived Behaviour Control

The concept of perceived behaviour control relates to the ability to perform an action or behaviour. It goes beyond perception to factors that may hinder or persuade an individual to pursue an action (Ajzen, 1991). In the following research, several reasons are underlined that could impede the practice of urine reuse and thus control behaviour of farmers.

4.6.1. Non-Motivational Factors

The first factor relates to smell. The food individuals consume especially adults contributes to the smell and quality of the urine. It is believed that eating habits influence the quality of the urine. Among respondents, infants' and animals' urine are held in higher regard than that of an adults just as it is in the Drangert and Nawab (2010) study in Pakistan.

Many respondents mention the issue of alcohol consumption. It is believed that the urine is of lesser quality if it comes from someone who consumes alcohol frequently. The smell would be more unpleasant if it were to be used in fields. Therefore, what is eaten is believed to affect urine. The belief that we are what we eat seems to be reflected in a person's perception of urine as well.

Most of the traditional uses of urine require using the urine of a child or an individual's own urine (Drangert et al., 2002; Duncker et al., 2007; van Vuuren, 2008). The urine of a child is seen as purer, as the child will not consume as many processed foods or alcohol as an adult. Therefore, if a person were to use the urine of another, there is a fear of what they consume could influence the quality of the urine.

Respondents fear that there could be pathogen transfer from a person's urine to crops. Similarly, found in the literature concerning the handling of human waste where it may expose individuals' to the risk of contracting HIV (Drangert et al., 2002; Duncker, 2006; van Vuuren, 2008). A few female respondents refer specifically to sexually transmitted infections (STI). Similarly, the issue of hormones and the potential impact hormones could have on the crops. Ms.J worries about the unpredictable impacts that may aggravate her perceived early onset of puberty among children:

> *"What comes out in our urine is not 100 percent, children are growing faster, just like women's breast getting bigger faster and sexual debut… it [hormones] affect the development of the children" (Ms.J).*

When concerned with logistics, the issues of storage, smell and availability were mentioned. Availability of urine may not be an issue, as we produce urine on a daily basis. Mr.Gw does not think the storage of urine could be feasible as the smell of stored urine would be too unpleasant to deal with. The smell would be a deterrent for customers. It would be perceived as dirty and unhygienic.

Similarly for transport and collection, individuals who require large amounts of urine, more than what they can produce from their household, would require the transport of urine from various sources to their fields. Although the respondents may feel comfortable using urine in their field, some are not willing to go around collecting it from their community. Moreover, most respondents do not have access to transport and presently rely on the organisations for transport logistics when it comes to farming purposes,

A few respondents do not see the practicality of using urine in their fields. Currently, they have sufficient 'free' access to fertilisers through their social networks. They know what to expect from their current techniques whereas if they were to use urine, they would not know what the outputs would be because they lack the knowledge and the experience.

Similar non-motivational factors arose in the research as it did in a study in Ghana where smell, consumer perception and health issues were the main concerns behind the scepticism of urine reuse (Mariwah & Drangert, 2011). The lacuna referred to most often by respondents was the need to gain more information on the topic, acquire skills. Then using urine in agriculture could be an option.

4.6.2. How to make the reuse of urine possible

According to most respondents urine reuse in agriculture could be made possible through training and workshops. First the workshops would target the farmers. Farmers must learn about the benefits, the risks of urine reuse and the application techniques. They are the first people who must be convinced and see if it is feasible.

There needs to be information dissemination from farmers to the community, in order for people to get used to the idea, and have the idea be mainstreamed. It needs to be a gradual process as most consumers *"cannot believe it. It is not easy to change their minds" (Mr.I).*

A practical manner in which training could happen, would be to witness it, i.e. demonstration plots to provide a comparison. People need to see it to believe it, Mr.Z states

that *"she's [the researcher] convincing me now. I might use it in some plot to see the difference between different plots, to compare".*

A few respondents see the youth as a potential for mainstreaming EcoSan. They see the youth as having the power to influence their parents and the future. In the statement below, Ms.J thinks that children would have a greater influence.

> *"They should start with children in school. Because with children and they tell their parents so it will be easier than if we tell the parents directly. It is hard to convince the people in the community, as they think it is a waste period and it is hard to compromise with them. But the children might have more impact. It is easier to communicate with children, than researchers or people from the department of agriculture" (Ms.J).*

Mr.G has an overall negative perception of urine and little knowledge about it uses. He dismisses the idea for himself. Yet, he sees potential for future generations. Mr.G states that: *"maybe in the future it could be an option".* Technology is continuously developing. The youth are learning about these new technologies everyday. They should be the first to adopt these new methods and ways of thinking about agriculture and the world.

Every respondent thinks it can be made possible in one way or another. None of the respondents have fatalistic view even those who are the most pessimistic. Although to change people's way of thinking is a slow and arduous thing to do. It requires commitment and passion, to make it feasible and sustainable. In order to promote the idea of urine reuse, respondents referred to workshops, training and demonstrations for comparative purposes. This type of support was provided in Mthatha, where the receptivity of urine has been high (van Vuuren, 2008). A few respondents focus on the next generation, encouraging the education of the youth as innovators but also as initiators in their own households. It is suggested that the children would bring in the new knowledge into their homes more convincingly than external experts.

4.7. Conclusion

Most of the respondents have been farming for decades. They have experience and training by being involved with the Agri-Hub and NMPLC. These trainings have changed how many of these farmers practice agriculture, now using more ecologically friendly techniques.

There are many different uses for urine in Zulu culture such as for health and traditional reasons. Yet most respondents have no or limited knowledge of urine's use for agricultural purposes. Overall, most respondents have a negative perception of urine.

Many respondents fear the repercussions of using urine, some of it relates to smell, other practical aspects such as lack of knowledge and technical know-how. Farmers are worried about the reaction they could receive from consumers and their community concerning urine fertilised comestible crops. Many respondents state that they would keep the reuse of urine secret, fearing the negative responses from consumers.

Some respondents are curious about the idea of urine reuse, although they would want to have training in order to apply it in a safe and healthy manner. All the ideas suggested by the respondents could help propagate the concept of EcoSan. It would allow for a significant role for Umbumbulu Agri-Hub and the NMPLC in training and knowledge diffusion. They already provide technical skills to the farmers. They have had great impact in affecting the farmers' agricultural practices by introducing more ecologically friendly principles. Why not 'close the loop' totally?

CHAPTER V: THE ATTITUDES AND KNOWLEDGE OF URINE AMONG AGRICULTURAL TRAINERS AND PRACTIONERS

5.1. Introduction

The purpose of this chapter is to discover more about the structures in place in the organisations the farmers are involved with. These organisations could represent an entry point for the concept of ecological sanitation in practice. They could provide a structured manner in which to introduce urine reuse, efficiently, comprehensively, while at the same time providing feedback and support for the farmers. During the interviews with farmers, the link between the organisations and the farmers was evident, especially those who seem, to be reliant on the structures set in place by the organisations'. It is relevant to understand the background of the organisations, the perception and knowledge of these key informants. They are the one's who hold, to a certain extent, the power and influence over the diffusion of knowledge to the farmers.

By considering both the perceptions of the farmers and the key informants it would allow for an understanding of the feasibility of implementing training for both groups involved in EcoSan and urine reuse. Therefore, the farmers with this newly acquired knowledge could do with this information what they deem fit.

5.2. Background of Informants and their Organisations

The Umbumbulu Agri-Hub

The Umbumbulu Agri-Hub (see Plate 5.1.) was developed to support small-scale farmers to implement permaculture principles. It is indirectly linked to the municipality and receives municipal as well as private funding. The team of trainers at Umbumbulu is quite small and started training farmers in 2009.

Mr.N, the mentor, is sustaining the affiliation between the Agri-Hub and the farmers. He has little formal education in agriculture but has gained knowledge through six years of experience in permaculture. He has worked in the agri-environmental field since 2006 before joining the Umbumbulu Agri-Hub in 2010. Ms.P has no formal environmental education either. However, her years of experience working on organic farms, and her familiarity with environmental issues, have given her the background to refer to herself as a sustainable development practitioner.

Plate 5.1. The Umbumbulu Agri-Hub

(Benoit, 09/07/2012).

The Umbumbulu Agri-Hub model has extended to support farmers in terms of sustained training, provision of seeds at discounted prices and gaining access to markets. This year training has begun in three new locations with plans to develop Agri-Hubs in those three areas around eThekwini (Ms.P, 20/07/2012).

As an organisation, the Agri-Hub does not encourage the use of chemical fertiliser, as it damages the soil. Ms.P referred to beneficial organic matter as a 'soil conditioner'. For phosphorus, crushed bone is encouraged by the Agri-Hub. As mentioned in Smith (1954), it was used as one of the sources of phosphorus prior to the mining of phosphates. To enrich the soil and bring it back to life, a mixture of whatever is available to the farmer is used to make compost. Typically, it is composed of leaves, cow dung, food scraps and worms to help with the decomposition. The input of this fertiliser is encouraged by the Agri-Hub as it is free and can be done by the individual farmers themselves as long as they have some knowledge of compost production. This is a skill that has been transferred through training sessions at the Agri-Hub.

The Newlands Mashu Permaculture Learning Centre (NMPLC)

The team at the NMPLC (see Plate 5.2.) is comprised of multiple workers who are hired by the municipality. Ms.S had been working at the NMPLC as a trainer for a decade. She has her Standard 6 but no educational background in agriculture. Since 2002, she has acquired her skills in permaculture while working at NMPLC. She views her work in a holistic manner as helping people,

"…to manage themselves, to get the fresh vegetables and maintain and look after themselves, even you can use a small space of the land to grow many things" (Ms.S).

Plate 5.2. NMPLC gardens

(Benoit, 11/07/2012).

Mr.B is a horticulturist for the eThekwini municipality. He works closely with the NMPLC. He holds a higher national diploma, the equivalent of a Bachelor of Science, in horticulture. Mr.B has been at the municipality for 28 years and involved in urban agriculture since 1999. In 2009, the agroecology unit was formalised. His view of the work done at NMPLC is as follows:

"…we decided to go back to the future. So, I'm determined that when the policies are written it will force us to go back to the future, which is non-conventional methodology that will enable us to happily conserve natural resources without putting any pressure on our soils, geologies and water" (Mr.B).

NMPLC helps to support the municipality's farmers by addressing issues of food security, preservation of natural resources and community participation. According to Mr.B, only non-synthetic, natural fertilisers are encouraged at NMPLC. Ms.S who provides training to farmers learned about composting at NMPLC. Until recently, she only knew the 'Zulu way'. She was taught from a young age, that only manure was used when planting. Prior to her involvement with the organisation to reuse and compost were unknown ideas to her. Now she encourages the farmers to use both manure and compost. Both organisations focus on

environmental and human health. They have increased the exposure of community members to permaculture and developed gardening practices in a more ecologically responsible and sustainable manner.

5.3. The Trainers' Perception of Urine

In both organisations, the trainers are aware of some uses of urine. According to Ms.S and Mr.N, both Zulu respondents, urine has cultural uses. Ms.S has used urine and mixed it with traditional medicine to treat flu and other illnesses. Similarly, Mr.N states that urine can be used to treat stomach and eye problems and as well as topically for insect bites. Moreover, Ms.S refers to a mixture of urine and a root can be used to chase away nightmares.

Ms.P states that for people of European descent urine has always been considered dirty, though her opinion differs. She read a book on urine therapy in her adolescence, which gave her a different view about urine. Her view is as follows:

> *"I've always see it as something that maybe, is part of our bodily process and not as a waste. The waste is the solids and the liquid is actually your own body manufacturing what you need to survive or to cure you. So I've always seen it as a resource" (Ms.P).*

Although Ms.P knows of urine therapy, she has never used it personally, and neither has Mr.B. However, he thinks that urine should be disposed of in an ecologically sound manner and not be flushed away unnecessarily. He mentions that if someone is in a dire situation without fresh water then that person can drink their own urine to survive.

All key informants working in the agricultural organisations believe that children's urine is purer because adults tend to often consume unhealthy food. Thus, the urine from adults will be less nutritious as well. To the fact, Mr.N alludes that what a person's ingests affects what is excreted, but how this occurs he does not know. Similarly Ms.P, from experience, refers to eating beetroot which makes urine be pink in colour.

Even if all informants are aware of alternative uses for urine, it is still thought of as a waste. Though they have the knowledge of its uses, only Ms.S has personally used urine in a positive way.

5.4. Perception and Knowledge of the Use of Urine in Agriculture

All the respondents are aware to a certain extent of the benefits of urine in agriculture though their willingness to use varies. From attending multiple workshops Mr.N remembers learning about the benefits of urine reuse. In one of the presentations, he recalls seeing photographs of crops from Asia that had been grown with urine and others without for comparative purposes. From this he saw the difference and the potential of urine to produce superior crops. Though, he has reservations, such as:

> *"If I live on a farm I will have a compost toilet. I will make sure all my family eats healthy and I will take all that energy back to the soil. It is black gold… I would use it (urine) for fruit trees until I get a correct moderate ratio for vegetables. But for now I do not have a certain ratio, I need to find out first, more about it" (Mr.N).*

The urine would have to be used and diluted immediately due to issues of storage and smell. If urine is stored then the smell would permeate and pollute the ambient air. On the other hand, faeces would have to be stored to take away the moisture and the smell. The composting process would also kill the pathogens that may be found in human waste (Mr.N, 09/07/2012).

Van Vuuren (2008) had found in his study that respondents specified that urine should not be used on root, leafy or vegetables that have contact with the ground. Similarly, Mr.N is quite sceptical about using urine in a vegetable garden with leafy crops. He does not have an issue with someone urinating directly next to a fruit tree, as it will take time before the urine is absorbed and reaches the fruit. According to Mr.N, applying urine during the ploughing or seedling process is more acceptable. He explains that:

> *"I am not too sure about pathogens you may apply in the soil but in the nursery you can control for pathogens. You can see if the plant is growing or dying or changing colours" (Mr.N).*

Using urine at the seedling stage would allow a farmer to have greater control over the plants. The growers would be able to observe, before the crops are ready for consumption, if there are negative impacts on the seedling. Thus, if used earlier in the process, the risk and the opportunity cost would be minimised if complications were to arise.

According to Mr.N, one of the benefits that would arise from urine reuse would be the creation of a 'new' source of nitrogen. It would also decrease the strain on water resources, as urine is composed of water. Moreover, it would decrease stress on the sewage system and decrease cost of infrastructure as it is a decentralised approach. The present lack of sanitation in the municipality may result in contamination of water bodies. Subsequently, it could then negatively affect the environment and the health of individuals, who end up drinking the water from those contaminated water sources as it did a decade ago in eThekwini (Roma et al, 2011).

Urine does not only contain nitrogen. Ms.P also referred to the phosphorus and urea content of urine. The exploitative manner in which agriculture is practiced today requires phosphorus to be added back into the soil. Phosphorus is often added in chemical form by farmers to replace what occurs naturally in the soil. There is a limit to the extraction as phosphate is a finite resource (EcoSanRes, 2008a; Cordell et al., 2009; Von Münch & Dahm, 2009). As a result, in commercial agriculture artificial fertilisers are added to the soil to replace what has been taken and this creates environmental problems. Ms.P has great confidence in urine and its composition as she states:

> *"Instinctively I would think that urine probably has the right proportion and ratios of everything. Just because of the way nature works and it is very clever" (Ms.P).*

However, she does not encourage the use of urine at the Agri-Hub and personally has never used it. Ms.P also comments that blood is a very good fertiliser. She has seen it being used in organic agriculture from the abattoirs in the United States. Ms.P is uncertain whether menstrual blood would have a positive impact. She states that there may be issues regarding hormones, a fact which is also highlighted by some of the farmers.

Both Ms.P and Mr.B states hormones and antibiotics are an issue not only to be considered when using human waste, but also with animal waste as well, such as horse manure. It is often used to make substrate, as Mr.B mentions about the equine industry…

> *"…if the horse is off beat or scale then the vet needs to give it a boost - usually [with] heavy with antibiotics that has found its way into the compost" (Mr.B).*

Ms.P sees antibiotics as an issue and believes that storing urine would get rid most pathogens but not antibiotics. Interestingly, she does not know anyone who uses human urine, even among environmentally conscious people. The only urine she has seen being used is horse urine. Ms.P states that there are positive and negative aspects of urine reuse, and offers some specifications if it is to be applied. She does not like the idea of having to handle urine and feels that a system that would minimise the handling of urine would be the best. This is contrary to the findings of Van Vuuren (2008) who found that people would rather use faeces to urine possibly because it more closely resembles manure. Ms.P prefers the idea of using urine. If she is to use it she would prefer using her own diluted urine. Ms.P does not like the idea of using other people's urine, and if she does, she would rather compost it instead of using it directly.

The people who work at NMPLC seem a bit more ambivalent about the use of urine in agriculture. At this point in time, the contents of UDDT are not being used as the specific content of the urine and faeces are unknown. Ms.S would want to make sure that the urine is tested prior to using it. Mr.B is aware of the benefits of human waste but believes that biodigesters as better structures for dealing with human waste and that would provide energy and compostable material for households.

The trainers are also worried about the direct application of urine. The level of toxicity may be too high and affect the quality of the soil in the long run. In the case of menstrual blood, Ms.S is concerned about the transmission of HIV, such as stated in Van Vuuren (2008). Similar to Ms.P, Mr.B believed that blood was beneficial for plants, referring to blood meal used in gardening.

Ms.S states that she would use urine in her garden but would more likely use it on non edible plants. Moreover if it is composted for two to three months, then the probability of disease transfer would decrease. Mr.B supports many gardens in the municipality and believes in the beneficial impacts of urine reuse such as its nitrogen content. He argues that urine would sustain plant growth and would add moisture to the soil. Moreover, Mr.B has much faith in the physiology of plants, as he states:

> *"Put anything through soil and the soil structure that is liquid [and it] polish, scrubbed and ameliorated before it comes out in the other end… So the plant won't take up more than it can handle. Then the plant is the only living thing on this planet, engineered to move liquids*

against the pull of gravity, then the leaves themselves through transpiration remove excesses"(Mr.B).

In conclusion these is an awareness of urine as a fertiliser among the key informants, but the exact manner in which to use urine efficiently and safely use urine is unknown. Similarly, there is hesitation in how urine would be logistically utilised and there are concerns about health and disease. It seems that prior to training the farmers on urine reuse, there would need to be specific training for the trainers. Then everyone involved would be aware on the appropriate EcoSan practices needed to gain the full benefits.

5.5. The Feasibility of Integrating Urine in Agriculture

During the interviews, most farmers were curious about urine reuse. They acquired their permaculture skills through training with the Umbumbulu Agri-Hub and NMPLC. These structures play an important role in deciding if training regarding the use of urine would or would not occur. This section seeks to get an understanding if whether it would be feasible to integrate urine reuse as a component of the training in either organisations and what would be the barriers to doing so. The following discussion presents the view of the trainers about including such training in their programmes

Mr.N states that he would start slowly. He would begin with his household and then move to other households in the community. Training could be done through educational comparative demonstrations of crops production to convince the community. According to Ms.P it would be a difficult task to educate the general populace about the EcoSan, as she is unaware of anyone who uses human urine, thus difficult to lead by example.

In relation to logistics, Ms.P has quite a few concerns. First, she argues that it is necessary to find a way to minimise the handling of urine as this could possibly reduce the feeling of disgust. One would also have to get the UDDT more widely accepted, as they have been received with some reticence by community members (Duncker, 2006). Ms.P argued that to do so one would have the UDDT look more like a conventional flush toilet. She is unaware that ceramic toilets UDDT already exist, although they do consume some water (Lienert and Larsen, 2006). This would also provide some aspect of dignity, as the look of the toilet and the fact that it is situated outside the home, are deemed 'undignified' (Nawab et al., 2006; Roma et al., 2011).

Ms.P is the only informant who mentioned race as a possible constraint to the reuse of urine. She does not elaborate, though she does mention that…

> *"…a lot of racism will also come in it might be fine if it's white people's urine and not so fine with Black people's urine, I don't know. But instinctively if there was such thing [urine reuse] they [the whites] wouldn't be totally happy with it" (Ms.P).*

Both Ms.S and Mr.B are sceptical about the potential of urine reuse being implemented at the NMPLC. They are not adverse to the idea but saw obstacles to putting it into application on a wider scale. Hence, their views are rather pessimistic.

Ms.S is aware that many farmers are dependent upon farming to earn an income and livelihood. Therefore, many would not be willing to try new techniques as they may not be as efficient as what they have previously practiced. Farmers would worry about consumer's opinions which could be damaging to their reputation and they might make a loss financially. Both Ms.S and Mr.B mention that there is a way to circumvent making the explicit statement that the crops are grown with urine. Farmers could rather state that these crops are grown in an 'organic and environmentally sustainable manner', which would be perceived positively by consumers.

Mr.B states that presently urine reuse is not a feasible practice in eThekwini although he states no disadvantages of using urine and said that it would only have beneficial impacts. The first benefit is the NPK composition of urine which has the same components as many commercial fertilisers. Secondly, urine would increase the moisture content of the soil, resulting in decreased water consumption.

Interestingly, respondents, Mr.B and some Swedish farmers stated about the growing process of crops that, *'unless they ask do not tell'*. If you go into more detail it is *"much to your own peril… as far as I am concerned Yo ur'in'e or Your Out" (Mr.B)*. What matters is that the urine fertilised crops look, smell and taste like those which customers are accustomed to (Lienert and Larsen 2009).

5.6. Conclusion

From the responses, the trainers in the agricultural organisations interviewed have positive views of urine in agriculture. However, it appears that even though they are aware of

the uses of urine, they do not know enough in order to apply urine in the appropriate manner. Presently urine reuse is not part of any training at the Umbumbulu Agri-Hub or the NMPLC. The evidence shows that they do not have the desire or the necessity to use urine in their organisation. Their main concerns are the handling of urine; the apprehension of what consumers would think; and lastly, the lack of knowledge to guarantee that the urine is suitable to be used on edible crops.

The respondents do not categorically refuse the idea of urine reuse in agriculture in eThekwini. They agree that it would be a slow process that would require demonstrations and education. According to one respondent, he prefers the idea of using biodigesters rather than urine reuse, as human waste could then become a source of energy. Yet there are some concerns that the idea of EcoSan would not be accepted. According to one respondent, racism may be an issue, with white individuals' unwilling to consume crops grown with urine from black people. Furthermore, the perceived risks of individuals' in urine reuse need to be addressed if appropriate implementation is to occur.

CHAPTER VI: DISCUSSION AND CONCLUSION: EMERGING THEMES IN URINE PERCEPTION

6.1. Introduction

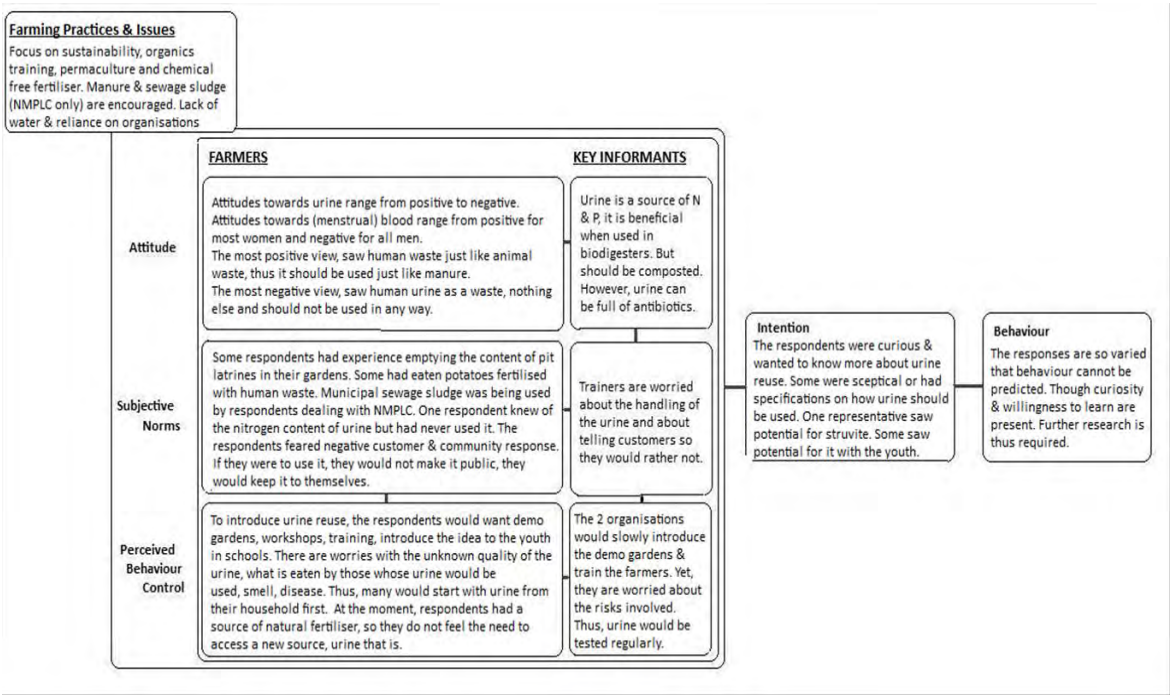
This final chapter provides a discussion of the main themes that emerged in this study on the perception of urine in agriculture by farmers and representatives from the training organisations. Qualitative interviews with 12 farmers and four representatives from both the Umbumbulu Agri-Hub and NMPLC were undertaken from July 5th 2012 through August 29th 2012. The data was analysed to highlight the themes that have emerged in relation to the potential use of urine in agriculture. The following chapter is devised with an introduction of the present farming practices of the respondents. Ajzen's theory of planned behaviour is applied to the results to understand to what extent the farmers and representatives behaviours may be influenced by their attitudes, subjective norms, perceived behaviour control and intentions which are each elaborated in separate sections (Ajzen, 1991). The three components of the TPB are associated with the respondent's intention in behaviour in relation to using urine in agriculture. Unlike most research based on the TPB, this study does not seek to determine behaviour nor actions that respondents' will take in the future. However, in the light of the study, EcoSan is an idea that has stirred some curiosity among farmers. Each research objective has been highlighted and answered. In conclusion, is the contribution this study has made to the literature on urine perception, the limitations of the study and some recommendations. The following figure, Figure 6.1 illustrates the theoretical concepts and the related themes that emerged from the respondents' interviews in relation to the theory of planned behaviour framework.

6.2. Present Farming Practices among Farmers

A discussion of the present agricultural practices and how they were acquired, aids in the understanding of how attitudes may affect aspects of behaviour. The evidence shows that there is a noteworthy bond between the farmers and the organisations with which they are associated. The connection appears to have greatly affected the farmers' agricultural practices. The farmers use a language that projects an environmental consciousness. The success of their gardens and the many techniques they are using can be attributed in part to the skills and training they have received from their respective organisations. Their training has focused on

sustainable agriculture: the organisations have introduced permaculture principles, encouraging the use of manure and in NMPLC only, sewage sludge. The Agri-Hub and NMPLC have introduced most farmers to organic agricultural practices and they are progressively phasing out chemical inputs which farmers were more accustomed to.

Figure 6.1 Main themes presented in the Theory of Planned Behaviour framework



Some farmers, like Mr.M, have used his own initiative to expand and go beyond the market access provided by the Agri-Hub. Most respondents in Umbumbulu, however, are still reliant on one network. The farmers, dealing with the NMPLC, access markets through their farmers' cooperatives. One of them has recently signed a contract with a grocery chain in the area. Physical geography constricts what strides can be made. The farmers' environment poses certain limitations to their production capacity such as rainfall and access to land. The NMPLC therefore helps the farmers where they can, by providing fertiliser in the form of manure and sewage sludge.

The other pressing issue faced by the farmers is access to water. The farmers in Ntuzuma have limited access to water and draw their supplies from a small polluted stream that has invasive species infecting the river banks. The Jojo's, which are large water tanks,

provided by the municipality are insufficient to meet the demands of the farmers (Roma et al., 2011). In Inanda, only a few of the Jojos' are filled on a monthly basis. Their irrigation needs are not being met and thus there is an insufficient amount of water for the crops they are capable of producing.

Although the farmers did not mention urine reuse as a means of decreasing water consumption and improving access to fertiliser, they may have if their situation was more desperate. They are being helped and somewhat sustained by the NMPLC and the Agri-Hub. Hopefully, in the long run, the farmers will be able to become more self-sufficient without needing the aid of the organisations to access these services.

6.3. Respondents Attitudes towards Urine

The evidence as shown in Figure 6.1 illustrates that there are diverging themes in attitudes, knowledge, experience, and the respondents' willingness to access more information about urine reuse. These responses are mirrored in the intentions of the farmers, whereby some are curious and want to know more about EcoSan such was the encouraging developments in Ghana (Danso et al., 2004; Cofie et al., 2011; Mariwah & Drangert, 2011).

In relation to menstrual blood, there is disparity between genders. Most male respondents do not want any menstrual blood in their soil, as it is culturally unacceptable for men to have any contact with menstruation. The issue of blood highlights an interesting point which relates to the ability to recognize blood as a substance; parallels can be drawn here to sludge or pit latrine contents. Evidence shows that in Southern Tanzania, where there was an initial ambivalence to planting trees in old latrine pits, people too discovered that the contents became unrecognisable and proved to be a great fertiliser for their trees (Drangert, 2004; Jackson, 2005). Individuals know that there is human blood, urine and faeces in the sludge and the pit latrine content. Yet the contents have remained idle for months and changed in such a way, that the substances no longer look familiar. In some instances, it makes the end user more willing to use it especially among respondents in Inanda and Ntuzuma as they have accepted sludge with the encouragement of the NMPLC.

In general, both representatives' and farmers' attitudes toward urine is negative. They consider it a waste product that needs to be disposed of, for some, preferably in an ecological manner. Many respondents are aware of cultural and environmental uses for urine, of which many have first-hand experiences. However, there is a discrepancy in people's attitudes. It

appears that urine can represent multiple things at the same time depending on the needs. For example, urine is considered beneficial for an eye infection but is otherwise considered a waste if there are no current use for it.

A few respondents have a positive or neutral perception of urine. It is seen as something that is part of the human body and thus can not be bad. Some refer to the use of animal urine and make a parallel with human waste, stating that there is no real difference between them. Thus, the argument is that if people regularly use manure, there should be less aversion to using 'humanure'. Similarly, one of the farmers and all representatives are aware of the beneficial components of urine, namely nitrogen and phosphorus. Yet, they do not encourage the use of it. They rather see human waste be biodigested or composted, if it is ever to be used. These two methods would allow for a decrease in the perceived risks involved when dealing with urine.

While there are multiple uses for urine in Zulu culture, urine is not something that is used on a regular basis. Most respondents state unfavourable attitudes toward urine, especially urine in the context of agriculture. In addition, it is a fairly unknown practice in eThekwini.

6.4. Respondents Subjective Norms towards Urine use in Agriculture

There are several themes that arose during this research that may affect respondents 'subjective norms' in relation to urine reuse as described in Figure 6.1. Most farmers know of and have experienced some uses of urine in their traditions. Yet, only two of the four representatives know of traditional uses of urine. In all, only Zulu respondents have knowledge of urine uses beyond from what was learned from books. Conversely, all representatives are aware to some degree of the use of urine in agriculture. None of the farmers have used urine on its own as a fertiliser. Yet, some farmers know and have used waste by emptying pit latrine contents into their fields.

Many respondents are willing to use products such as dry sewage sludge, pits latrine contents, as its components are indistinguishable and due to its physical similarity to manure, even though they are aware of consumers' negative perceptions to human faeces and urine. In fact, according to Mr.M, it should be obvious that human urine and faeces are beneficial and will not harm plants. He gives the example of guavas. Many guavas trees are not planted but are found scattered in fields. The seeds usually come from human and bird faeces. According to Mr.M, there is less resistance to eating guavas because a guava tree takes years to grow

whereas spinach grows much faster. The example demonstrates that the idea of human waste in agriculture in not rejected but can be accommodated under certain conditions. As in Turkey, people accepted the idea of urine reuse and were willing to tolerate its use in certain situations as with landscape plants (Beler Baykal et al., 2011). Yet, it seems that visually and explicitly knowing the provenance is a mental block for individuals who are faced with the idea of human waste reuse.

The perceived social pressures that farmers feel from their community and customers also affect their willingness to pursue urine reuse. A few respondents have experienced the benefits of EcoSan without advertising the practice to their community. One of the respondents, although never having used urine before, worries on a personal level about what others would think of urine reuse as presently the idea of EcoSan is new in the community. There worries are not unfounded, as was experienced by farmers in Switzerland who were forbidden to use wastewater in their fields because of consumer pressure (Lienert & Larsen, 2009).

One of the concerns raised by respondents is in relation to business. For example, one respondent stated that he knows the beneficial impacts of urine (Mr.M, 19/07/2012).Yet, his 'subjective norms' have influenced his concerns about growing his business and retaining his customer base. He perceives that the dominant attitude to urine is disgust and is unwilling to risk his business, even for the potential benefit urine could bring.

As urine is generally perceived negatively by consumers, the respondents who recognise the potential in urine reuse would withhold the fact that the crops they are selling are fertilised with human urine as stated by Lienert & Larsen (2009) study based on Swedish farmers. Most respondents argue that if consumers knew this they would lose their customer base. Moreover, respondents assert that presently most consumers are not aware of how the vegetables they purchase are fertilised. Thus, not stating that urine has been used to fertilise the crops would not deter the fact that the crops would be grown in an environmentally sound manner and would not contain any chemicals. From this evidence 'subjective norms' or how the farmers view the opinions of others, play an important role in determining their intentions and their potential behaviour.

6.5. Respondents Perceived Behaviour Control towards Urine use in Agriculture

Among those who have knowledge of EcoSan, none of the respondents reflected the precise technical knowledge that is found in the literature (Jönsson et al., 2004; WHO, 2006). There are various themes depicted in Figure 6.1 relating to specific elements that could be dealt with in order to make urine reuse more appealing to farmers. If EcoSan is ever to be mainstreamed, individuals need to have specific knowledge about the proper use of urine for agriculture in their context. In the literature review, several case studies of urine application in gardens were successful in getting people's curiosity aroused about EcoSan, asking questions, seeing the value of urine and in some cases using urine on their own crops (Danso et al., 2004; Jackson, 2005; Tilley et al., 2009; Dagerskog & Bonzi, 2010; Kassa et al., 2010; Cofie et al., 2011). Therefore, for the purpose of skills transfer, trainers should receive initial training and workshops on urine reuse. Then in turn these two organisations could provide workshops on urine reuse to the farmers in order to 'close the loop'. Furthermore, demonstration gardens could allow individuals to witness firsthand the impacts of urine reuse. Farmers would then be able to decide if they wish to apply the concept of EcoSan in their gardens or continue on their current path. Nonetheless, they would have been exposed to new ideas and have accessed to knowledge which may be useful should they wish to resort to the practice later on. Presently, access to fertiliser is not a barrier to their agricultural production but it may become in the future.

The 'perceived behaviour controls', (i.e. smell, disease, urine contents) are in the most part issues that can be dealt with through the transfer of skills and knowledge. The respondents are concerned with issues of pathogens, hormones and the quality of the urine in relation to what is ingested. If extensive testing of urine and adequate application is done, then there should be no concern about negative consequences. In order to progressively introduce EcoSan, households could start with using urine generated at home and use it on crops for personal consumption. In this way, individuals' would have more means of control over possible pathogens, hormones and nutrient content of the urine.

In order to persuade the general public of the benefits of urine reuse, there needs to be extensive testing performed to guarantee the safety of the process and reduce risks. In doing so, the scientific soundness of the process will likely give peace of mind to both proponents and benefactors of EcoSan.

6.6. Intention in relation to Urine use in Agriculture

All respondents think that urine application in agriculture is possible and none of them have a defeatist view. Though it will take time, trying to persuade people is a slow and arduous process. It requires commitment and passion, to make it feasible and sustainable. Even the most pessimistic of respondent's sees a glimmer of hope, if not for them to use but for future generations.

A novel idea could be to introduce the topic of EcoSan to the youth and have the concept as part of their educational curriculum. Educating young people on this topic will allow them to be exposed to environmentally sustainable sanitation systems that have beneficial impacts on their environments, well-being and their health. It could potentially improve their food security. Similarly, the youth are also drivers of change and can influence what is done in their community and their households. Children learning new concepts would tell their parents about them and could possibly influence their family to put those concepts into practice.

According to one of the organisation's representatives', the use of struvite is a way in which urine could be applied to avoid explicitly stating that urine is being applied as a fertiliser. Struvite could overcome the issues of smell which is a reason of the reluctance of some the respondents. This would in turn, address the concerns about what people in the community think and the issue of disease, HIV/AIDS and hormones, as the urine is transformed into a powdered form which does not smell or resemble urine (Cordell et al., 2009). This would mitigate 'Peak phosphorus', as struvite's content is predominantly phosphorus based and it is easier to manipulate than a liquid.

Ideally, agricultural practices should to be socially and environmentally sustainable. As Mr.B stated *"There are so many simple practices in the field that no one wants to do because we have been mentally colonised otherwise".* He would want agricultural practices to go beyond what has been mainstreamed. Environmental issues, water scarcity, and fertiliser access are moot issues among the respondents of this study. At the moment, everyone has access to all over the above through the Agri-Hub and the NMPLC, though for how long?

6.7. Research Objectives

Evidence was gathered to address the following research objectives through the two case studies of the Umbumbulu Agri-Hub and the Newlands Mashu Permaculture Learning Centre:

i. To explore farmers' general and cultural perceptions of urine and its potential use for fertilising crops.

ii. To explore farmers' knowledge and understanding of urine as a fertiliser and its potential impact on their crops.

iii. To understand the key informants' (those who transmit agricultural knowledge to the farmers) perceptions and knowledge of urine, in general, and as a fertiliser.

iv. To assess the possibility of incorporating the method of using urine as a fertiliser into the one of the methods of fertilising in the training programmes and among farmers.

Overall the research objectives were answered by the evidence collected. The first objective explored perceptions of farmers in relation to urine. The respondents, who were of Zulu descent, were aware of multiple uses of urine in accordance with their culture, knowledge of which had been passed down by their parents' use of urine. Other uses they had heard of or learnt from traditional healers. Although, most were aware of traditional uses of urine, a few respondents were not. All except for one farmer were unaware of the fertilising nature of urine. Though, a few knew the fertilising potential of humanure.

While exploring the farmers' knowledge and understanding of urine, it was found that farmers believed that urine reuse in agriculture would damage their crops and that the urine would burn the plants. Many farmers were unaware of the beneficial impacts urine would have on their crops. The more optimistic respondents thought that any manure whether animal or human would be good. However, only one farmer knew that urine would be beneficial as it would be a source of nitrogen.

In general, the key informants knew of the fertilising qualities of urine. However, they did not know the specifics of its application and its impacts on crops through the nitrogen and phosphorus content. Two informants knew of alternative uses of urine for medicinal or traditional purposes which they had used. The two other informants knew of alternative uses from what they had read, but not from personal experience. Although, the informants knew of

many beneficial uses of urine, overall they still considered urine negatively, as a waste product.

Finally, the informants were not encouraging in the possible implementation of urine reuse as part of the training. They offered alternatives such as producing struvite from urine and then using it in the gardens. They stated that they would possibly use it in trees but would not be strong proponents of the concept of ecological sanitation. They wanted more testing in order to be certain that the practice had little or no risk. This belief is also mirrored by the farmers who were concerned by the practice as it is unknown to them. However, unlike the trainers the farmers seemed more enthusiastic about learning more about the concept and seeing it in practice, in order to make a more informed decision.

6.8. Conclusion

6.8.1. Contribution to Literature

This study, unlike many done in South Africa, did not focus on sanitation or the receptivity of UDDTs. The topic as been explored quite extensively and is somewhat controversial. This study focuses solely on urine reuse and whether the household had a UDDT or not. The literature on EcoSan on the African continent seems to be concentrated in East and West Africa. Most of the studies have employed quantitative tools such as large scale surveys using questionnaires. Few have been qualitative in nature. This study confirms much of the evidence produced by the studies that were done in South Africa (Drangert, et al., 2002; Jackson, 2005; Duncker, 2006; Duncker et al., 2007; WRC, 2007; van Vuuren, 2008; Wilkinson et al., 2010; Okem et al., 2012). Moreover, the qualitative nature of the study allowed respondents to provide more in-depth information on their view of urine and it uses. Some themes that were brought up include: historical EcoSan practices, men's issues concerning menstruation, the possibility for future generations to mainstream urine reuse, the current fears and perceptions of the respondents and their lack of knowledge on the topic. Finally, and importantly, their willingness to learn more about it and see it applied in practice.

6.8.2. Limitations of the Study

This masters' research comprised several limitations in relation to finances, time, logistics, the sample and the personal characteristics of the researcher. First, the amount of money invested in the research and the time span to complete it was limited. It was entirely

self-funded and this affected several other limitations. Ideally, if there would have been more time, a pilot garden could have been started at both the Agri-Hub and the NMPLC. In doing so, it would have provided a real life demonstration for the respondents, and would have allowed for the researcher and respondents to interact and develop a better rapport. However, the research interviews in order to be completed by the deadline, had to be carried out within a few months to meet the requirements of a coursework Master's thesis.

In order to be organised and have access to respondents, I only interviewed farmers who engage with the Agri-Hub and NMPLC, organisation which encourage an organic and chemical-free philosophy of agriculture. In the past ten years, several of the respondents have made changes in their practices in order to become more ecologically sustainable. An assumption could therefore be made that the farmers were more receptive to non-chemical methods such as urine reuse.

On a more personal level, some factors were out of my control as I wanted to be present and conduct the interviews. I am a young, white, foreign female. Some respondents may have not felt comfortable discussing, a topic which is considered intimate by many, with someone of the opposite sex and different cultural background. I tried to have a level of casualness to the topic, so to make the respondent feel comfortable. To what point that approach was successful I cannot say.

Lastly, as a result of my questioning on the respondents' perception of urine and their agricultural practices, many farmers became curious about the science behind EcoSan. However, for ethical reasons, I could not provide guidelines for the farmers to follow for the respondents' safety and my lack of accurate scientific knowledge. My assumption was that if they had any queries they would direct them at their respective trainers. In turn, these organisations would provide accurate information as most of the key informants had some knowledge of EcoSan practices or knew whom to contact in order to access sound scientific information.

6.8.3. Recommendations

The purpose of this study was not to predict behaviour but to understand how the respondents feel about urine and its use in agriculture. From the evidence collected, it can be recommended that an increase in training and workshops on urine reuse could help shift the present knowledge and acceptance of urine as a 'medicine' to an acceptance of its utilisation

in agriculture. Evidence shows that there is potential to change their intentions and their behaviour by providing further knowledge on urine reuse to address their concerns as much interest was shown in this practice. This study serves as preliminary research to explore individuals', especially farmers' perception of urine and its potential use in agriculture. Therefore, further research is required to add to this preliminary study, if urine reuse is to be incorporated into mainstreamed agricultural practices in a non intrusive and sustainable manner.

In relation to EcoSan, policies could be developed to accept the use of urine in agriculture under certain conditions. This would allow farmers to use wastewater and human waste appropriately without fearing repercussions from municipal or other authorities. In order to prevent negative perceptions from consumers, promotion campaigns or education on the practice could be facilitated. At the moment I find it premature to put in place policies that explicitly encourage the practice.

Currently, the farming contexts of the respondents are not dismal. However in the future, climate change and its impacts may push these farmers to the limit where urine reuse will not seem like such a far-fetched idea. In Nepal, individuals have created a 'human urine bank', where the urine from UDDTs in the community is being collected in order to fertilise land that has been spoiled by the overuse of chemical inputs. In Nepal, the idea of urine reuse has been accepted by the community at large. It has been mainstreamed to such as extent that the majority of the inhabitants are contributing to a urine bank set up in the community (Uddin et al., 2012). A urine bank could eventually be implemented in eThekwini to gain community support. I would argue that EcoSan could be integrated into agricultural workshops in both organisations. There are researchers based at the University of KwaZulu-Natal working in the field of EcoSan who could work in partnership with the organisations. As proponents of ecologically sound agricultural techniques, the Agri-Hub and NMPLC should provide exposure to the concept of urine reuse which is part of an ecological manner of practicing agriculture. The respondents have stated that they would like to have workshops with accurate information, and then they would be able to make their own decision on whether or not they would like to 'close the loop'.

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Appendix I

Key Informants Interview Schedule

A) Demographics

1. How old are you?
2. What is your educational background?
3. What is your post (job description at _____) and how long have you been employed with this organization? And in this sector?
4. What do you know about UDDT toilet?
5. What can be done with the urine and faeces from UDDT?

B) Urine perception

6. For yourself, is there meaning attached to human urine?
7. Are there cultural or religious meanings attached to human urine? If so what are they?
8. Is there a difference between the urine of a child and of an adult? If so, in what way?
9. What are the uses of urine?
10. What perceptions do you have about urine?
11. What relationship do you have to urine?
12. In which ways are animal and human urine similar or different?

C) Urine Fertiliser Knowledge

13. How would you feel about eating vegetables grown with animal manure?
14. How would you feel about eating vegetables grown with human urine?
15. What type of fertiliser(s) do you encourage the use of? And Why?
16. Would you use urine in the vegetable garden? And why? What kind of crops can be grown using fertiliser from human urine?
17. What happens if you apply human urine on plants?
18. How do you think the presence menstrual blood in the urine influences the use of urine as a fertiliser?

D) Future/Feasibility for Urine Fertiliser

19. What would be the benefits of using urine in agriculture?
20. What would be the disadvantages of using urine in agriculture?
21. How would others (in your household, community members, consumers…) feel about eating urine fertilised food?
22. What would their concerns be?
23. How could their concerns be addressed?
24. What would change people's minds to start using human urine for growing food?

Appendix II

Farmers Interview Schedule

A) Demographics

1. How old are you?
2. What is your educational background?
3. How long have you been a farmer?
4. How large is the surface area in which you grow your crops?
5. What type of crops do you grow?
6. What is the main water source used to irrigate the crops?
7. The food produced is for what purpose
8. Who participates in the gardening process? What are the reasons why you started growing crops?
9. What has been (or are foreseen) impacts (+/-) it has had on yourself and your household?
10. What type of sanitation system do you have in your household? At the farm?
11. What do you know about UDDT toilet?
12. What can be done with the urine and faeces from UDDT?

B) Urine perception

13. For yourself, is there meaning attached to human urine?
14. Are there cultural or religious meanings attached to human urine? If so what are they?
15. Is there a difference between the urine of a child and of an adult? If so, in what way?
16. What are the uses of urine?
17. What perceptions do you have about urine?
18. What relationship do you have to urine?
19. In which ways are animal and human urine similar or different?

C) Urine Fertiliser Knowledge

20. How would you feel about eating vegetables grown with animal manure?
21. How would you feel about eating vegetables grown with human urine?
22. Do you use fertiliser? What type of fertiliser(s) do you use (what is found in the fertiliser)? And why?
23. How much do you spend on fertiliser on a monthly basis?
24. What would be your preferred fertiliser(s)? And Why?
25. Would you use urine in the garden? And why?
26. Is there a tradition to compost excreta or any use of human waste as a fertiliser?
27. What kind of crops can be grown using fertiliser from human urine?
28. What happens if you apply human urine on plants?
29. How do you think the presence menstrual blood in the urine influences the use of urine as a fertiliser?

D) Future/Feasibility for Urine Fertiliser

30. What would be the benefits of using urine in agriculture?
31. What would be the disadvantages of using urine in agriculture?
32. How would others (in your household, community members, consumers…) feel about eating urine fertilised food?
33. What would their concerns be?
34. How could their concerns be addressed?
35. What would change people's minds to start using human urine for growing food?

Appendix III

Informed Consent Form

I, Natalie Benoit, student number 211550318, am doing research on *'Individuals' Perception and the Potential of Urine as a Fertiliser in eThekwini'*. This research is done in order to fulfil the requirements for a Masters degree in Development Studies under the supervision of prof. Dianne Scott from the School of Built Environment and Development Studies at the University of KwaZulu-Natal. I am going to invite you to be part of this research. This consent form may contain words that you do not understand. Please ask me to stop as we go through the information and I will take time to explain. If you have questions, you can ask them of me or my contact details are below:

School of Built Environment and Development Studies, University of KwaZulu-Natal, Durban Natalie Benoit, Masters Student, natalie.benoit@hotmail.com, 083-864-1131

The aim of this research is to understand the perceptions and the knowledge of key stakeholders and farmers about using fertiliser in the form of urine on crops. It will also help to determine if this practice would be socially acceptable in order to contribute to the debate on the potential of food security in eThekwini. This research will involve your participation in an up to one hour long interview, where the interview will be recorded in audio-format. The information gathered will be kept in secured storage. Excerpts from the interview may be part of the final research dissertation. Do you give your consent for: (please tick one of the options below) to be used in the report?

Your name, position and organisation, or	
Your position and organisation, or	
Your organisation or	
None of the above	

You do not have to take part in this research if you do not wish to do so. You may refuse to answer any question or stop participating in the interview at any time that you wish without your reputation being affected or any other consequences.
Please sign this form to show that I have read the contents to you

---------- (signed) ---------- (date)

---------- (print name)