Research Paper

Human excreta: a resource or a taboo? Assessing the socio-cultural barriers, acceptability, and reuse of human excreta as a resource in Kakul Village District Abbottabad, Northwestern Pakistan

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ABSTRACT

Sustainable reuse of human excreta in socially and religiously conservative societies is extremely difficult. People’s perceptions and acceptability regarding the reuse of human excreta is mainly linked to their culture. In addition, certain societies regard the cultural and social barriers more than the religious barriers. The aim of this study is to understand the perceptions of people about the reuse of human excreta for agricultural purposes. Qualitative research methods were used for data collection. Farmers in the village recognized the importance and economic benefit of reusing human excreta. They accepted the reuse of human excreta on their farms only if they were supplied with a treatment facility. Contrary to the farmers, the local community showed reluctance in reusing human excreta while recognizing the nutritional value of it. It was therefore concluded that the main barrier in sustainable and safe re-use of human excreta lies in socio-cultural and religious foundations of traditional societies like Kakul village in Abbottabad District.

Key words | accessibility, feces, human excreta, recycling, rural, urine

INTRODUCTION

Communities round the globe identify themselves with bioregions and are actively re-localizing their material resources. The focus of the localized issue revolves mostly around food security. However, the focus as predicted by researchers will soon shift to the other end of the nutrient cycle, i.e. recycling of human waste (Murtaza et al. 2010). Many researchers working on recycling of human waste argued that the blind flushing of excreta is equal to flushing of our personal responsibility. Therefore, in Pakistan too, excreta disposal is very complicated and is linked with various issues. The two major aspects of excreta mishandling are, first, the excreta which is not disposed of properly gets mixed with underground drinking water aquifer, second, the multiple, socio-cultural and religious taboos related to recycling and disposing of excreta (Murtaza et al. 2010).

Similarly in the case of Pakistan, to address the possibility of the reuse of human excreta it is mandatory to probe deeper and carefully into socio-cultural barriers. The existing body of literature and critical analyses of the institutional setup in the country shows that there are no specific rules and regulations which address the scientific incorporation of recycled human excreta in the fields, nor is there any concept of ecological sanitation or decentralized systems. The sanitation ladder stops at the Community Led Total Sanitation (CLTS) approach, which means that the harmful effects of sanitation are not yet...
being completely understood, particularly in the Water, Sanitation and Hygiene (WASH) sector. In addition, it implies that sanitation is studied and understood as a part of water supply systems but as a separate sector. The field of sanitation requires a great deal of research and study as the currently practiced approaches are neither useful enough nor sufficient to overcome the problems caused by poor sanitation. In view of all this complexity, this research is framed to address and understand the perceptions of local communities and farmers regarding the reuse of human excreta. The main research questions formulated are what are the community’s perceptions about the reuse of human excreta as a resource? In addition, how socio-cultural and religious barriers sabotage the ecological sanitation process?

Setting the background of the study

Historical overview of excreta used as a resource

The reuse of human excreta in agriculture is very ancient. Practices around human excreta handling can be understood by looking at the advancements that have occurred over time. However, this understanding is influenced by philosophical, cultural and religious beliefs about nature, norms and values related to excreta (Kira 2005). For example, China has a long history of reusing human excreta as a resource in farming. During the Qin dynasty (221–207 BC) and Qin-Han Dynasty (221–220) expression such as ‘using human excreta in the field’ and ‘composting using human excreta’ can be traced (Luo 2001). Similarly, in the Ming and Qing Dynasties (1368–1911 AD) China was using human waste together with animal waste as fertilizers. Chinese farmers considered human excreta as a precious commodity until 1949, and firms in Beijing and Wuhan would control the commercial selling of human excreta. Similarly, King (1927) reported that people in the Far East used to save their excreta for religious purposes for about thirty centuries and then used it for farming. Human excreta was considered a precious commodity in China and in 1908, Shanghai city sold 78,000 tons of human excreta to a contractor for US$31,000 (King 1927).

During the eighteenth and nineteenth centuries, agriculturists and public health workers came up with a solution for human waste disposal. According to them, the logical way of disposing human waste was to make it a part of the nature cycle (Stoner 1997). During the 19th century, many examples of reuse of human excreta in Europe were found. Sewerage systems developed with the passage of time and human excreta made its way to the agro-activities. In 1800, sewage farming was very popular due to its high nutritional value and expensive alternative methods. During the nineteenth century, the water carriage sewerage system was established which later became more sophisticated and popular. Many countries of the world still consider wastewater treatment unproductive, as they are more interested in using raw sewage for farming. For example, Paris had sewage farms as early as 1868 and Berlin in 1876; Melbourne, Australia established its first sewage farm in 1897, in Mexico the first sewage farm was established in 1904 and at this time there were 14 sewage farms serving a population of 200,000 in the USA. However, the case of developing countries is the opposite. The farmers, who like to use raw sewerage system in their lands, pay a high price for its high fertility value (van der Hoek et al. 2004). About 80% of the wastewater in developing countries is used for irrigation (Gunnerson et al. 1984, Murtaza et al. 2010).

Pakistan’s perspective

In Pakistan, poor management of ground water resources and lack of alternative resource options has magnified the use of ill-treated or untreated wastewater for irrigation in urban, peri urban and in rural agriculture (Ensink et al. 2004; Murtaza et al. 2010). In Pakistan, 32,500 ha of land is directly irrigated with wastewater (Strauss & Blumenthal 1990; Ensink et al. 2004).

Due to better opportunities in larger cities in Pakistan, people are migrating from rural to urban centers in huge numbers. According to UNICEF (2015), it is estimated that by 2025, 50% of Pakistan’s population will shift towards urban centers. This huge influx of population in urban areas has posed a serious threat to fresh water scarcity and increased used of untreated wastewater in agriculture (Strauss & Blumenthal 1990; Ensink et al. 2004). According to FAO (2002), discharge produced by 14 major cities in Pakistan, calculated on the basis of the 1998 population census, is approximately $1.83 \times 10^{7} \text{m}^3 \text{h}^{-1}$. However, a
relatively recent wastewater assessment in Pakistan reflected that the country produces 962,335 million gallons ($4.369 \times 10^9$ m$^3$/yr). The total water supply is $4.6 \times 10^8$ m$^3$/day, and about 30% of wastewater is used for irrigating an area of 32,500 hectares (Ensink et al. 2004). In addition, 64% of total wastewater in Pakistan is disposed of either into rivers or into the Arabian Sea. Similarly, 400,000 m$^3$/day wastewater is additionally added to canals.

**Societal perception and association towards human excreta and sanitation**

In addition to the historical importance of excreta, the societal perception towards human excreta has a direct impact on the sanitation habits and approach of people. Defecation and urination are considered as a private and personal act and people show unwillingness to highlight this issue. Moreover, it is related to the feeling of dirt and disgust. In many societies, the act of urination and defecation is considered as an unacceptable topic of discussion. Every society has its own tacit norms and taboos related to excretion. Perceptions and ideas about what is dirty associated with daily habits greatly influence sanitation approach. For example, another person’s excrement is often perceived as more disgusting than one’s own (Drangert 1998). The older generation in North West Frontier Province (now Khyber Pukhtoonkha) in Pakistan exhibit strong sensitivities about excreta and toilet and continue to favor open defecation. For them, an in-house latrine or toilet is similar to being closer to untouchable and impure human excrement in comparison to open defecation away from the home. According to them, an in-house toilet is akin to ‘animals eating and shitting in the same place’.

Such perceptions are difficult to maintain in crowded urban areas and may gradually disappear (Nawab 2006, PhD thesis). The understanding and practices of sanitation change from society to society and region to region with the strong influence of religion (Nawab & Drangert 2011).

Besides the social adherence or repulsion towards the issue, religion and culture has also imposed a prominent effect on people’s behaviors and attitudes. Religion, caste, superstitions and social psychology dictate an individual’s approach to sanitation (Nawab & Esser 2008). The history of excreta handling and sanitation systems being guided by social construction of technology and values is in many ways related to our religious beliefs and the power of the synagogue, church, mosque, temple, etc. For example, before urban life, Jews were not allowed to live in places without synagogues, toilets and water supply along with some other necessities of life. The Jewish law also asks for burial of human waste even during times of war. Deuteronomy 23:13–15 states ‘and it shall be when thou sittest down outside, thou shalt dig therewith, and shalt turn back and cover that which cometh from thee’. However, Jewish law seems more concerned about human benefits irrespective of its impact on the environment. Islam also advocates that the entire bounty of nature is created for the sake of human beings: ‘to them is subjected whatever is in heaven and the earth’ (Al-Quran:2:22; 13:17; 14:32–3; 16:5–16; 16:80–1 78:6–16 and in other chapters). Regarding human excreta, Islam advocates adopting all necessary measures to restrict a body or clothing to come in contact with urine and feces, as this would disqualify a person from praying. A survey conducted by Nawab (2006, PhD thesis) on societal preference in designing an ecological sanitation system in North West Frontier Province (NWFP), Pakistan made an interesting observation: ‘Every household wanted water within the toilet or latrine for anal cleaning, which is common in Muslim cultures. The Islamic religion requires is permitted only when the impurities have been removed (Faruqui et al. 2001; Nawab 2006, PhD thesis). For example, thermophilic composting produces humus-like substances which carry no visual and/or odors connected with the original material. Among the Hindus, the ancient scriptures Artha Ved (detailed code of conducts for rituals) clearly specifies the extensive use of water for personal hygiene. An elaborate drill for defecation, for different classes (caste) of people, has been prescribed in the Aryan (1500 BCE) scriptures Manusmriti Vishnupuran. For example a married...
individual was expected to chant a verse from the scriptures before proceeding for defecation. The sacred thread (worn across the chest by the Hindus) was expected to be rolled to a smaller size and be placed around the right ear. The head was to be covered with a cloth, in the absence of which the sacred thread was to be brought over the head and placed around the left ear. Then while observing silence and facing north in the day and south in the night, the married individual could then defecate. While defecating one was not expected to touch water; after defecation the water pot was to be held in the right hand, with the left hand being used for anal cleaning. These rules were modified for men and women, saints, celibates, daytime and night time, traveling time, sick time, etc. However, nowhere do we find excrement included more in a religious context than in Buddhism. An integral dimension of Buddhism is reincarnation, which promotes the harmonious concept of recycling life’s treasures; it is therefore not surprising that Buddhist cultures treat earthly resources (including human excreta) similarly (Jenssen et al. 2004; Nawab 2006, PhD thesis). If we look into Jewish, Christianity and Islamic teaching, learning and practicing the above-mentioned beliefs from childhood produce a sense of disgust about human excreta, which Winblad & Simpson-Herbert (2004) described as a Faecophobic culture: excreta as a waste not a resource. On the other hand, if we look into the cultures of East Asian and South Asian countries, human excreta has been used as a fertilizer for thousands of years. This could partly be due to religious beliefs (Buddhism) and partly due to their centuries old cultures and self-constructed values about excreta as a valuable product.

**STUDY AREA**

The study is conducted in Kakul village of Abbottabad (Figure 1). Abbottabad district is divided into two Tehsils Abbottabad and Havelian and fifty-one Union Councils. Abbottabad is located in the Province of Khyber Pakhtunkhwa in the North-East of Pakistan. Area-wise, District Abbottabad is 1,967 km², with a population of 881,000 and an average annual growth rate of 1.82%. Some 83.12% of the population lives in rural areas. The total literacy rate is 37.26% in which 58.66 is recorded in urban and 32.51% in the rural area. The literacy rate among male and female was 52.82 and 21.14%, respectively, which is analogous to the number of existing educational institutions, i.e. 1,086 for boys and 528 for girls (ERRA 2007). Village Kakul is one of the largest and prominent union councils of district Abbottabad. The secondary data collected from the local government office reflects that the total population of the UC (Union Council; union council
is an elected local government body. A village council usually comprises a large village and surrounding areas, often including nearby small villages. The term Union or Village Council may be used for localities that are part of cities.

Kakul is 21,408, i.e. males 10,663 and females 10,744, which equates to 49.8 and 50.18% respectively. The annual population growth rate is 1.79. Kakul village is agrarian in nature. The major source of livelihood comes from agriculture. People in the village adhere to values of Islam. Kakul village is selected for studying the issue because rapid changes in the sanitation practices have been observed in the last three decades. This change started in the 1960s and 1970s mainly due to increasing literacy rates and exposure to media.

RESEARCH METHODOLOGY

This research study has used a qualitative research approach. A total of 50 interviews and two focus group discussions were conducted. The research methods for the field study comprised of household interviews, key informants interviews, FGDs and personal observation. Mixed methods were used to gather information that would answer the proposed research questions. To understand and capture the transition in sanitation practices and diversity of opinions regarding the recycling of human waste, men, women and farmers were interviewed. Purposive and stratified sampling techniques were used. Only those respondents were approached from whom maximum information could have been extracted. Samples were divided into different strata, i.e. males, females and farmers. Within the male and female categories, sub-strata were made. They were further divided into three groups with respect to their ages (group 1 consisted of males and females with age above 50, group 2 had middle-aged people from 25 up to 35 and group 3 had young girls/boys from 13 to 20 years). A major data collection tool was semi-structured interviews. The questions were open-ended and were designed in a way that the respondents found them easy to understand. A participatory approach was adopted and two focus group discussions (each with the group of males and females) were held in the village to ensure maximum community participation.

RESULTS AND DISCUSSION

In this section, results and discussion are presented. Data is further categorized into different sub-themes and analyzed and discussed by keeping in mind the nuances and delicacies of the issue. It is known worldwide that societal perceptions have a direct impact on sanitation habits and approaches. Every society operates on its own norms and tacit knowledge about the concepts. Defecation and urination are considered private and personal acts which are related to a feeling of dirt and disgust and most of the people are hesitant to highlight it. The following themes will discuss various aspects of the issue dynamically.

Health, open defecation and latrines

Community members established the direct link of sanitation practices and health. One of the female respondents said, ‘Nowadays even children consider it shameful to defecate in open. And this change in attitude has decreased the disease ratio manifold. Open defecation is risky as it attracts flies and other insects. These insects and flies then carry germs around with them and spread diseases.’ However, there was a contrast in views of the community members. For some, open defecation was a healthier way of excreting as the feces gets dried up in the sunlight killing germs and diseases, whereas in latrines the black water ultimately gets mixed with underground water resulting in underground water contamination. One of the female respondents said, ‘Open defecation was healthier than latrines because in open defecation the excreta is away from the house and in latrines everything is underground within the house. Our houses are built over them, we are breathing the same air and even the gases evolved from the gutters are also being added to the air we breathe.’

Another important aspect is to understand the shift from open defecation to latrines in Kakul village. One of the major reasons is growing population and rapid urbanization in the village. Women themselves think, and men confirmed, that the environment around the village is not safe for women anymore. The harassment cases have increased, and in such situations people prefer to build latrines inside their houses. Moreover, building a latrine is a status
symbol rather than for environmental purposes. During field visits it was noticed that latrine construction followed the convention pattern, i.e. the flush is connected to the septic tank and soakage pit. No scientific measurements were taken into account during the construction process. There were people who were against the latrine construction inside houses as for them it was un-Islamic. However, latrines are preferred over open defecation by the community because they added comfort to their lives.

Reuse of human excreta and socio-cultural barriers related to it

It was observed that people were uneasy while talking about reuse of human excreta as a resource, although many people have the knowledge of reusing human excreta as a fertilizer. People said that they felt comfortable as long as excreta is recycled properly in a recycling plant. One of the females said, ‘I often watch a program on the Discovery channel in which the host talks about using urine as a fertilizer and the instant I see it I feel like throwing up. I wonder if that man washed himself many times as urine contains a lot of germs which might affect his health. If I can’t watch a man reusing his urine as fertilizer then how can you imagine me doing it? It’s nearly impossible.’

Another lady said that her house is 80 years old and before septic tank and soakage pits they were using pit latrines. They used to dig a hole and used it as a latrine. After filling of one pit, they used to cover that and dig another. Once all pits were filled, they were emptied in the fields and were used as fertilizers. People found no fault in this practice because it was related more with their mode of defecation than reusing of human excreta. Similarly, she told a story of her great grandmother who once had kidney beans for dinner. At midnight she felt the need to use the toilet but since there were no latrines at home, she defecated in the mud-stove. It was impossible to leave her excreta open therefore she kneaded it with the ashes and made small dung cakes with it. The next morning when she was asked about them, she replied that we can use animals dung for heating purposes then why can’t we use our own excreta for this. It shows that practices of reusing human excreta were present historically but there was no organized discussion and mechanism for it. Currently, the same pattern is prevailing. Raw sewage is encouraged to be used in the fields, however discussing the health risks related to it are taboo.

The community majorly rejected the idea of human waste composting because they were apprehensive about the reuse of human excreta. They used the term najasat (dirt) and said that Allah has given Muslims paki (purity) so how can they reuse their own excretion? People linked sanitation with hygiene. In their opinion, excreta handling is unhygienic and would damage health. However, some of the people also suggested that if a sophisticated technology is brought into use, only then could human excreta be reused without much issue, because manually treating the waste for reusability would not be acceptable for the community.

One of the male respondents said that his neighbors were visiting from Naran Valley (a medium size town in North of KP, particularly known for its scenic beauty and tourism) and practiced the reuse of human excreta. They dug two pits and used them for defecation one after another. After filling of both the pits, they emptied the first pit, reused the excreta in agricultural land and used the pit for defecation again. He further added that in the old system the nutrients returned to the land, which made open defecation a better system than the latest sanitation strategy. However, social and cultural taboos attached to the reuse of human excreta cannot be undermined. Social class segregation also plays an important part in this regard. Only lower classes or cleaners are associated with handling, managing and reusing of human excreta. The Khans (the powerful class) of the area, when asked about reusing excreta said, ‘If we start reusing human excreta people would mock and taunt us by comparing us to the sweepers. It is a matter of our dignity.’ It was noticed that people were not as bothered about this matter on a religious basis as they were socially and culturally.

Reuse of human excreta in agricultural activities

People in the village were aware of human excreta being used in the fields as water from the gutters is dumped directly into the fields. In some cases the latrine outlets directly open into the drains which are collected and used in the fields by the farmers. Similarly, when gutters get
blocked and sweepers are called in to fix the problem, the black water from the gutter is sold to the farmers which also eventually goes in the fields. Everyone in the community knows about it but refrained from getting into discussion.

The community was ready to reuse excreta for annual crops like wheat, maize, barley, etc., but they refused to consider this for vegetable farming. They said that vegetables are consumed directly while the handling of annual crops is different. When the reuse of human excreta was discussed with the male community members and a group of farmers, the response was very positive. Although they welcomed the idea, at the same time they showed some concerns related to the current issues in farming and the switching from conventional trends to new approaches in agriculture. They said that the lands were more fertile back then when open defecation was in practice. One of the main reasons is that humans at that time were very close to nature, they returned what they got from it. So the cycle of give and take continued smoothly, whereas now, the innovations in society provide comforts to human beings on one hand but at the same time create negative effects on health and the environment.

Farmers were not only in favor of making human excreta compost but also shared their personal experiences of composting using animal dung and dry leaves. Their procedure included digging a hole where excreta or dry leaves were dumped and covered for six months. In the case of animal dung, usually farmers prefer to add urine because according to them the urine fulfills the water requirement and makes better compost. In addition to urine, the carbon and nitrogen ratio should be properly maintained for which artificial urea is added in the compost, therefore the mixture comprises of GOBER + UREA + GOBER + UREA + SOIL. It is then left for six months to compost and turn into a good quality manure.

Farmers agreed that it is possible to make compost with human excreta because it is organic and preferable to be used as fertilizer. The synthetic fertilizers used now have not only degraded the land quality but have also reduced the yield. The vegetables produced have lost their taste and humans have developed many diseases which were unheard of before. Farmers also showed their aversion towards artificial fertilizers and complained that they are quite expensive for them to purchase and have to be added repeatedly in the field to get an effective result as compared to animal manure. It is also learnt that during the open defecation period people preferred defecating on their own lands instead of random fields in order to add fertilizer (excreta) to their own lands. Farming communities suggested that there should be proper strategic planning for the reuse of human excreta. The excreta from the community should be collected via pipes and be taken to the farming lands. They referred to the plant that was installed during the British rule in Nawasher (a small town in Abbottabad district) and said that different duties should be assigned to different people from the community. People from the village should be properly trained to manage the plant, however, quarterly monitoring should be carried by government experts.

At the community level, many people came up with different solutions for excreta management. One of the females said that there should be a solid waste disposal system similar to train and airplane systems. Excreta should be collected in latrines, drawn into a container and taken to a treatment plant before deeming fit to be used as fertilizer. Some suggested that every street in the village should be provided with a public latrine which should be used more often by people instead of their home latrines because it would be easier to excrete from a single point rather than from every household. People preferred the reuse, recycle and application of excreta on land at the community level than individual household levels. They argued that its reuse at household and individual level is not acceptable.

**Change in the behavior of the people towards excreta with time**

Surprisingly, a very profound change in the behavior of people is noticed when the excreta changes its composition and color with time. For the majority, excreta becomes acceptable as its color changes to dark brown and becomes odorless. Fresh excreta are more repulsive, smelly and contain a considerable number of germs and disease agents. One woman explained that sunrays kill the germs and dry up the excreta. This is the reason for accepting the old excreta. Similarly, different behaviors and attitudes were seen regarding grey and black water. Table 1 is structured
According to the acceptability level of six products that were investigated, i.e. urine, feces, grey water, wastewater, excreta (mixed), fresh feces and treated feces matter. This categorization is done based on color, smell and composition of the product without its scientific analysis. In the following table, this ranking will be compared to the rankings of World Health Organization and Nawab (2006, PhD thesis), who made the rankings during his research in NWFP, Pakistan.

From the above table it is noticed that grey water reuse is most easily acceptable as it is clear water from bathing and the kitchen and is less odorous as compared to other products. Followed by grey water, treated feces were accepted because after turning into compost it resembles animal manure and can be used in the fields. Next is urine because it is liquid in state and evaporates completely. Fourth is the sewage water. Farmers use sewage water directly from large drains or collect it from the gutter to use as fertilizer. Lastly, fresh feces alone and fresh excreta (urine + feces) both are categorized as the most repulsive products. This categorization and people’s acceptance reveals that if modern technology, training and proper sensitization is initiated in communities then reuse of human excreta is possible even in religiously conservative societies.

The change in excreta color and composition can be linked with its safe disposal and is considered essential for public health protection. The unsafe disposal of excreta is the principal cause of transmission of pathogens in the environment (Esrey 1996; Esrey et al. 2001; Hutton & Haller 2004). It is estimated that over twice the number of people lack access to improved sanitation than lack access to an improved water supply. Excreta disposal technologies may represent a risk to groundwater, whereas inappropriate design, siting and maintenance of sanitation facilities can contaminate groundwater and result in public health risks from drinking water. However, public health risks occurring due to the absence of improved excreta disposal are likely to exceed those posed by contamination of groundwater from sanitation alone.

**Economic benefit generated from reuse of human excreta**

People were well aware of the economic benefits of reuse of human excreta. People in the community showed their interest to reuse human excreta if economic benefit was ensured. They also agreed to practice if the initiative is taken properly. People also related the economic benefit with the nutritional value of the feces and urine. Particularly, farmers illustrated that if reusing and recycling of human excreta comes into practice they would easily save the cost of artificial fertilizers. This practice would also help them in increasing the fertility of their lands and increase the crop yield. Established literature also shows that a person excretes all the nutrients he eats during a year and the amount of these nutrients is almost equal to what is needed to grow the required food. A person needs at least 250 kg of cereals annually. Table 2 shows the amount of the three nutrients required for this produce. The nitrogen content in urine alone seems to vary with the intake of

<table>
<thead>
<tr>
<th>Product</th>
<th>WHO rating health risk</th>
<th>Instant visibility</th>
<th>Visibility after days</th>
<th>Instant smell</th>
<th>Odor later</th>
<th>Ranking by Bahadar et al. (2006)</th>
<th>By participants of authors research</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urine</td>
<td>Yellow liquid</td>
<td>No traces on the ground</td>
<td>Slight</td>
<td>Strong smell if not on soil</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Treated feces</td>
<td>Brown/yellow matter</td>
<td>Earth like material</td>
<td>Moderate</td>
<td>None</td>
<td>4</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Grey water</td>
<td>Almost like clean water</td>
<td>Damp spot on ground</td>
<td>Slight</td>
<td>Foul smell if not on soil</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Wastewater</td>
<td>Greyish water</td>
<td>Black water if not filtered</td>
<td>Slight</td>
<td>Foul smell if not on soil, from sludge</td>
<td>3</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Fresh excreta</td>
<td>Brown/yellow liquid</td>
<td>Dark brown wet matter</td>
<td>Strong</td>
<td>Less strong</td>
<td>6</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Fresh feces only</td>
<td>Brown/Yellow matter</td>
<td>Slightly dry matter</td>
<td>Moderate</td>
<td>Strong</td>
<td>5</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

Table 1 | The ranking of human urine and feces
protein. The reuse of human excreta in the agricultural fields as fertilizers would also increase organic farming and would improve health conditions and the overall environment.

If the reuse and recycle approach is integrated into agricultural communities, people will shift towards organic living resulting in an improvement of health conditions and crop yield.

CONCLUSIONS

Kakul village presents a dynamic perspective on sanitation practices and reuse of human excreta. The community, which is predominantly Muslim, not only understands the importance of nutritional and economic value and reuse of human excreta but also identifies the dire need of introducing ecological technologies of reuse and recycle human waste. The village at present is experiencing both open defecation and latrine systems. Since the village is agrarian in nature, agricultural activities have also seen shifts. Farmers are dependent on artificial fertilizers as compared to natural. This shift in practices is affecting people’s health and soil quality at large.

Multiple socio-cultural and religious taboos and barriers are attached to reuse of human excreta. However, the farmers have recognized the importance of reuse by tracing it back to the historical practices from open defecation to pit latrine disposal in the fields. People generally hold the view that if the government introduces efficient technology then reusing and recycling the human waste would become acceptable. This study concludes that the government can work towards ecological solutions by involving the community and bringing their perspective in policy making and in designing and implementing the technology. The bottom-up approach will, to a large extent, ensure sustainability of the policies and the ownership of the technology at community level if introduced.

REFERENCES


<table>
<thead>
<tr>
<th>Important nutrients</th>
<th>Urine, 500 L/year</th>
<th>Feces, 50 L/year</th>
<th>Total</th>
<th>Nutrients needed for 250 kg cereals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen</td>
<td>4.0 kg 88%</td>
<td>0.5 kg 12%</td>
<td>4.5 kg 100%</td>
<td>5.6 kg</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>0.4 kg 67%</td>
<td>0.2 kg 33%</td>
<td>0.6 kg 100%</td>
<td>0.7 kg</td>
</tr>
<tr>
<td>Potassium</td>
<td>0.9 kg 71%</td>
<td>0.3 kg 29%</td>
<td>1.2 kg 100%</td>
<td>1.2 kg</td>
</tr>
<tr>
<td>Total N + P + K</td>
<td>5.3 kg 1.0%</td>
<td>1.0%</td>
<td>6.3 kg</td>
<td>7.5 kg</td>
</tr>
</tbody>
</table>
King, F. H. 1927 Farmers of Forty Centuries; Or, Permanent Agriculture in China, Korea, and Japan. Cape Publishers, London.


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