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A Traditional Closed-Loop Sanitation System in a Chronic Emergency: A Qualitative Study from Afghanistan

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Abstract: The use of closed-loop sanitation systems (CLSS), or reuse-oriented sanitation systems, has increased in recent years, and such systems have been successfully implemented in many parts of the world. However, no research has explored Traditional CLSS (T-CLSS) for a long-term humanitarian situation. This study explores the strengths, weaknesses, opportunities and threats (SWOT) of T-CLSS in peri-urban and rural contexts in three different provinces in Afghanistan (the first study of its kind in Afghanistan). Participatory research tools, such as transect walks, focus group discussions, smart community gatherings and interactive workshops, were applied to assess the SWOT associated with T-CLSS. The results indicate that T-CLSS has been practiced historically in both peri-urban and rural areas using local and traditional knowledge, skills and technologies. The socio-cultural acceptance of the system in both rural and peri-urban areas is an important strength of this established system. However, due to chronic development challenges in the study regions, T-CLSS may possibly lead to exposure to microbial contaminants. It is recommended that the feasibility of an improved CLSS be assessed and implemented in light of the issues that are inherent in the use of T-CLSS in Afghanistan.

Keywords: closed-loop sanitation; rural; peri-urban; SWOT; chronic-emergency; participatory research; Afghanistan

1. Introduction

Poor water, sanitation and hygiene (WASH) are some of the most serious problems affecting people in areas where a humanitarian crisis exists. Improved sanitation is critical for public health and environmental safety, especially during and after acute emergency stages. If human waste is not managed properly, sanitary disasters can occur, which lead to increased public health risks affecting vulnerable populations, particularly refugees and internally displaced people (including children, the elderly, pregnant and lactating mothers) who have fled their countries due to conflicts, wars, disasters and political instability [1–3]. Both short- and long-term sanitary initiatives are required to minimize the risk of disease and death. Over the last two decades, there has been a trend towards recovering resources/nutrients from sanitation systems in order to close the loop of sanitation systems. The closed-loop sanitation system (CLSS), or reuse-oriented sanitation system, has been proposed, successfully implemented, and evaluated in many parts of the world using improved technical and non-technical approaches in both cold and temperate regions. The main principles of this system are to improve overall WASH and to recover resources/nutrients from organic waste streams, particularly human faeces [4–8].

Proper sanitation and handling of human waste is required if it is to be used as a fertilizer. Ultimately, with proper use, this can lead to positive environmental, health, education and economic development outcomes. Ecological sanitation aims to diminish waste that could pollute the environment by using diverse technologies and solutions to treat human waste and produce suitable farming fertilizers [9–11]. Ecological sanitation addresses social, economic and ecological sustainability. As discussed by Patinet (2012) in the context of Afghanistan, the recovery of human waste can play an important role in climate-change mitigation and adaptation [12]. Ukoje and Yusuf (2013) highlight the key benefit of using human waste as fertilizer, namely its accessibility. The authors also recognize the drawbacks: inconsistent availability of the required quantity and longer periods required for nutrient release to plants. Low-cost fertilizer production reduces production costs for farmers and is thus seen as a possible avenue to increase food security in rural communities. This approach can empower and enhance farmers' self-sufficiency by allowing them to produce fertilizers locally rather than relying on international markets. This leads to increased fertilizer availability at all socioeconomic levels. Using primarily locally sourced materials (with little or no dependence on external inputs) supports rural livelihoods and sustainable rural development [13,14]. Locally available resources (such as human faeces) improve the outcomes of agricultural production, contributing to asset diversification and coping strategies for rural inhabitants in low-income countries. This ultimately addresses the issue of rural poverty [15].

The concept of using human excreta to fertilize agricultural lands or aquaculture ponds is not new (particularly in Asia and parts of Africa) [16]. However, the related technological interventions have developed over time. Indeed, human faeces have been widely used without significant treatment in agriculture and aquaculture in many parts of the world for hundreds of years. Jensen et al. (2008) demonstrated that farmers from Vietnam and Southern China recognized human excreta as 'valuable fertilizer' [17]. Cofie et al. (2004) found that nearly two-thirds of farmers in Northern Ghana use faecal matter as a cost-effective and traditional method to improve soil fertility to increase maize and sorghum yields, and to compensate the effects of the high temperatures and long dry periods of the savanna climate [18]. Conversely, a recent study found that farmers in Southern Ghana were highly reluctant to use human waste on their agricultural lands [19]. Harada (2007) performed a cost analysis of night-soil treatment systems (NTS) and showed that NTS is cost effective when compared to conventional sewerage systems. Harada concluded the study by highlighting urine as a valuable resource and suggested the proper application of urine to agricultural land as a method to obtain nutrients, especially phosphorus, to support food production [20]. However, there are communities of both Muslims and non-Muslims who are reluctant to use/handle human waste due to cultural barriers and taboos. For example, contact with human excreta is abhorred in most Islamic cultures. In Indonesia, however, night soil trading and the direct application in fish culture were reported for Jakarta and West Java despite these places having dominant Islamic cultures [21]. Although challenges exist, cultural barriers and taboos can often be overcome through education and increased awareness [6,7,19].

Afghanistan, the location of the current study, is facing a long-term humanitarian crisis and has made little progress in the field of sanitation from 1990 to 2015. Currently, only 32% of the population have access to proper sanitation, representing the world's worst sanitation situation [22]. Nevertheless, the government of Afghanistan is committed to reaching its Sustainable Development Goals (SDGs) [23] of which sanitation is an integral part. In Afghanistan, including urban centres, such as Kabul and Kandahar, it is common to apply human faeces from dry toilets, without treatment, directly to agricultural fields [12]. No systematic research exists that explores the current status of this traditional practice in either peri-urban and rural contexts. Furthermore, no evaluation of the efficiency, relevance or sustainability of this type of traditional closed-loop sanitation system (T-CLSS) exists. In response to this gap in the literature, the current study was conducted under Afghanistan's programme intervention areas under Action Contre La Faim (ACF). The main objective was to examine the strengths, weaknesses, opportunities and threats (SWOT) inherent in the existing T-CLSS and to improve the design and planning for the future introduction of improved CLSS [8]. This study aims to improve the existing system in terms of increased safety by reducing risks involved in both human and environmental contexts. In addition, the study explores how T-CLSS can support productivity, markets and job creation in a local context. Finally, the authors seek to contribute to the discovery of sustainable and efficient solutions for excreta disposal and management in large urban centres.

2. Materials and Methods

2.1. Study Area

This study was conducted in January and February 2015 in five different villages across three provinces in Afghanistan (Table 1, see also Figures 1 and 2). ACF Afghanistan runs WASH, food security, livelihood and nutritional programs in these provinces. The global aim of ACF is to eradicate hunger in a comprehensive, effective and lasting way while supporting efforts to end hunger and fight poverty. The organization's mission is to save lives by preventing, detecting and treating malnutrition during and after emergencies and conflict situations. They base their work on integrated approaches for advocating and raising awareness for a range of sectors, including nutrition, health and healthcare practices, food security and livelihoods, and WASH. This same holistic approach was applied to the sites selected for this study. These sites suffer from both conflict-based insecurity and undernutrition issues.

Table 1. Study locations and demographic information.

Village, District and Province	No. of Families	Population	No. of Toilets	Type of Toilet (Traditional)
Yousuf Bangi, District 13, Kabul (Peri-urban)	328	2624	328	Vault with urine diversion
Tangi-e-Yaqub, Dar-e-Suf Bala, Samangan (Rural)	244	1500	200	Vault
Chobaki Payan, Dar-e-Suf Payan, Samangan (Rural)	250	1500	250	Vault
Mashi wa Nigeri, Dehdadi, Balkh (Rural)	1000	7000	1000	Vault
Deh Hassan, Khulam, Balkh (Rural)	220	1087	40	Vault

The ACF intervention in Afghanistan began in October 2001 in areas affected by conflict, including Kabul (central region) and Samangan (northern region). The focus of ACF's response in the selected provinces is to prevent undernutrition among children who were 6–59 months old, and pregnant/lactating women, through Community-Based Management of Acute Malnutrition (CMAM). Their approach is designed to gather information on the nutritional status of the population and to strengthen food security in communities that are dependent on rain-fed agriculture. This ensures access to potable water and adequate sanitation in addition to increasing awareness of hygiene issues. The ACF aims to promote hygiene and provide safe water and sanitation to the most vulnerable and marginalized populations in both rural and urban areas.

The current study is part of a larger international research project aimed at improving CLSS [8] and knowledge dissemination in several countries. This larger research project also includes a project in Mongolia that is jointly executed by ACF Mongolia and the University of Science and Technology Beijing, which is funded by ACF International France. The current study was approved by ACF Afghanistan and oral consent was obtained from the study research participants after they were informed of the study objectives and its possible outcomes (Internal ACF Research Project Reference Number is H3T).

The risks inherent in visiting certain study areas for assessment presented a challenge that limited certain aspects of the study. The research team was not able to conduct a quantitative survey to obtain more scenario-based outputs. A further limitation was the absence of female participants in both focus group discussions and smart community gatherings due to socio-cultural factors.

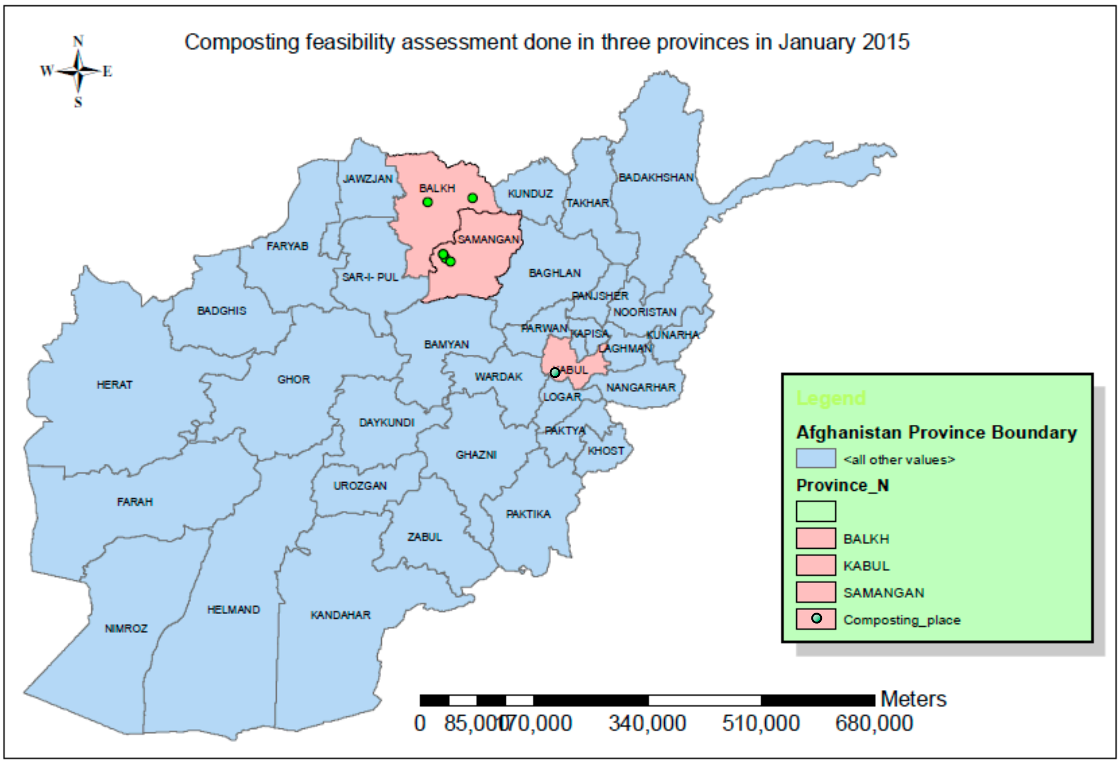

Figure 1. Study area map.

2.2. *Strength, Weakness, Opportunity and Threat Analysis*

This study undertook a SWOT analysis of T-CLSS in the study area. The following qualitative field investigations were conducted to address SWOT components: transect walks, focus group discussions (FGDs), smart community gatherings (SCG) and interactive workshops (IWs).

2.3. *Transect Walks*

A transect walk involves accompanying community members from location to location throughout their community. During these walks, a range of questions are asked in order to locate the resources and target infrastructures (toilets) related to the study [24]. Five transect walks were performed, one in each of the five villages (see Figure 2), to identify the types of toilets, the sanitary situation, the location of faecal matter storage, the transportation methods, the locations of composting systems and agricultural fields where untreated faecal matter is applied and the existing technological interventions. Photographs were taken during the transect walks to provide image-based scenarios of the T-CLSS for analysis. Key community members from each village took on the role of informant and shared the above-mentioned information during transect walks.

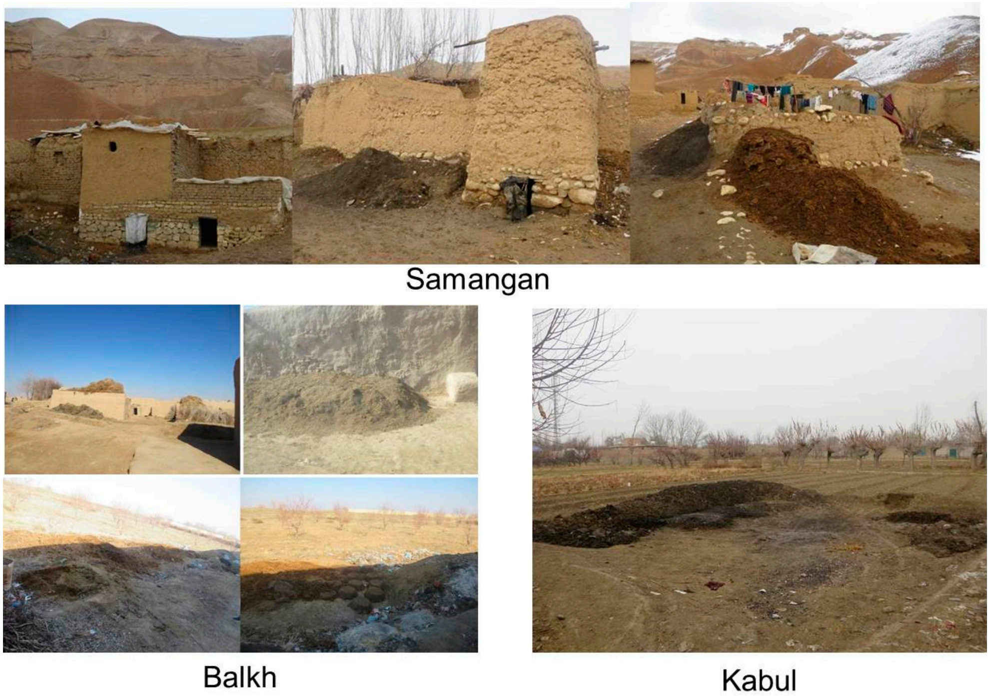

Figure 2. T-CLSS practices in three different provinces (Uddin, Sayed Mohammad Nazim, 2015).

2.4. Focus Group Discussions (FGDs)

FGDs are efficient ways to obtain information and assess interactions among similarly interested individuals in small group settings within a short time frame [25,26]. During a FGD, a 6 to 12 member group participates in free and spontaneous discussions that are gently guided by a facilitator or researcher [27]. A total of four FGDs in four villages, and one FGD in the peri-urban area of Kabul, were conducted among the target groups to assess the existing situation and address key SWOT components. In this study, each FGD consisted of 8–10 people (primarily men representing the population responsible for T-CLSS activities in Afghanistan) and discussions were facilitated, prompted by previously designed open-ended questions based on the T-CLSS context of the community's respective area. Generally, FGDs lasted less than two hours. ACF WASH and Food Security and Livelihood (FSL) team members communicated with participants to support the principal investigator in translating and facilitating each discussion. All FGDs were recorded using audio recorders and results were analysed shortly afterwards.

2.5. Smart Community Gatherings (SCGs)

The SCG consists of a group of 20 diverse community members from the village and surrounding areas. These include members with different occupations and socio-economic levels (e.g., farmers, traders, service holders, community/village leaders, community development council members and school teachers). The SCG was organized in the target village of Samanghan province. This new qualitative method seeks to fill gaps between the research community and development community by bringing them together in one platform to contribute to sustainable development. Two main facilitators from both the research and development sectors facilitated the group to keep discussions open in both research and development contexts. Semi-structured and more specific questions were asked during the 2–3 h discussion on certain topics, such as the history of faecal matter application, toilet design, existing faecal composting techniques, WASH-borne disease prevalence, agricultural production with and without human faeces, and the exploration of indigenous solutions. The discussion was both transcribed and recorded for analysis.

2.6. Interactive Workshops

Small (10 ACF participants) and large (25 participants including other stakeholders) IWs were also organized. The researcher and a humanitarian worker facilitated these workshops for the purpose of data generation and validation. Open questions were asked during IWs with the objective of investigating SWOT components and validating the collected field information. For both peri-urban and rural communities, the information was presented in a tabular format to compare scenarios of SWOT components. IW participants discussed and provided ideas and solutions related to the study. All responses were noted and included in the SWOT analysis tables found in the results and discussion section.

3. Results and Discussion

3.1. Existing T-CLSS Situation

Most of the toilets in the peri-urban context are urine-diverting vault toilets, while rural areas use traditional vault toilets that lack urine diversion. Most toilets in the peri-urban area are emptied by local farmers who apply the faecal compost to their lands. In rural areas, toilets are emptied by each household and applied to their land for agro-production. In most cases, faecal matter is transported by either donkeys, horses or humans (particularly adult men). A marketing system for selling agro-products in local markets was only observed in peri-urban areas in Kabul. In the case of rural areas, farmers consumed their own agricultural products that were produced with their faecal compost. Figure 3 shows the existing T-CLSS practices in both peri-urban and rural Afghanistan.

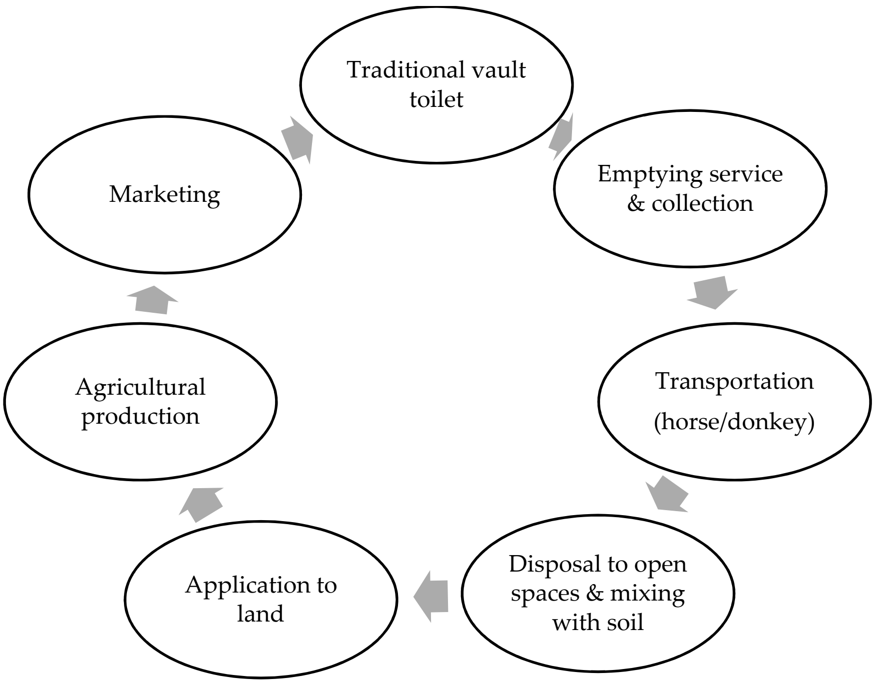

Figure 3. T-CLSS in peri-urban and rural Afghanistan (Adapted from [8]).

3.2. Strengths

Table 2 shows the SWOT components of the T-CLSS in both peri-urban and rural contexts in Afghanistan. The results from FGDs, SCG and IWs for the peri-urban area of Kabul and surrounding rural areas reveal several T-CLSS strengths. One major strength is the wide socio-cultural acceptance of the system, which has been practiced for several centuries. This positive approach to dealing with faecal matter and consuming the agro-products produced by faecal compost is rarely seen in many other parts of the world, especially in the context of peri-urban settlements (e.g. Mongolia) [8] and in Muslim communities in Pakistan [28]). In peri-urban areas, a group of 58 farmers run the system throughout the year by collecting faecal matter from traditional urine-diverting vault toilets in the village and surrounding areas in order to fulfil the local demand for agricultural products. Most farmers are not interested in using chemical fertilizers due to the negative impacts on their land. Instead they prefer organic compost, particularly fertilizers produced by faecal matter. A sum between 300 and 500 Afghani (5–9 USD) per household is paid to farmers each time their toilet is emptied. This signifies another strength of the traditional system: the contribution of the existing T-CLSS to local businesses. In rural areas, most villagers have their own land where they can apply traditional faecal compost to close the loop of the traditional sanitation system. The farmers and communities are in favour of improving the existing system. However, there is a lack of technical knowledge and availability of funding for these communities.

Table 2. SWOT on T-CLSS in peri-urban and rural Afghanistan.

Peri-Urban	Rural
Strengths	
• Socio-cultural acceptance of faecal matter application. • A high number of farmers using this system. • Demand for marketable products produced by faecal matter both in local and city central markets. • Lack of interest in chemical fertilizers. • Existing historical system; introducing a completely new system, rather than improving the existing system, is not currently required. • Higher production by T-CLSS than with low-quality chemical fertilizers. • Farmers' interest in improving the system. • Availability of agricultural land among farmers. • Customers know the faecal matter products. • Faecal matter is available in sufficient quantities. • Farmers receive money from the community for their faecal collection.	• Socio-cultural acceptance of faecal matter application. • Almost every household has been using the existing system for hundreds of years. • People are interested in improving the system. • Most have their own farming land where they can apply faecal compost. • A new pit system has been introduced during the last two years. • Equal production compared with chemical fertilizers. • Interest in cooperating with NGOs/institutions. • Interest in creating cooperatives among the farmers using the system. • Economic sustainability by using an abundant, renewable low-cost resource.
Weaknesses	
• Lack of funding and capacity to improve the system. • Lack of policy and regulation. • Lack of skilled human resources and lack of technical knowledge about the system. • Lack of technology innovation. • Little/no support/subsidies/actions from central or local government. • No farmer cooperatives exist in the area and farmers are not organised in the existing system. • Not enough production based on demand. • Some farmers still face land scarcity.	• Traditional compost is not sufficiently available. • The existing system takes more time (almost 1/2 year) to build up the compost. • No cooperatives, no interest in a large group to manage faecal composting. • Lack of funding and capacity to improve the system. • Lack of policy and regulation. • Lack of skilled human resources and lack of technical knowledge on the system. • Lack of technology innovation. • Little/no support/subsidies/actions from both central and local government and NGOs to improve the system. • No application during winter.

Table 2. *Cont.*

Peri-Urban	Rural
Opportunity	
• Job and business creation through existing system marketing and technology innovation. • Interest in creating co-operatives among the farmers using the system. • Production of good quality agro-products by using the existing system rather than chemical fertilizers. • Advocacy for clear regulation and policy interventions by the government. • Development of traditional and improved CLSS. • Application of urine for agro-production. • Income generation.	• Production of good quality agro-products by using the existing system rather than chemical fertilizers. • Advocacy for clear regulation and policy interventions by the government and NGOs. • Development of the traditional system into improved CLSS. • Possibility of improving soil fertility. • Urine-separation system can be developed for land application.
Threats	
• Unplanned disposal of both solid and liquid waste. • Health risks due to transmitting infectious agents and pathogens during traditional CLSS. • Improper CLSS application and spread of disease (80% of diseases are WASH-borne, such as diarrhoea, typhoid and dysentery). • Environmental threats (especially to aquifers). • Cold weather condition • Complaints in neighbourhoods due to the bad smells in the areas concerned. • Less land will be available due to migration from rural areas to Kabul city. • Future plans for septic tanks due to modernisation can impact household budgets.	• Water-collection streams might be affected by this system. • Health risks due to transmitting infectious agents and pathogens during traditional CLSS. • Occurrence of WASH-borne diseases, such as diarrhoea, typhoid and dysentery. • Inadequate protective equipment is used during the processes of faecal matter handling and management. • Climatic conditions, particularly the cold temperature during the winter season, could increase the cost of the CLSS system if external heating energy is used. • Application of chemical fertilizers.

3.3. Weaknesses

Several weaknesses were found (Table 2) during the FGDs, SCG and IWs in both peri-urban and rural areas. Little or no funding and a lack of technical and non-technical capacity (e.g. training, awareness campaign) were found to be major weaknesses in both rural and peri-urban contexts. Not a single cooperative exists in either area to aid in the proper development or maintenance of the systems. Furthermore, there are no co-operatives that exist to support local fundraising. In Afghanistan, no policy or regulation exists on human faeces composting or its application, which can also be considered a weakness. Using the existing T-CLSS, faecal-compost takes an average of 1 year to mature to a condition that is suitable for application. There is no application during the winter. Our study also revealed that in both peri-urban and rural areas, the composting process was often not carried out properly. This increases the risk of faecal contamination of both soil and streams where local populations produce their agricultural crops and obtain their drinking water. In peri-urban areas, some farmers face land scarcity that threatens their continued agricultural production with faecal compost, while communities in rural areas have sufficient land for their production.

3.4. Opportunities

A list of opportunities was developed using the results of the FGDs, SCG and IWs. Good quality agro-products can be produced with faecal compost in both peri-urban and rural areas. Some business opportunities are supported within the existing system, particularly in the peri-urban context. The results also show that it may be possible to introduce urine separation systems in rural areas to reduce the work load and to decrease the heavy dilution and mixing of urine and faeces. Positive results and opportunities, such as these, should be leveraged to garner governmental support and to encourage stakeholders to improve the existing system, thereby reducing the T-CLSS-borne risks and hazards.

3.5. Threats

There were very few threats raised in either peri-urban and rural areas based on discussions during the FGDs, SCG and IWs. However, the health and environmental risks of the T-CLSS transmitting water-borne diseases and environmental contaminants represent a real threat. There is a strong possibility of stream contamination in villages in rural areas as almost all villagers collect stream-water for drinking and other purposes. The unsafe handling of faecal matter during emptying, collection, transportation and application presents another potential risk of infections and food and environmental contamination. The application of chemical fertilizers was also considered as one of the threats, particularly in rural areas due to insufficient and incorrect handling of organic and faecal compost. The results from the FGD in Samangan revealed that WASH-borne diseases, such as diarrhoea and dysentery, have high prevalence among children in the area due to improper faecal matter management and unimproved sanitation systems. This leads to unforeseen costs for villagers as families spend an estimated 5000 Afghani (90 USD) per year for child healthcare.

The current study revealed that migration from rural areas to the urban centre of Kabul is also another threat. Kabul, Ghor and Balkh and Kandahar in the south are areas where intense in-migration occurred as a result of not only conflict and insecurity but also of recurrent water shortages linked to climate change. This migration has led to increased population density in existing residential areas. A large number of families have also settled outside the planned areas in informal settlements in the hilly areas of Kabul, and these settlements are progressively expanding outside city limits.

3.6. Way Forward

An integrated strategy is necessary to improve T-CLSS in both rural and peri-urban areas. Each component of T-CLSS (Figure 4) must be improved for resource/nutrient recovery, and in terms of environment and health protection, to reduce risks and threats associated with existing T-CLSS.

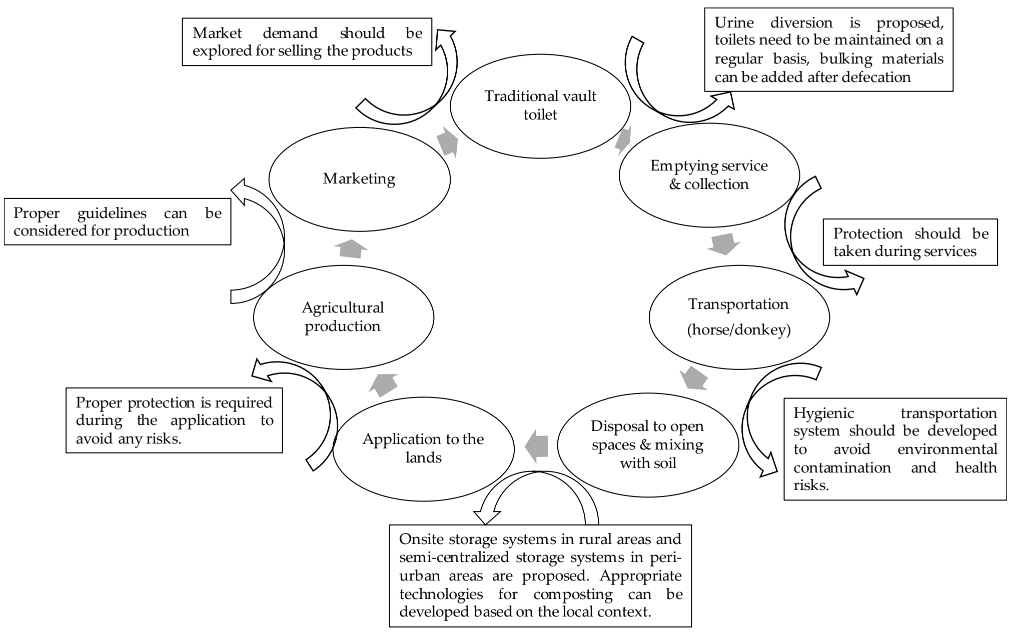

Figure 4. Proposed strategies to improve T-CLSS.

Urine diversion and regular toilet maintenance are proposed, particularly in rural areas. In addition, bulking materials can be added after defecation to reduce pathogens at the source. Caution should be used during the emptying, collection and mixing services. Hygienic transportation systems should also be developed to avoid environmental contamination and health risks. An onsite storage system in rural areas and a semi-centralized storage system in peri-urban areas is suggested to reduce the risks associated with contaminants leeching into groundwater or nearby streams. Greenhouse composting, onsite box composting and composting toilets can be developed based on local contexts. Greenhouse systems may extend the composting cycle through the ambient temperature effect. Proper protection is required during application to avoid any risk. Proper guidelines need to be created for faecal compost production and proper handling is required during application. These guidelines can be developed through effective co-ordination with the relevant government and non-governmental departments.

4. Conclusions

Participatory research tools were used to analyse SWOT components of the T-CLSS in peri-urban and rural Afghanistan. The results show that T-CLSS in Afghanistan is socio-culturally accepted in both rural and peri-urban areas, despite the long-term humanitarian crises. This can be considered to be a strength of T-CLSS, and this can be used to support future system improvements. There are many opportunities and growing interest in developing new systems and in improving the existing system to reduce the threat of the improper handling of human faeces. Therefore, it is highly recommended that the feasibility of improved CLSS should be assessed, with consideration of the existing T-CLSS and its socio-technical, economical and institutional aspects. As the overall quality of soil in Afghanistan is poor with low organic content, a lack of nutrients, high pH and calcium carbonate and low water-holding capacity [29], faecal compost may improve soil quality if properly produced and applied. Alternatively, it may be possible to apply urine after separation to agricultural fields, which is an option that could be explored with proper scientific and social research. The use of animal and human faeces to increase soil fertility for agricultural production is also economically sustainable since it reuses an abundant and renewable resource. From a sustainable livelihood perspective, the incorporation of primarily locally-sourced materials with little or no dependence on external inputs contributes to more sustainable rural development, particularly during a post-conflict period. For these reasons, it is important to explore best practices and appropriate technologies for further development of a CLSS that is capable of generating high quality organic fertilizer to be used in agricultural production.

One of the policy recommendations is to inform decision-makers of the benefits of improved CLSS, including environmental protection, health improvement and resource recovery. Each of these three aspects has an economic value that can be leveraged to drive policy makers to understand and support the system in Afghanistan. The initial costs of improving the system may be higher than maintaining the status quo. However, over the long term, such a system should recover its initial cost and save money. The authors found that many WASH-borne diseases were highly prevalent in the study areas, with child deaths unfortunately found to be a common consequence. This suggests that besides saving money, the improved T-CLSS can also ultimately save lives. Many international development agencies are already working in Afghanistan to improve the overall developmental situation. CLSS is an important part of development and partnering with other international agencies working in the area is key in ensuring the improvement in the overall WASH objectives.

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