

WASPA ASIA

Safe Reuse of Wastewater and Treated Excreta in Agriculture: Options, Assessments and Potential Barriers to Risk

Water's Edge, Battaramulla

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ASIA PROECO II



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Acronyms and Abbreviations

COSI	Community Self Improvement
EcoSan	Ecological Sanitation
IWMI	International Water Management Institute
KW	Keerthi Wijesingha
LA	Learning Alliances
NGO	Non Government Organization
PAP	Participatory Action Plan
SEI	Stockholm Environment Institution
WASPA	Wastewater Agriculture and Sanitation for Poverty Alleviation
WHO	World Health Organization

1 Workshop Objectives and Agenda

The objective of the workshop was to present and discuss wastewater, greywater and excreta management and agricultural use. The perspectives of the technical and non-technical options for risk reduction were presented and discussed, as well as the nutritional benefits with the re-use. This was compared with the “WHO Guidelines for the Safe Use of Excreta, Greywater and Wastewater in Agriculture” and with the current management options as related to barriers to disease transmission as well as with different sanitation system solutions, including dry toilets. The second objective was to discuss holistic planning in this field, and the potential for other fields, through the concept of networks or Learning Alliances.

Revised Times	Presentation/Discussion	Person
20 min (9.30 – 9.50)	Opening. Introduction. Aim of the Workshop.	KW
30 min (9.50 – 10.20)	Summary of the WASPA project in Sri Lanka/Bangladesh, including the concept of Learning Alliances	KW
10 min (10.20 – 10.30)	Short views and comments from participants	KW facilitate
30 min (10.30-11.00)	WHO Guidelines for the Safe Use of Excreta, Greywater and Wastewater in Agriculture. How does it apply in the local perspective? PART I	TAS
11.00-11.30	BREAK	
30 min (11.30 – 12.00)	WHO Guidelines for the Safe Use of Excreta, Greywater and Wastewater in Agriculture. How does it apply in the local perspective? PART II	TAS
30 min (12.00 – 12.30)	Questions and views from participants. Local applicability and constraints	KW and TAS
12.30-13.30	BREAK	
90 min (13.30-15.00)	Technical and non-technical aspects of treatment and reuse. Barriers to disease transmission and management options for risk reduction.	TAS
30 min (15.00-15.30)	Group discussion on its applicability in the local context. Possibilities and constraints!	KW facilitate
15.30 – 15.50	BREAK	
40 min (15.50-16.30)	Stakeholder opinions and institutional arrangements. Legal options within the local context. Monitoring and the potential role of stakeholders/alliances in this respect	PJ
30 min 16.30 – 17.00	Final discussion and closing remarks	

2 Facilitators

- Professor Thor Axel Stenström, Stockholm Environment Institute in Sweden who and advisor to the World Health Organization (WHO).
- Mr. Keerthi Wijesingha, WASPA Senior Program officer for Community Self Improvement (COSI).
- Alexandra Clemett, Researcher, International Water Management Institute (IWMI)
- Palitha Jayaweera , Programme Director, COSI

3 Representation

The following institutions or organizations were represented by the 58 workshop participants:

- Abans Environmental Service
- French Embassy
- International Federation of Red Cross
- UNOPS
- SIDA
- Central Environment Authority
- Department of Agriculture
- National Cleaner Production Center
- University of Colombo – Department of Forestry and Environmental science
- University of Colombo – Faculty of Science
- University of Colombo – Faculty of Medicine
- National Institute of Health Science
- Sevanatha
- Lunawa Environment and community development project
- Irrigation Management Division
- Sunday Observer
- Asian Foundation
- National Water Supply and Drainage Board
- Forut
- Sarvodaya
- Department of Agriculture
- Irrigation Department
- Energy Forum Guaranteed
- BURNS
- Ministry of Health
- The delegation of European commission to Sri Lanka and Maldives
- European Union
- IWMI
- COSI Foundation

4 Introduction

Wastewater Agriculture and Poverty Alleviation in Asia, WASPA Asia aims to:

- To contribute to the improvement of livelihoods through increased agricultural output, reduced pollution and lessened food chain contamination.
- To do this we must make local people, local authorities and national agencies key partners.

The WASPA Asia project is funded primarily under the EU Asia Pro Eco II Programme of the European Union. It is being undertaken by the International Water Management Institute (IWMI), Sri Lanka; Community Self Improvement (COSI) Foundation, Sri Lanka; the International Water and Sanitation Centre (IRC), the Netherlands; NGO Forum for Drinking Water Supply and Sanitation, Bangladesh; and the Stockholm Environment Institute (SEI), Sweden. The project pilot cities are Rajshahi City in Bangladesh and Kurunegala City in Sri Lanka, with a time span from December 2005 to December 2008.

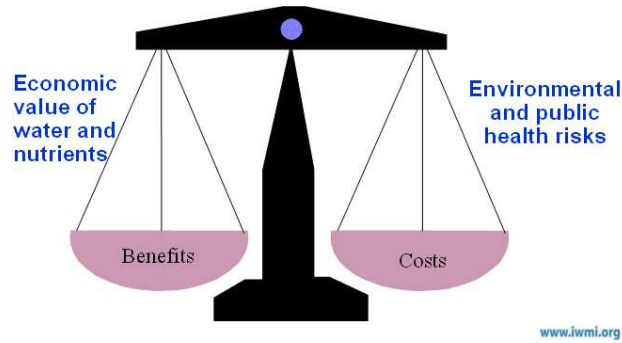
4.1 Background to WASPA

Due to the increasingly stringent regulation on the discharge of wastewater as well as the scarcity of fresh water, there is a need to consider the re-use of marginal quality waters for irrigation purposes. Waste water irrigation is not new for many countries in arid and semi arid regions. For instance although some may wonder as to how wastewater can be of any productive use, wastewater agriculture is a centuries old practice particularly in China. Even some western parts of the world, particularly Berlin has also a history of wastewater agriculture as early as the 18th century.

Sewage, often untreated, is used to irrigate 10 per cent of the world's crops, according to the first ever global survey of wastewater irrigation. With the increasing scarcity of portable water this can be seen as primarily a convenient and relatively inexpensive method of disposing wastewater, which is a common issue all over the world. Nevertheless it is not without its share of both positive and negative influences.

As shown as in the illustration below, the trade-offs of wastewater agriculture consist of:

Positive	Negative
Conserve and re-use water which is a scarce resource.	Health risks for the irrigators and communities in prolonged contact with wastewater
Provide a reliable/ continuous water supply to farmers	Health risks for the consumers of wastewater crops, especially vegetables
Low cost method for sanitary disposal of municipal waste water	Contamination of groundwater
Reduce pollution of rivers, canals and other surface water bodies	Build up of chemical pollutants in soils
Conserves nutrients minimizing the need for artificial fertilizers	Creation of habitats for disease vectors
Increase crop yield	



It is important that we evaluate how we generally respond to this wastewater irrigated agriculture activities. Our responses may range from an one polar where we strictly prohibit the use of wastewater to the use of appropriate treatment (primary, secondary) followed by regulated use with flexible standards linked to specific use, incorporating **“Turn a blind eye” as well as using without treatment.**

5 WASPA Implementation

The project “Wastewater Agriculture and Sanitation for Poverty Alleviation in Asia” has the objective: “To contribute to the improvement of livelihoods of urban communities in Bangladesh and Sri Lanka, through integrated sanitation, wastewater management and agricultural use, for improved agricultural output, reduced environmental pollution and lessened food chain contamination.” This is to be improved by increasing knowledge generation and sharing through the establishment and functioning of groups known as Learning Alliances (LAs); and development and implementation of action plans to address related issues. WASPA also aims at bringing the identified issues and practices to a national level forum By identifying local government as major stake holders of the project and To help achieve Millennium Development Goals.



5.1 Approaches and Methodologies

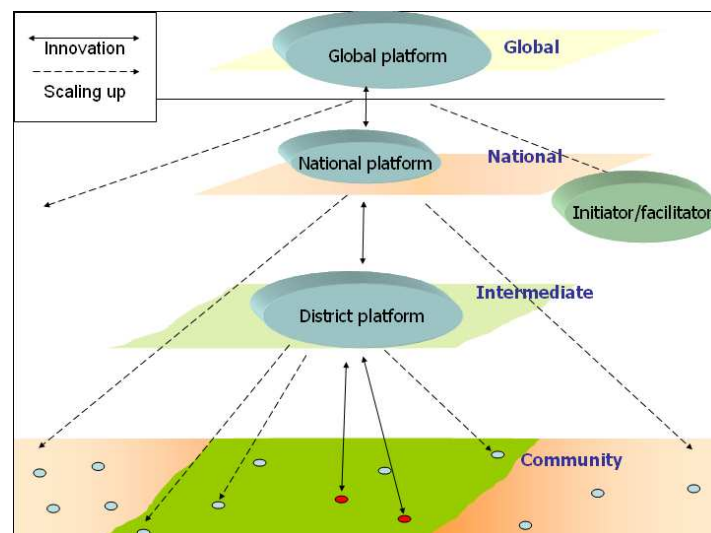
- To test solutions for **sanitation and decentralised wastewater** management for its use in **agriculture**.
- Holistic and sustainable wastewater management through interventions in the whole chain of improved sanitation, contaminant reduction, waste treatment, disposal, use in agriculture and promotion of hygiene behaviour.
- Achieved through **stakeholder involvement** to facilitate the development and implementation of **participatory action plans (PAPs)** to test technologies for safe waste management and application in agriculture.
- Share experience through **Learning Alliances** at different levels and learning events and build capacity

The Specific Objectives of WASPA are:

- To improve **knowledge generation** and sharing, to **strengthen the capacity** of local stakeholders at various levels, and to improve collaboration between them, through learning alliances (LAs).
- To **minimise health risks** by reducing urban water pollution through PAPs for appropriate sanitation and wastewater management, in conjunction with improved household and food hygiene.
- To **improve the livelihoods of poor farmers** through the responsible utilisation of domestic wastewater in agriculture and to **reduce the associated health risks** to farmers and consumers.

Here it is considered that the Learning Alliances play a key role to the sustainability of the project. A Learning Alliance was defined as A series of interconnected multi-stakeholder platforms at different institutional levels (national, district, community, etc.), aiming to speed up the process of identification, development and scaling up of innovations (based on Moriarty et al., 2005)

Learning Alliances are stakeholder groups brought together around issues to find **innovative solutions** and to improve **scaling up**.



Elements:

- Multiple institutional levels
- Multiple stakeholders (non-peers)
- Facilitated platforms

5.2 Activities

In order to create sustainable livelihood development, and increase the feasibility of wastewater and hygiene promotion related agriculture activities, WASPA is engaged in following activities:

- Identification of stakeholders and existing networks
- Individual awareness raising meetings with identified stakeholders
- Stakeholder analysis
- Assessments – results provided to stakeholders
- Formation of platform by bringing stakeholders together
- Core group formation – to direct the project
- Induce engagement with national level, through existing networks

5.3 Next Steps

WASPA hopes to build sustainability through:

- Increasing collaboration within the local Learning Alliance.
- Implementing action plans with the LA members.
- Sharing knowledge on the process.
- Seeking sustainability
- Institutional arrangements

Here the main emphasis is given to the establishments of institutional arrangements which hold the key to the sustainability of all the activities that were and will be conducted during the project phase. Moreover through the development of Learning Alliances, it is expected that institutional arrangements can also function as leverage for institutional arrangements and networking.

5.4 Discussion

Q – Considering the phenomenon of new townships – is WASPA focused only on urban areas?

A - As a pilot project WASPA's main objective is to focus on Wastewater irrigated agriculture and related poverty alleviation and hygiene promotion activities. Hence it is currently concentration on Kurunegala area and

Q- What has been done for the Improvement of learning level?

A - As illustrated through the Diagram 4.1.a the grass root level of the LA should have connectivity up to the top most level, or the global level of the Learning Alliance.

Community level should be connected to the global level. In most instances the global level of the LA is not connected nor included in the learning alliances which hinder the maintenance of Sustainability.

There should be an institution or a collection of institutions to monitor and keep the project continuation once the project implementers/ (NGO) removes them selves from the position of the implementers.

Q- How do you relate water consumption in the city Vs. Waste Water produced/ used?

A - A study has been conducted by practical action for solid waste management, which also includes a comparative study on goods consumptions and solid waste generation. But no sufficient data exists on consumption and Wastewater generation in urban areas.

Q- It is important to have an integrated institutional network that addresses wastewater management in Sri Lanka. The existing system doesn't look into all the aspects of the water management mechanism.

A - This is one of the issues that WASPA is trying to address by creating learning alliances and also by knowledge sharing. The loop holes of the existing system can be identified in such systems which can be addressed by policy and decision makers of national level. The existing system in Sri Lanka only functions for drinking water distribution and water irrigation activities only. Hence the inclusion of wastewater management into the existing water management mechanism of Sri Lanka is of vital importance.

6 WHO Guidelines for the Safe Use of Excreta, Greywater and Wastewater in Agriculture

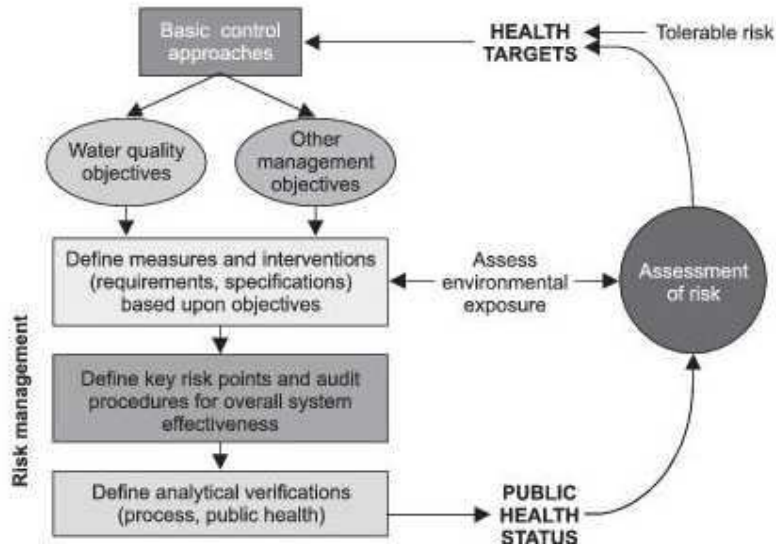


As introduced by Professor Stenstrom, the primary objectives of these guidelines is to protect the health of individuals and benefit the health status of communities by the safe use of wastewater, excreta and grey water in a range of agricultural applications considering the positive health outcome through its contribution to better nutrient and food security. The use of excreta, grey water and wastewater in agriculture is spreading globally and 10% of the world's population is thought to consume wastewater irrigated food. The driving forces behind the increased use of wastewater, excreta and greywater for agriculture world wide include increasing water scarcity and stress and degradation of freshwater resources.

The guidelines relate to an integrated risk management framework - The Stockholm framework applied from the point of generation to consumption of products grown using wastewater, excreta and grey water. The approach followed in these guidelines is intended to lead to national standards and regulation that can be readily implemented and enforced and are protective of public health.

The guidelines are targeted at decision makers and regulates of WHO member states that are responsible for planning and Implementation of sanitation related activities. They will also be useful for those with a stake (stakeholders) or interested in safe use of wastewater and excreta and grey water, public health, water and waste management sectors. The WHO guidelines are intended to provide consistent level of health protection in different settings and they should be adapted for implementation under specific environmental, socio-cultural and economic condition at the national level or below.

The individual elements of the Stockholm Framework and how they specifically relate to the use of excreta and wastewater in presented below.

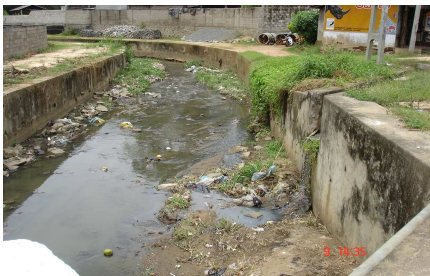


The WHO guidelines are a management system to promote and systematically address the safe use of excreta, greywater and wastewater in agriculture. It covers the intentional and unintentional impact of wastewater (where surface as well as ground water can get contaminated) and includes:

- The Stockholm framework for the recirculation of waste water and excreta
- Assessment of health risk
- Health based targets
- Health protection measures
- Monitoring and assessment
- Socio-cultural aspects
- Environment and economic considerations
- Policy planning and implementation

A summary of the WHO guidelines is provided in Annex 1.

7 Management Options for Risk Reduction



Low-income communities which do not have adequate sanitation facilities are exposed to a high risk of infection with excreta-related diseases. Children under the age of 3 are particularly susceptible to diarrhoeal diseases. Older children and adults are likely to be infected with intestinal worms, most commonly the human roundworm (*Ascaris lumbricoides*) and the human hookworms (*Ancylostoma duodenale* and *Necator americanus*).

“Practical Action” was requested to brief the participants on the ECOSAN – dry toilet project that has been undertaken by his organization. Although this is a new concept and quite a challenge, it was adapted by the recipients better than expected. The operational toilets units built in the areas of Ampara, Matara and Kurunegala had brought positive results.

As freshwater becomes increasingly scarce due to population growth, urbanization and, probably, climate change, the use of wastewater, excreta and greywater in agriculture and aquaculture will increase. In some cases, these are the only water and nutrient resources available to poor communities. Although there are benefits to using these substances - including health benefits, such as better nutrition and food security for many households - uncontrolled use of these substances may be associated with significant negative human health impacts. These health impacts can be minimized when good management practices are implemented.

The use of wastewater for crop irrigation is becoming increasingly common. Resulting crop yields are higher, as wastewater contains nutrients necessary for plant growth: However, there is the risk that wastewater irrigation may facilitate the transmission of intestinal nematode infections and faecal bacterial diseases to both consumers and agricultural workers.

The procedures are simple and effective, require a minimum of equipment, and can be carried out by persons with little or no previous parasitological or microbiological experience.

Risks related to wastewater agriculture could be assessed based on following 2 categories.

Microbial Risk: Quantitative Microbial Risk Assessment (QMRA) provides a supplementary framework to epidemiology studies for identifying potential risk for particular pathogens from source to recipient, especially farmers in this case. As environmental health assessments make use of environmental occurrence of pathogens to the probability of infection (microbial risk) in many wastewater/excreta reuse applications in agriculture.

It generally involves:

- **Hazard identification:** the range of pathogens (classes and species of disease- causing organisms)
- **Exposure assessment:** the magnitude of exposure (the number of organisms consumed) for each identified hazard
- **Dose-response assessment:** the expected physical response (infection/disease) to the hazard in the population is evaluated (dose-response relationship)

Chemical Risk: The chemical risk assessment framework provides numerical tracking of pathogens through the environment.

In order to prevent Microbial and Chemical risk direct exposure to wastewater needs to be limited while focusing on water treatment and hazard identification. For long term purposes it is also important to establish an evaluating system that will look into systematic water treatment and hazardous identification.

There should be – documentation and monitoring and validation of the activities for future references This will later influence operations monitoring validation and evaluation in later phases.

Management of microbial risk involves identifying sources of contamination and managing barriers to prevent contamination from reaching the consumer or exposed population. The focus of risk management is to take a systems approach examining the entire process as a whole including environmental and human elements. This involves:

- Hazard analysis
- Identification of critical control points (CCPs)
- Establishment of critical limits for each CCP
- Monitoring and corrective action

Establishing Bio gas systems were also introduced as method of making use of human excreta, even wastewater. Biogas originates from biogenic material and is a type of biofuel. One type of biogas is produced by anaerobic digestion etc of degradable materials such as biomass, manure or sewage, municipal waster etc. these plants can be designed based on the material available and the size.

7.1 Discussion

Q - How can we guarantee that the water is contaminated with heavy metal etc. will not cause bio accumulation?

A - In order to address the issue of bio acumination the following steps could be adhered.

- Find pollution point
- Oil and grease and microbial contamination –already analyzed
- Heavy metal contamination –already analyzed
- Low income communities and hospital waste
- Use of anaerobic ponds and grease traps
- For service stations onsite treatment plants such as grease traps. Currently Working on a one for hospitals

Q- Where are these coliforms found?

A - Coliform is a broad class of bacteria found in our environment, including the feces of man and other warm-blooded animals. The presence of coliform bacteria in drinking water may indicate a possible presence of harmful, disease-causing organisms.

Drinking water must be free of disease-causing organisms called pathogens. Pathogens can be viruses, protozoa or bacteria. Waterborne pathogens cause diseases such as hepatitis, giardiasis, and dysentery. To actually test water for specific harmful viruses, protozoa and bacteria is very time consuming and expensive. In addition, not all water laboratories are equipped and approved to do the testing required. Therefore, testing water for specific organisms is limited to investigating specific waterborne disease outbreaks. Coliform bacteria are used as water quality indicators for two main reasons:

- Coliform may be associated with the sources of pathogens contaminating water.
- The analysis of drinking water for coliform is relatively simple, economical and efficient.
- The presence of coliform in drinking water indicates possible contamination and potential health risk.

Q- The problem of accumulation of heavy metals when being used for some time?

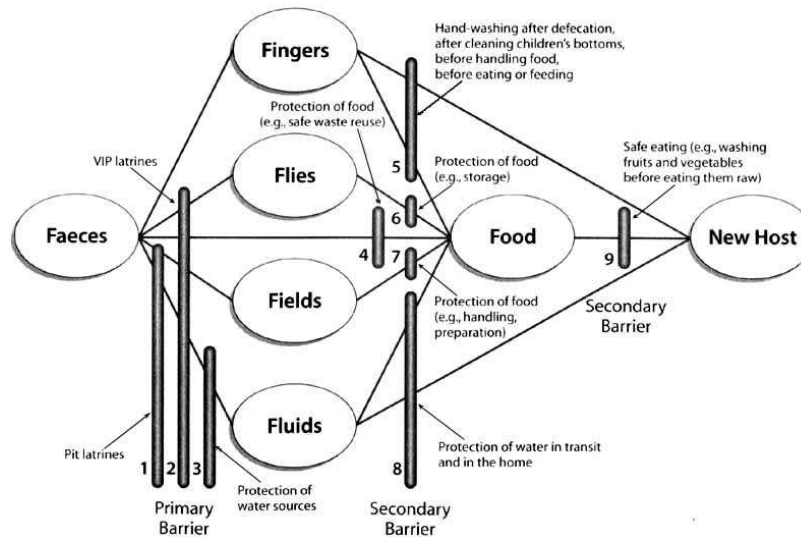
A - Constant soil and water sampling needs to be carried out to prevent such unhealthy situation

Q- What changes are needed on an institutional level to cope with this kind of environmental change?

A - First and foremost there should be an Attitude and behavioral changes (informal) along with an Institutional analysis that will eventually help identify the short comings of the institutional set up that does not support such activities. After this evaluation and revision along with the behavioral change the planning and implementation of environmental change related activities may take place.

8 Technical and non technical aspects on treatment and reuse

Many pathogens can survive for long enough periods of time in soil or on crop surface to be transmitted to humans or animals. Usually but not always their presence in water is proportionately related to the amount of faecal contamination present. The pathogens may be a combination of helminthes, bacteria, viruses and protozoa. Hence this can be identified as one of the main methods of disease transmission and the possible routes of disease transmission from excreta to humans can be illustrated as follows.



“F” diagram – transmission of diseases from excreta

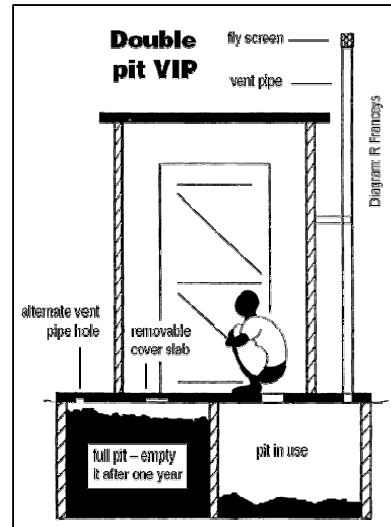
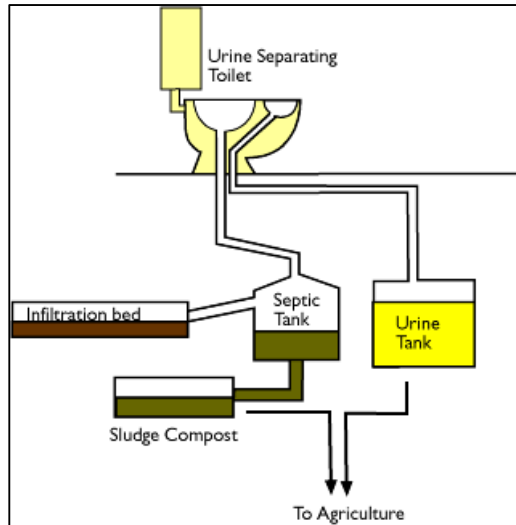
Treatment of wastewater, grey water and excreta can be done both onsite as well as offsite.

8.1 Onsite Treatment of excreta, wastewater and grey water

Onsite sanitation installations are likely to grow in numbers, and their use and performance are essential to achieve the targets for tolerable disease control. Growth the population growth growing quantities of excreta and greywater will have to be dealt with as the excreta and waste water from commercial and non commercial units as well as grey water from households are still disposed untreated.

Dry pit latrines and Ecological sanitation

A dry toilet does not need water to function. Most dry toilets used in developing countries are simple pit latrines or Ventilated Improved Pit (VIP) latrines. They consist of holes in the ground that can be covered when full or emptied for re-use after a period of stabilization. Ecological toilets are a special type of dry toilets that separate urine and feces.



Onsite biogas units

Clean water—for drinking, washing and food preparation—and safe human excreta disposal is crucial in preventing the spread of infections that cause illness, disability and death among millions of people each year. Human excreta gives off gas as it decomposes. Given the right temperature and mix of wastes, gas can be made from anaerobic digestion of agricultural and animal waste. And this flammable gas, a mixture of methane and CO₂, can be used: for direct combustion in cooking or lighting applications; or to power combustion engines for motive power or electricity generation.

Wider use of biogas units would help reduce the demand for firewood in peri-urban areas and would supply high-quality fertilizer for local farming efforts. At the same time the cost of fuel such as hydropower generated electricity and commercial cooking gases can also be minimized. As a safe excreta disposal this also prevents surface and ground water contamination to a considerable length. Such household plants are used widely in China where the gas produced is used for cooking and lighting.

Faecal sludge treatment – reuse for agriculture

Sludge is produced from the treatment of wastewater in on-site. Faecal sludge contains essential nutrients (nitrogen and phosphorus) and is potentially beneficial as fertilizers for plants. The organic carbon in the sludge, once stabilized, is also desirable as a soil conditioner, because it provides improved soil structure for plant roots. Options for sludge treatment include stabilization, thickening, dewatering, drying and incineration. The latter is most costly, because fuel is needed and air pollution control requires extensive treatment of the combustion gases. It can be used when the sludge is heavily contaminated with heavy metals or other undesirable pollutants. Prevention of contamination of the sludge by industrial wastes is preferable to incineration.

8.2 Offsite Treatment of excreta, wastewater and grey water

Simplified sewerage

Simplified sewerage is an important sanitation option in semi-urban areas of developing countries, especially as it is often the only technically feasible solution in these high-density areas. It is an off-site sanitation technology that removes all wastewater from the household environment. Conceptually it is the same as conventional sewerage, and are laid in the front yard or under the pavement (sidewalk) or, if feasible, inside the back yard, rather than in the centre of the road as with conventional sewerage. It is suitable for existing unplanned low-income areas, as well as new housing estates with a regular layout. With simplified sewerage it is crucial to have management arrangements in place to remove blockages, which are more frequent than with conventional sewers.

Anaerobic ponds

Anaerobic ponds are one of the simplest, wastewater treatment systems, because the wastewater essentially treats itself. The primary treatment takes place in the anaerobic pond, which should be mainly designed for removing suspended solids, and some of the soluble element of organic matter. On general terms, anaerobic ponds function much like open septic tanks and work extremely well in warm climates. Designers have always been preoccupied by the possible odor they might cause. However, odor problems can be minimized in well designed ponds.

Facultative Ponds

Among other off-site alternatives for the treatment and re-use of excreta and wastewater community level treatment through anaerobic ponds, facultative ponds can also be effective as a high cost treatment plant. These ponds are of two types: primary facultative ponds receive raw wastewater, and secondary facultative ponds receive the settled wastewater from the first stage (usually the effluent from anaerobic ponds). Facultative ponds are designed for BOD removal on the basis of a low organic surface load to permit the development of an active algal population. This way, algae generate the oxygen needed to remove soluble BOD₅.

8.3 Risk Reduction Approaches

Studies have shown that there have been risks of transmission of intestinal parasitic infections to agricultural workers, their families and nearby population with the use of Wastewater for agriculture related activities. Exposure to wastewater had caused skin problems as well.

Some of the methods that could protect human health from such diseases and infections are:

- Excreta and wastewater treatment
- Crop restriction
- Proper Excreta and wastewater handling and application techniques – withholding periods for pathogens to die
- Appropriate food preparation methods (such as washing, disinfecting, peeling)
- Human exposure control and hygiene education

Crop restriction and crop selection

Certain crops are more susceptible to contamination than others. The greatest health risks are associated with crops that are eaten raw –for example salad crops especially if they are root crops (i.e radish, onion) ; or that grows close to the soil (lettuce, zucchini). As the farmers of Wilgoda are engaged in paddy cultivation the level of risk associated with the crop type is considerably low. For other types of crops, different waste water application systems can be applied to minimize the contamination. (i.e Flood and furrow irrigation, spray and sprinkler).

Application techniques for mineral contamination

The use of wastewater may introduce potential toxic pollutant into soil. Through food chain transfer, these toxics may affect the health of consumers. This also may lead to contamination of surface and ground water as well. These toxics could be heavy metals and organic chemicals. Many of the heavy metals are beneficial in small quantities but, boron, fluorine etc can be harmful once consumed through the food chain. In order to avoid such crisis:

- Use organic chemicals as pesticides and fertilizers
- Wastewater treatment before being used in the fields
- Use of plants that absorb these excessive heavy metals in wastewater streams or collection points
- Identification of sources of hazardous pollutants

Withholding period

It is always recommended that there be a period of at least one month between application of urine, treated excreta or faecal sludge and final crop harvesting. This will minimize the risk levels associated with pathogenic bacteria, viruses, and parasitic protozoa. Microbial die-off is related to desiccation of the sewage sludge, and is faster in warmer, drier conditions.

Human exposure control and hygiene education

Human risk associated with this is linked mainly to the occupational exposure of those who handle excreta and wastewater and consumption of potentially contaminated products. Poor domestic and personal hygiene diminish the positive impact of improved excreta and wastewater management on community health.

Benefits of irrigated urban farming

In rural and peri-urban areas of most developing countries, the use of sewage and wastewater for irrigation is a common practice. This is mainly due to the facts

- Commonly available than fresh portable water sources
- Nutrient and economic benefits
- Useful for urban farmers
- Provide a reliable/ continuous water supply to farmers
- Low cost method for sanitary disposal of municipal waste water
- Conserves nutrients minimizing the need for artificial fertilizers
- Increase crop yield

In Sri Lanka, the use of treated wastewater and excreta for agriculture purposes is almost a new phenomenon and existing systems do not support wastewater and excreta management to a

sufficient extent. There is also a need to create awareness among the general public on the issue of excreta and wastewater and grey water disposal. Water Quality management- introduced to school curriculum and the uses of treated grey water, wastewater and excreta must be made aware.

9 Taking WASPA Forward

9.1 Discussion

Q - Is land slope a measure for health control?

A - It is only a measure if we are only dealing with ground water contamination. There are restrictions when it comes to the establishment of sanitary facilities such as toilets that would prevent the pollution of surface and ground water i.e in Sweden the pit of the latrine should be built with a distance of 35-50 to water sources. If such facilities are built on Lime, calserous or volcanic soil there can be certain risks associated with it due to chemical reactions that may cause by the soil condition.

Following are some of the major outcomes the group activity that was based on the topic “How can the information from this workshop be made useful?”

- Refer to the pilot study on water quality by UNICEF.
- Kurunegala too will face the phenomenon of Ekala-Jaela, Rathmalana and Moratuwa due to the tax concessions that have been bestowed on Kurunegala. Hence it will be exposed to more and more industries hence the potential for the increase of pollution will also be high. As we have already learned valuable lessons in waste management in those areas through trial and error it is best that we begin the preparations for Kurunegala to avoid such situations.
- Although it is recommended to change the type of the crop to suit the water quality and availability people are reluctant to do so – this situation can especially be seen in the dry zone where generations have been paddy cultivating farmers.
- It is important to maintain and retain the sustainability of the project by different stakeholders coming together. Through Networking the project can be turned into a programme that will continue to function once the project phase is over and the NGO's etc responsible for project implementation has been removed from the area. The main aim of the project should be to become a catalyst while empowering people to function on their own after sometime.
- As urban agriculture is not in the irrigation inventory, wastewater agriculture should be recognized and institutionalized. Hence relevant policies and studies should be conducted.
- It was also noted that various agencies are working in isolation in projects such as these, therefore it would be best if such organization can build up a network for learning and knowledge sharing.
- But the maintenance of such a network can prove to be difficult. In the case of the maintenance of the Kandy Lake networking has worked very well but at times it is difficult to maintain and keep the continuity. The weakness of the Kandy Lake Maintenance networking is that it was not documented.
- Create awareness in municipal councils and other relevant agencies
- Municipalities of Sri Lanka are structured for constructions mainly. Hence in order to reorganize and expand for new activities such as waste water management etc these institutions will need to be restructured. (functional changes)

- AS the Divisional secretary has the authority to ask others to participate, they should play a lead role such activities.
- Use wastewater for forest plantation.
- Abandoned paddy fields can be made into wetlands to reduce the contaminant concentration.
- Creating awareness of Liquid compost for agriculture
- Revision of PHI manuals, curriculum of the PHI's will be refueled.
- Conducting of comparative studies when executing

Annex 1: Summary of WHO Guidelines for the Safe Use of Wastewater, Excreta and Greywater, 2006

The United Nations General Assembly (2000) adopted the Millennium Development Goals (MDGs) on 8 September 2000. The MDGs that are most directly related to the safe use of wastewater, excreta and greywater in agriculture and aquaculture are “Goal 1: Eliminate extreme poverty and hunger” and “Goal 7: Ensure environmental sustainability.” The use of wastewater, excreta and greywater in agriculture and aquaculture can help communities to grow more food and make use of precious water and nutrient resources. However, it should be done safely to maximize public health gains and environmental benefits.

In 1973, the World Health Organization (WHO) produced the publication *Reuse of effluents: Methods of wastewater treatment and public health safeguards*. This document provided guidance on how to protect public health and how to facilitate the rational use of wastewater and excreta in agriculture and aquaculture. Technically oriented, the publication did not address policy issues *per se*.

A thorough review of epidemiological studies and other new information led to the publication of a second edition of this normative document in 1989: *Health guidelines for the use of wastewater in agriculture and aquaculture*. The guidelines have been very influential with respect to technical standard setting and also at the policy level, and many countries have adopted or adapted them for their wastewater and excreta use practices.

The present third edition of the Guidelines has been updated based on new health evidence, expanded to better reach key target audiences and reoriented to reflect contemporary thinking on risk management.

Box 1: What are the Guidelines?

The WHO Guidelines are an integrated preventive management framework for maximizing the public health benefits of wastewater, excreta and greywater use in agriculture and aquaculture. The Guidelines are built around a health component and an implementation component. Health protection is dependent on both elements.

Health component:

- establishes a risk level associated with each identified health hazard;
- defines a level of health protection that is expressed as a health-based target for each risk;
- identifies health protection measures that, used collectively, can achieve the specified health-based target.

Implementation component:

- establishes monitoring and system assessment procedures;
- defines institutional and oversight responsibilities;
- requires system documentation;
- requires confirmation by independent surveillance.

VOLUME I: POLICY AND REGULATORY ASPECTS**Policy Aspects**

This chapter covers policy aspects as a basis of governance and the international policy framework. It includes policy aspects related to: implementation of WHO Guidelines to protect public health; wastewater, excreta and greywater use and its benefits and health risks; international policy implications and trade; cost-effective strategies for controlling negative health impacts; policy formulation and adjustment, based on objective defining, situation analysis, policy appraisal, needs assessment, political endorsement, dialogue and research. Institutional arrangements and inter-sectoral collaboration are also an important part of the chapter.

In developing a national policy framework to facilitate the safe use of wastewater, excreta and greywater in agriculture and aquaculture, it is important to define the objectives of the policies, assess the current policy environment, formulate new policies or adjust existing ones, and develop a national strategy. Environmental protection is a policy goal in most countries, from the viewpoints of both conservation of natural resources and ecosystem services and public health protection. Yet such a view overlooks the value of the source of water or nutrients for plant production and fish cultivation.

The main policy issues to investigate are:

- *Public health*: To what extent is waste management addressed in national public health policies? What are the specific health hazards and risks associated with the use of wastewater, excreta or greywater in agriculture and aquaculture? Is there a national health impact assessment policy? Is there a policy basis for non-treatment interventions in line with the concepts and procedures contained in the Stockholm Framework?

- *Environmental protection*: To what extent and how is the management of wastewater, excreta and greywater addressed in the existing environmental protection policy framework? What are the current status, trends and expected outlook with respect to the production of wastewater, excreta and greywater?

What is the capacity to management wastewater, excreta and greywater? What are the current and potential environmental impacts? What are the options for reuse in agriculture or aquaculture?

- *Food security*: What are the objectives and criteria laid down in the national policies for food security? Is water a limiting factor in ensuring national food security in the short/medium/long term? Are there real opportunities for the use of wastewater, excreta and greywater in agriculture and aquaculture to (partially) address this problem? Is reuse currently practiced in the agricultural production system? Has an analysis of the benefits and risks of such waste use been carried out?

The steps to develop a policy are:

- establishment of a mechanism for ongoing policy dialogue;
- defining objectives;
- situation analysis, policy appraisal and needs assessment;
- political endorsement, dialogue engagement and product legitimization;
- research

Regulation

This chapter provides an overview of the technical issues that regulators should consider when developing new or modifying existing regulations for the safe use of wastewater, excreta and greywater in agriculture and aquaculture. Essential functions in regulation include:

- identification of hazards;
- generating evidence for health risks and the effectiveness of possible health
- protection measures to manage them;
- establishing health-based targets to manage health risks;
- implementing health protection measures to achieve the health-based targets; and
- system assessment and monitoring.

It also covers pathogen reduction options such as excreta storage, greywater treatment, disinfection and so on, as summarized in Table 1.

Table 1: Pathogen reductions achievable by various health protection measures

Control measure	Pathogen reduction (log units)	Notes
Excreta storage without fresh additions	6	The required pathogen reduction to be achieved by excreta treatment refers to stated storage times without addition of fresh untreated excreta. Pathogen reductions for different treatment options are presented in chapter 5 of Volume 4.
Greywater treatment	1→4	Values relate to the relevant treatment options. Generally, the highest exposure reduction is related to subsurface irrigation.
Localized (drip) irrigation with urine (high-growing crops)	2–4	Crops where the harvested parts have not been in contact with the soil
Materials directly worked into the soil	1	Should be done at the time when faeces or urine is applied as a fertilizer
Pathogen die-off (withholding time one month)	4→6	A die-off of 0.5–2 log units per day is cited for wastewater irrigation. Reduction values cited are conservative to account for a slower die-off of a fraction of the remaining organisms.
Produce washing with water	1	Washing salad crops, vegetables and fruit with clean water
Produce disinfection	2	Washing salad crops, vegetables and fruit with a weak disinfectant solution and rinsing with clean water
Produce peeling	2	Fruits, root crops
Produce cooking	6–7	Immersion in boiling or close-to-boiling water until the food is cooked ensures pathogen destruction

Sources: Beuchat (1998); Petterson & Ashbolt (2003); NRMCC & EPHCA (2005).

The guidelines also provide recommendations for microbial monitoring, using *E.coli* as the parameter, and Helminth eggs, as shown in Table 2.

Table 2: Recommended minimum verification monitoring of microbial performance targets for wastewater and excreta use in agriculture and aquaculture

Activity/exposure	Water quality monitoring ^a parameters	
	<i>E. coli</i> per 100 ml ^b (arithmetic mean)	Helminth eggs per litre ^b (arithmetic mean)
<i>Unrestricted irrigation</i>		
Root crops	≤10 ³	≤1
Leaf crops	≤10 ⁴	
Drip irrigation, high-growing crops	≤10 ⁵	
<i>Restricted irrigation</i>		
Labour-intensive, high-contact agriculture	≤10 ⁴	≤1
Highly mechanized agriculture	≤10 ⁵	
Septic tank	≤10 ⁶	
Aquaculture	<i>E. coli</i> per 100 ml ^b (arithmetic mean)	Viable trematode eggs per litre ^b
<i>Produce consumers</i>		
Pond	≤10 ⁴	Not detected
Wastewater	≤10 ⁵	Not detected
Excreta	≤10 ⁶	Not detected
<i>Workers, local communities</i>		
Pond	≤10 ³	No viable trematode eggs
Wastewater	≤10 ⁴	No viable trematode eggs
Excreta	≤10 ⁵	No viable trematode eggs

^a Monitoring should be conducted at the point of use or the point of effluent discharge. Frequency of monitoring is as follows:

- Urban areas: one sample every two weeks for *E. coli* and one sample per month for helminth eggs.
- Rural areas: one sample every month for *E. coli* and one sample every 1–2 months for helminth eggs.

Five-litre composite samples are required for helminth eggs prepared from grab samples taken six times per day. Monitoring for trematode eggs is difficult due to a lack of standardized procedures. The inactivation of trematode eggs should be evaluated as part of the validation of the system.

^b For excreta, weights may be used instead of volumes, depending on the type of excreta: 100 ml of wastewater is equivalent to 1–4 g of total solids; 1 litre = 10–40 g of total solids. The required *E. coli* or helminth numbers would be the same per unit of weight.

Volume 2: Wastewater Use in Agriculture

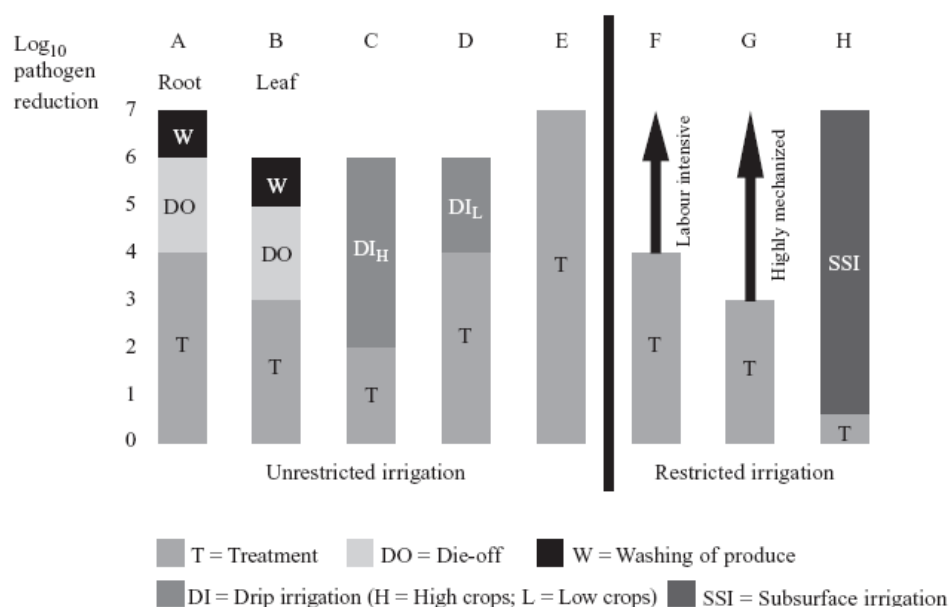
Volume 2 builds on Volume 1, providing more details. It describes the present state of knowledge regarding the impact of wastewater use in agriculture on the health of product consumers, workers and their families and local communities (Table 3). Health hazards are identified for each vulnerable group, and appropriate health protection measures to mitigate the risks are discussed. The purpose of this volume of the Guidelines is to ensure that the use of wastewater in agriculture is made as safe as possible, so that the nutritional and household food security benefits can be shared widely within communities whose livelihood depends on wastewater-irrigated agriculture. The Guidelines provide an integrated preventive management framework for safety applied from the point of wastewater generation to the consumption of products grown with the wastewater and excreta. There are many ways

in which crops can be treated or managed to reduce viral, bacterial and protozoan pathogens, including irrigation method, die-off, washing practices and treatment, as shown in Table 4.

Table 3: Summary of health risks associated with the use of wastewater for irrigation

Group exposed	Health threats		
	Nematode infection	Bacteria/viruses	Protozoa
Consumers	Significant risk of <i>Ascaris</i> infection for both adults and children with untreated wastewater	Cholera, typhoid and shigellosis outbreaks reported from use of untreated wastewater; seropositive responses for <i>Helicobacter pylori</i> (untreated); increase in non-specific diarrhoea when water quality exceeds 10^4 thermotolerant coliforms/100 ml	Evidence of parasitic protozoa found on wastewater-irrigated vegetable surfaces, but no direct evidence of disease transmission
Farm workers and their families	Significant risk of <i>Ascaris</i> infection for both adults and children in contact with untreated wastewater; risk remains, especially for children, when wastewater treated to <1 nematode egg per litre; increased risk of hookworm infection in workers	Increased risk of diarrhoeal disease in young children with wastewater contact if water quality exceeds 10^4 thermotolerant coliforms/100 ml; elevated risk of <i>Salmonella</i> infection in children exposed to untreated wastewater; elevated seroresponse to norovirus in adults exposed to partially treated wastewater	Risk of <i>Giardia intestinalis</i> infection was insignificant for contact with both untreated and treated wastewater; increased risk of amoebiasis observed with contact with untreated wastewater
Nearby communities	<i>Ascaris</i> transmission not studied for sprinkler irrigation, but same as above for flood or furrow irrigation with heavy contact	Sprinkler irrigation with poor water quality (10^6 – 10^8 total coliforms/100 ml) and high aerosol exposure associated with increased rates of infection; use of partially treated water (10^4 – 10^5 thermotolerant coliforms/100 ml or less) in sprinkler irrigation is not associated with increased viral infection rates	No data on transmission of protozoan infections during sprinkler irrigation with wastewater

Table 4: Examples of options to reduce pathogens



Volume 3: Wastewater and Excreta use in Aquaculture

Volume 3 undertakes the same task for aquaculture as Volume 2 did for agriculture. It therefore gives health-based targets for waste-fed aquaculture.

Table 5: Health-based targets for waste-fed aquaculture

Exposed group	Hazard	Health-based target ^a	Health protection measure
Consumers, workers and local communities	Excreta-related diseases	10 ⁻⁶ DALY	Wastewater treatment
			Excreta treatment
			Health and hygiene promotion
			Chemotherapy and immunization
Consumers	Excreta-related diseases	10 ⁻⁶ DALY	Produce restriction
	Foodborne trematodes	Absence of trematode infections	Waste application/timing Depuration
	Chemicals	Tolerable daily intakes as specified by the Codex Alimentarius Commission	Food handling and preparation Produce washing/disinfection Cooking foods
Workers and local communities	Excreta-related pathogens	10 ⁻⁶ DALY	Access control
	Skin irritants	Absence of skin disease	Use of personal protective equipment Disease vector control
	Schistosomes	Absence of schistosomiasis	Intermediate host control
	Vector-borne pathogens	Absence of vector-borne disease	Access to safe drinking-water and sanitation at aquacultural facilities and in local communities Reduced vector contact (insecticide-treated nets, repellents)

^a Absence of disease associated with waste-fed aquaculture-related exposures.

Volume 4: Excreta and Greywater use in Agriculture

Traditional waterborne sewerage will continue to dominate sanitation for the foreseeable future. Since only a fraction of existing wastewater treatment plants in the world are optimally reducing levels of pathogenic microorganisms and since a majority of people living in both rural and urban areas will not be connected to centralized wastewater treatment systems, alternative sanitation approaches need to be developed in parallel.

Volume 4 provides health-based targets for excreta and greywater use that may be achieved through different treatment barriers or health protection measures. The barriers relate to verification monitoring, mainly in large-scale systems, as illustrated in Table 6. The health-based targets may also relate to operational monitoring, such as storage as an on-site treatment measure or further treatment off site after collection. This is exemplified for faeces from small-scale systems in Table 7.

Table 6: Guideline values for verification monitoring of large-scale treatment systems of greywater, excreta and faecal sludge used in agriculture

	Helminth eggs (number per gram total solids or per litre)	<i>E. coli</i> (number per 100 ml)
Treated faeces and faecal sludge	<1/g total solids	<1000/g total solids
Greywater for use in:		
• Restricted irrigation	<1/litre	<10 ⁵ ^a Relaxed to <10 ⁶ when exposure is limited or regrowth is likely
• Unrestricted irrigation of crops eaten raw	<1/litre	<10 ³ Relaxed to <10 ⁴ for high-growing leaf crops or drip irrigation

^a These values are acceptable due to the regrowth potential of *E. coli* and other faecal coliforms in greywater.

Table 7: Recommendations for storage treatment of dry excreta and faecal sludge before use at the household and municipal levels

Treatment	Criteria	Comment
Storage; ambient temperature 2–20 °C	1.5–2 years	Will eliminate bacterial pathogens; regrowth of <i>E. coli</i> and <i>Salmonella</i> may need to be considered if rewetted; will reduce viruses and parasitic protozoa below risk levels. Some soil-borne ova may persist in low numbers.
Storage; ambient temperature >20–35 °C	>1 year	Substantial to total inactivation of viruses, bacteria and protozoa; inactivation of schistosome eggs (<1 month); inactivation of nematode (roundworm) eggs, e.g. hookworm (<i>Ancylostoma/Necator</i>) and whipworm (<i>Trichuris</i>); survival of a certain percentage (10–30%) of <i>Ascaris</i> eggs (≥4 months), whereas a more or less complete inactivation of <i>Ascaris</i> eggs will occur within 1 year.
Alkaline treatment	pH >9 during >6 months	If temperature >35 °C and moisture <25%, lower pH and/or wetter material will prolong the time for absolute elimination.

^a No addition of new material.

Table 8: Recommended storage times for urine mixture based on estimated pathogen content and recommended crops for larger systems

Storage temperature (°C)	Storage time (months)	Possible pathogens in the urine mixture after storage	Recommended crops
4	≥1	Viruses, protozoa	Food and fodder crops that are to be processed
4	≥6	Viruses	Food crops that are to be processed, fodder crops ^d
20	≥1	Viruses	Food crops that are to be processed, fodder crops ^d
20	≥6	Probably none	All crops ^e

^a Urine or urine and water. When diluted, it is assumed that the urine mixture has a pH of at least 8.8 and a nitrogen concentration of at least 1 g/l.

^b Gram-positive bacteria and spore-forming bacteria are not included in the underlying risk assessments, but are not normally recognized as a cause of any infections of concern.

^c A larger system in this case is a system where the urine mixture is used to fertilize crops that will be consumed by individuals other than members of the household from whom the urine was collected.

^d Not grasslands for production of fodder.

^e For food crops that are consumed raw, it is recommended that the urine be applied at least one month before harvesting and that it be incorporated into the ground if the edible parts grow above the soil surface.

Conclusion

These four volumes therefore provide important guidance on management of wastewater, greywater and excreta for productive end-use, which covers technical, policy and health issues. It is recommended that anyone working in these sectors should refer to these Guidelines, especially where unregulated use is currently taking place. It should also be noted that this use may be direct or indirect, where wastewater, greywater or excreta have contaminated sources of water that are being used for irrigation, as is likely to be the case in Sri Lanka and will increase as the population increases unless steps are taken now.