WASPA – ASIA

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

Mahaweli Reach Hotel, Kandy

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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 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)

2 Representation

Among the 36 participant (Annex 1) the following institutions or organizations were represented:

- Kurunegala Pradehiya Shabha
- Ministry of Agriculture Kurunegala Municipal Council
- Irrigation Department of the Kurunegala Municipal Council
- Provincial Environmental Authority
- Board of Investments
- ACS Kurunegala
- GKWSSP Water Board
- Agromart Foundation
- Practical Action
- IWMI
- COSI Foundation

3 Introduction

Mr. Keerthi Wijesingha introduced the aim of the two day workshop:

- Present and discuss waste water, grey water and excreta management and agricultural use.
- Discuss perspectives of technical and non-technical options for risk reduction.
- Nutritional benefits of wastewater and excreta re-use.
- Understanding the WHO Guidelines for the Safe use of Excreta, Greywater and Wastewater for Agriculture.
- Barriers to disease transmission.
- Different sanitation systems (e.g. dry toilets).
- Exposure assessment and the comparison of current assessments and participatory action plan of WASPA project.
- Discussion of the role of different stakeholders and their responsibilities.
- How to cover knowledge gaps and the assessment of options for the future.

The participants were encouraged to raise any issues related to wastewater agriculture and wastewater management without being constrained to the project outline of WASPA. Any

concerns were requested to be brought up to the facilitators and other participants for discussion and suggestions.

4 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 stakeholders of the project and to help achieve Millennium Development Goals.

4.1 Approaches and Methodologies

Introducing the Approaches taken in implementing the project in Kurunegala, it was pointed out that
The approaches are designed to suit the needs of the project area and the communities in question.
The main approaches of WASPA consists of

- 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

It was further explained that the main methodologies followed in implementing the project activities, were also in par with the needs of the area and the population;

- Participatory Action Experiments
- Active cooperative participation
- Building learning alliances
- Designing and Implementation of PAP’s

The project site of WASPA, Sri Lanka includes 12 divisions within the Kurunegala city limits and 3 more Grama Niladari Divisions outside the city boundaries. The farmer communities in Aswedduma, Dematagaha Palessa and Kaudawatte are making use waste water for their paddy cultivation and farming activities.

4.2 WASPA Visions and Participatory Action Plans

WASPA's 3 main visions are:

1. To have drainage facilities to collect, rain water and liquid waste by removing solid waste, proper treatment and disposal, capacity building and creating awareness and regulations.
2. To have adequate access to and use of proper sanitation, water supply and solid waste collection services for all households in Wilgoda pura as well as capacity building on hygienic practices and maintenance of facilities in coordination between the community and the municipal council within 2 years
3. to optimize yield and improved health for the farmers who irrigate fromW anicut by access to irrigation water and infrastructure within the standard, and access to knowledge on how to use pesticides and fertilizer in conjunction with low quality irrigation water.

Based on WASPA's main Visions the participatory action plans have been developed and implemented to maintain the long term sustainability of the project.

Some of the PAP's developed were:

- Education of farming community on sanitation issues particularly due to wastewater usage
- preparation of fertilizer recommendation guidelines for wastewater agriculture area and conducting trainings and workshops to raise awareness on fertilizer and pesticide usage
- Creating awareness on Commercial Units in WASPA project area about liquid and solid waste
- Information sharing with Greater Kurunegala Sewerage Treatment Project (GKSP)
- Improving the hygiene and environmental sanitation behaviour in Wilgoda
- Providing data & information on Safe waste water disposal methods to the polluters through a booklet.
- Stakeholder workshop with the industrialists, consultants and experts on wastewater treatment, such as this one is also a part of the WASPA PAP.

Discussion

- Health point of view – Although the local municipal council and department of health have advised and warned against discharging hazardous waste to the channel it is not practiced. Hence, the use of wastewater can be hazards for the framers.
- Agriculture point of view – The unregulated use of chemical fertilizers and pesticides by framers often pollutes the surface water and ground water. Hence it is necessary that awareness programs are carried beyond the borders of the urban council to village levels.

- Local Council's regulatory and implementation point of view – The local authorities have developed methods that contribute to the control of wastewater discharge to the canals. They also carry out awareness programs especially among industries, schools and health care centers etc.
- NGO's point of view - The role of the NGO's in such instances are critical as they can gain an in-depth understanding of the issues and work closely with different groups of stakeholders to overcome and address the issues. NGO's can be the bridge that connects the local government and the stakeholders.
- Agrarian services point of view – Projects of this nature is useful in education the concerned framers of Wilgoda, and in collaborating with farmer organizations, Agrarian services department and the framers.
- From irrigation point of view – As the farmers of Wenera uses wastewater for both Yala and Maha crop seasons. They need to assist the stakeholders.

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

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.

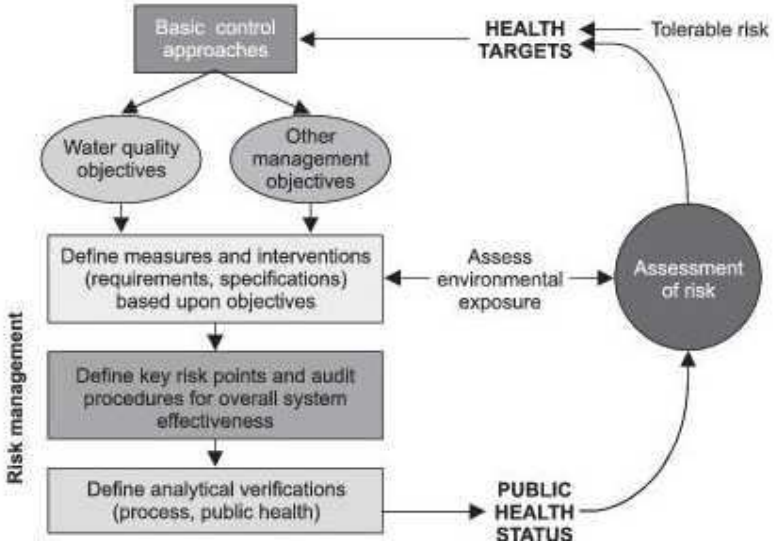
The guidelines relate to an integrated risk management framework - The Stockholm framework applied from the point of generation to consumption of products grown using wastewater, excreta and grey water. The approach followed in these guidelines is intended to lead to national standards and regulation 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.

The guidelines 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.

WH0 guidelines are intended to provide consistent level of health protection in different settings and they should be adapted for the implementation under specific environmental, socio-cultural and economic condition at the national 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

The discussion also covered issues of:

- Protection of human health

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. 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 pf faecal contamination present. The pathogens may be a combination of helminthes, bacteria, viruses and protozoa.

- Sanitation practices

Therefore it is important for farmers to make use of safety measures such as wearing boots to minimize the direct exposure to wastewater. Meanwhile authorities must take steps to maintain the non-hazardous quality of waster water hence eliminating the threats towards the nearby population.

- Recommended crop types / Crop Restriction

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.

- Food Preparation measures

Vigorous washing of rough-surfaced salad crops (i.e lettuce, parsley) and vegetable eaten uncooked in tap water reduces bacteria by at least 1 log unit. For more health safety washing in disinfectant solutions or in a detergent and rinsing in tap water can reduce helminth egg numbers by 1-2 log units.

Peeling of fruits and root vegetable and finally cooking them are a few more effective methods of reducing pathogen contamination in food.

- Advisory to national standard setting for wastewater, greywater and excreta

The WHO guidelines can be used to formulate or even revise the existing policies and procedures undertaken in wastewater and excreta management of the country.

- National policy perspective and policy issues

On a national policy perspective, the contribution of stakeholders should be discussed to assign responsibilities, for Learning Alliances (LA) and knowledge sharing.

- Institutional arrangement and networking

Once the institutional roles and responsibilities are made clear through a policy framework it is important to have an institutional arrangement and networking system for coordination of activities, sustainability and strength. It is important ot focus on reporting and communication of these net worked institutions along with support services and training. It is important to maintain representation of all levels from farmers to policy makers to consumers in this institutionalized network for better clarity and sustainability.

- Economical implications of various wastewater treatment methods etc

It was advised that low cost methods of water treatment such as anaerobic ponds, grease and garbage traps and sludge treatment are as effective as high cost, technical water refinery plants.

- Monitoring and evaluation

Regarding the WASPA project, the planners should look into the issues of: different types of pollution; different sources of pollution; and different exposure level of different groups. It is critical that the issues are visualized by breaking down the entire picture into sub-sections that can be addressed individually but ensuring that the system is still considered as a whole. This is known as a systematic approach and in the case of wastewater management should include:

- Wastewater disposal from the town - graywater (washing water) and blackwater (toilet waste) from households, industrial effluent, oil and grease, and hospital discharges
- Solid waste discharged from the town
- Waste disposed along the system (e.g. en-route to Wilgoda anicut) - communal latrine discharge and solid waste disposal

In Kurunegala mosquito breeding in open drains and in the channel was identified as the biggest health issue rather than the lethal contamination issues. It is therefore important to conduct an exposure assessment to deduce who is exposed and how; this is important in planning risk management. To address the problems of wastewater local and appropriate treatment systems should be used such as using anaerobic ponds and grease traps, without trying to implement waste water purifying plants that can be extremely costly to build as well as to maintain. It is also critical that a monitoring mechanism is developed to measure the progress and the continuation of all the efforts carried out. In the local scenario the key problems occur en-route. Therefore, it is necessary to consider: how can assessments be conducted; types of input required and available; the existing documentation and actual documentation needs; and aspects of exposure in Agriculture and health perspective.

5.1 Discussion

- *Q1 - What are the parameters that should be used to monitor the water composition? Is the monitoring of pathogens sufficient?*

Solution – as pathogens are much more destructive than other composition matters such as heavy metal and grease, clinical waste must be treated properly before being discharged to common waste water streams

- *Q2 - Sampling of the water steam at different locations*

Solutions – the sampling of waste water that runs along the channel is an important clue to understand the potential benefits and risk in using the wastewater. Therefore, the institutional support must be gained for lab testing etc.

- *Q3 - The need to incinerate wastewater from hospital and private establishments related to healthcare services. (Private nursing homes)*

Solution - As clinical waste in the forms of liquid and solid can be very dangerous if exposed there is a strong need to put to stop to discharge of untreated waste from hospitals. The local authorities have a great role in executing such preventive actions.

- *Q4 - Regulation of discharge of industrial water to the water stream*

Solution - a networked monitoring system must be established as above.

- *Q5 - Risks of non-communicable dieses such as heavy metal poisoning to diabetics due to the use and exposure to waste water*
- *Q6 - Methods to correct the misbelief that diseases are caused by consuming wastewater irrigated agri products*

Solution – As wastewater agriculture has not been a common practice in Sri lanka, people have developed various misconceptions. Most reported kidney failures and heavy metal poisoning is due to the excessive use of chemical fertilizers and pesticides along with the accumulation of heavy metals such as cadmium, mercury and arsenic. Therefore in order to prevent such health issues verification sampling of water must be conducted closer to the agriculture fields. The introduction of effective organic fertilizer and pesticides was also considered to be a good solution for the issue.

- *Q7 - Methods to purify heavy metal contaminated water(due to the excessive use of pesticides)*

Solution – As the method of applying pesticides to the crops can increase the level of exposure to the waterways, the farmers' needs to be educated about the potential risks involved. At the same time freshly burned wood (charcoal) acts as an absorber of heavy metal in the water, and also can be used as a method of purifying water to an extent.

- *Q8 - A scheme to stimulate the people/ dischargers of waste, who do not benefit from the use of waste water in the form of tax reductions, issuing of recognition certificates by the local government.* Solution – the existing schemes such as polluter pay initiation, issuing of Environment Protection license by the M.C recognition of the best hotel/food outlet based on hygiene etc were discussed.

- Q9 - The possibility of introducing Energy production units (ie.e Bio gas)

Solution – the reuse of waste and excreta can be used to produce bio-gas. But the economical feasibility for the cost of establishing such a unit might be low.

6 Management Options for Risk Reduction

Barriers against disease transmission and management options for risk reduction were discussed in relation to using wastewater and excreta for agriculture purposes. The presentation covered:

How transmission of diseases from excreta occurs through:

- Vector breeding of mosquitoes
- Introduction of a methodical sewerage
- Introduction of anaerobic ponds
- Crop health
- Human health

- Risk reduction approaches and strategies (from wastewater generation to use of wastewater)
- Introduction of bio-gas technology in brief
- Human excreta vs. animal manure for fertilizers or as a method of energy recovery

“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 bought positive results.

6.1 Group Discussion: Applicability in the Local Context

A group discussion on the applicability of options for wastewater management in the local context was conducted. The groups were given 20 minutes to discuss what categories of groups exposed are, why they are exposed and what are the potential health related issues. Then each group was given the chance of presenting their discussed issues based on given approaches. A summery of the data presented by the groups is as follows;

Who are exposed (broad categorization)?

- Low income families that live along the wastewater channel
- Farmers who use the wastewater for agriculture purposes
- Families that use water from the channel for household purposes
- Daily users of surface and underground water sources that are in close to the channel
- Households that live in flood affected areas
- Consumers of crop produce
- All people that migrates to Kurunegala on a daily basis for business and other purposes
- The entire Kurunegala towns
- The suburbs of Kurunegala
- Natural Bio diversity of the channel and surrounding areas
- The entire natural water system including rivers etc.

How are they exposed?

- Low income families that have to live along side the odorous wastewater stream
- By using untreated wastewater for agriculture that can contain hazardous material for both the crop health as well as for farmers health
- By using unfiltered or untreated water from the channel for daily household purposes
- Stagnated water that helps the breeding of mosquitoes
- Uneducated low income families create more pollution
- Exposure to natural disasters such as floods increase the vulnerability for disease transmission and pollution
- Crops can be heavily contaminated with heavy metal
- Crop yield can be low due to water and soil contamination (changes in metal and mineral content and the ph values of the soil and water)

- Consuming fish that has been affected by contaminated water
- Loss of land value due to pollution
- Bad odor

Some of the (potential) health related issues that were brought up in the group presentations were:

- Mosquitoes due to stagnated water along the channel, which happens because of the dumping of solid waste to the canal so that the water flow is obstructed and pools of rain water collect.
- Due to the discharge of industrial, clinical waste and excreta the farmers who use the wastewater may be exposed to toxics and hazardous waste.
- The wastewater stream also affects the surface water as well as the ground water.
- The issue of malnutrition coupled with the ill health of the people, especially children who are exposed to the waster water in various ways.

7 WAPSA Participatory Action Plan

On the second day a summary of day 1 was given. Then the group was given a set of color cards and was requested to engage in a discussion in order to highlight aspects that need to be added to the existing WAPSA Participatory Action Plan (PAP). The color cards were to be used to write down their suggestions and to be the given to the project team and the facilitators for further discussion.

A video was shown that was created by an NGO who has been working to promote Environmental sanitation and the use of dry toilets. Such technologies are quite effective in reducing the level of ground water pollution as the ensure structure of the building is above the ground and also the water used, urine and the excreta are reused to maximize its nutrient quality and reduces the discharge of untreated faecal material to the environment.

7.1 Discussion: Introduction of Ecological Sanitation to Kurunegala

The Chief Medical Officer of Health of the Kurunegala area expressed the importance that she felt in the introduction of dry toilets to the residents of Elugala. As their residential area is situated on rock land, there is a difficulty in introducing the conventional pit latrine systems to that community. She also requested that the WASPA project introduce them in Wilgoda.

The introduction of dry toilets has not been considered as an objective of WASPA since WASPA has been mainly concentrating on the development of the existing sanitary facilities of Wilgoda where reconstruction and development work is being taken place. However, the WASPA project would be willing to consider such a request, even though it may be challenging to advocate for dry toilets. It was suggested that the team visit the dry toilets constructed by Practical Action in Elugala.

The MOH felt that although some people are aware of these dry-toilet prototypes, due to financial constrains the people find it difficult to build such types of toilets. Another constraint may be the availability of these dry toilet prototypes, especially the squatting pan or the commode set. It was suggested that commercial availability would create awareness as well as interest among the people to build and use the dry toilet proto types; some prototypes that have been made in cement as a substitute for produced ceramic toilets and these could be promoted in the private sector.

7.2 Discussion: Practices for the safe use of excreta and greywater

The following were brought to discussion: problems associated with the emission of wastewater to natural waterways; the need to keep a balanced nutrient level in water and soil for agriculture; importance of crop selection in wastewater agriculture; and application of wastewater in Sri Lanka.

The positive feedback from the participants was:

- Reduce industrial waste.
- Recognition of the problem of solid waste.
- Contaminant identification.
- Removing waste from industrial outlets.
- Straining of oil and grease using small dams and grease traps.
- Introduction of garbage traps to reduce the down flow of solid waste materials.
- Need of comparative studies between the outcome of wastewater irrigated crop yield and the natural water irrigated crop yield.
- The need for the ministry of agriculture and affiliated institutions to play a key role in demonstrating the effectiveness and the benefits of the safe use of wastewater for agriculture.

During the question and answer session which followed, the following issues were raised by the participants.

- The issue of constant monitoring of the system to ensure its optimized execution that benefits the stakeholders
- The need to sample water and soil quality and the methods available for it
- The possibility of obtaining the support of the related institutions for lab testing of water soil and crops (i.e. JAICA)
- The possibility of developing a ready-made easy to use test kit for framers to conduct soil and water sampling by their own
- The possibilities of conducting sampling along the channel to trap the industrialist that discharge untreated blackwater

Under the PAP of the WASPA Kurunegala that they have already taken steps to collaborate with the ISB Kurunegala in soil and water testing. It was also suggested by one of the participants to make use of the Bathalagoda Agriculture testing Lab at the institute for

experimental rice-paddy crop. Another suggestion was made to conduct the soil tests in the coming dry season as it is the best possible time of the year to obtain accurate soil samples.

Priority should be given to human health aspects and then to the crop health; although major outbreak of diseases have not surfaced in the area in question, there have been complaints of the spread of itchy rashes among the farmers and their families who use waste waster for agriculture in other parts of the world.

7.3 Discussion: Health Issues

- Introduction of measures and methods to reduce the discharge of wastewater e.g. through the use of grey water for Home gardening)
- Prevention of solid waste disposal to the channel
- Health education
- Health care for disease control
- Cleaning and clearing of the channel to regular down-flow of water
- Conduct awareness programs for the safe use of wastewater and excreta for agriculture from national to community level
- Examination of the routine life of the farmers to understand their health issues and the level of exposure that may create risks either now or in the longer term
- Introduction of risk reducing equipment for farmers
-

7.4 Discussion: Agriculture perspective

- Assistance in fertilizer recommendation is needed
- Introduction of less vulnerable crop types
- Creation of resource centers and facilitators
- A storage facility for crop selection

7.5 Discussion: Institutional Perspective

- Informing the public through the PAP
- Empower them to function independently
- Documented networking of related institutions and stakeholders to ensure the continuation of the solutions provided

8 Taking WASPA Forward

The participants were urged to think about who is responsible for each of the actions from waster water production until it reaches the agriculture fields. It appears that the ‘responsibility’ of the urban council in health, sanitation and agriculture related issues seems to stop at the point of the urban border and there is no continuity of the practices observed by the Municipal Council beyond that..

The question was raised about the practical functionality of the Core Group of this project. The response was that the main foundation for this project was laid by the Core group that consists of people from the institutional as well as the community level. As the Core Group system will be tuned and empowered to function on its own it is hoped that they will be taking over the responsibility of the running of the mechanism. It is also expected that due to the awareness programs that have taken place and due to the rigorous implementations of regulatory action the polluters will discontinue dumping the solid waste and untreated waste water into the channel.

It is expected that there will be behavioral change in the Wilgoda community with the incorporation of best practices in hygiene and sanitation. Through WASPA, the project is hoping to address the physical and long term benefit creation for the Wildoda and surrounding community. The aim is to build a platform between the disconnected stakeholders for long term sustainability.

Professor Stenström made a surprising ending to the discussion by presenting USD 50 to one of the participant who requested to conduct an essay competition among the schools of Kurunegala on World Environment day.

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); NRMMC & 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	
Agriculture	*E. coli* per 100 ml[b] (arithmetic mean)	Helminth eggs per litre[b] (arithmetic mean)
Unrestricted irrigation		
Root crops	$\leq 10^3$	≤1
Leaf crops	$\leq 10^4$	
Drip irrigation, high-growing crops	$\leq 10^5$	
Restricted irrigation		
Labour-intensive, high-contact agriculture	$\leq 10^4$	≤1
Highly mechanized agriculture	$\leq 10^5$	
Septic tank	$\leq 10^6$	
Aquaculture	*E. coli* per 100 ml[b] (arithmetic mean)	Viable trematode eggs per litre[b]
Produce consumers		
Pond	$\leq 10^4$	Not detected
Wastewater	$\leq 10^5$	Not detected
Excreta	$\leq 10^6$	Not detected
Workers, local communities		
Pond	$\leq 10^3$	No viable trematode eggs
Wastewater	$\leq 10^4$	No viable trematode eggs
Excreta	$\leq 10^5$	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

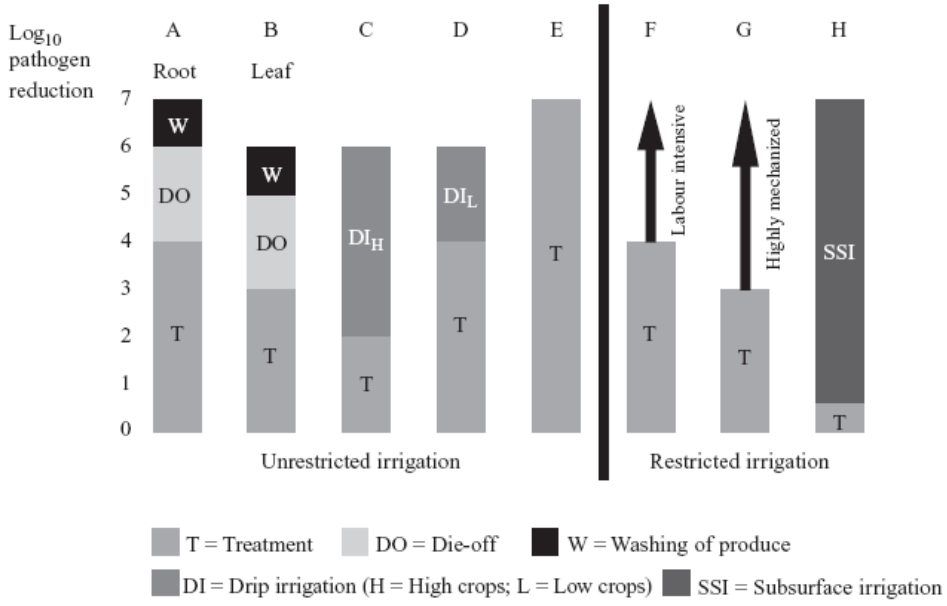
Volume 2 builds on Volume 1, providing more details. It describes the present state of knowledge regarding the impact of wastewater use in agriculture on the health of product consumers, workers and their families and local communities (Table 3). Health hazards are identified for each vulnerable group, 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 *Ascaris* infection for both adults and children with untreated wastewater	Cholera, typhoid and shigellosis outbreaks reported from use of untreated wastewater; seropositive responses for *Helicobacter pylori* (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 *Ascaris* 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 *Salmonella* infection in children exposed to untreated wastewater; elevated seroresponse to norovirus in adults exposed to partially treated wastewater	Risk of *Giardia intestinalis* infection was insignificant for contact with both untreated and treated wastewater; increased risk of amoebiasis observed with contact with untreated wastewater
Nearby communities	*Ascaris* 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
			Waste application/timing
	Foodborne trematodes	Absence of trematode infections	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
			Use of personal protective equipment
	Skin irritants	Absence of skin disease	Disease vector control
	Schistosomes	Absence of schistosomiasis	Intermediate host control
			Access to safe drinking-water and sanitation at aquacultural facilities and in local communities
	Vector-borne pathogens	Absence of vector-borne disease	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)	***E. coli* (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 *E. coli* and *Salmonella* 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 (*Ancylostoma*/ *Necator*) and whipworm (*Trichuris*); survival of a certain percentage (10–30%) of *Ascaris* eggs (≥4 months), whereas a more or less complete inactivation of *Ascaris* 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.