

# ***Safe Use of Wastewater in Agriculture:***

## ***WHO Guidelines***

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# *The need for guidelines*

- ◆ **More than 10% of the world's population consumes food irrigated with wastewater. The percentage is higher in low-income countries with arid and semi-arid conditions**
- ◆ **Use is growing in response to increasing:**
  - **water scarcity and stress**
  - **expanding populations**
  - **recognition of the value of wastewater**
  - **environmental pollution from discharges**
- ◆ **Guidelines and policies are required to promote maximum benefits from using wastewater while guarding against health risks**
- ◆ **On an international level guidelines are required to facilitate trade of wastewater - irrigated food products**

# Summary of Health Risks

Raw and poorly treated sewage causes disease

## Consumers

- helminth infections from untreated sewage
- cholera, typhoid, shigellosis from untreated sewage
- diarrhoea from poorly treated sewage
- cyclospora infections linked to wastewater

## Farmworkers and their families

- helminth infections from untreated sewage (higher for children). Hookworm if footwear not worn
- *Salmonella* from untreated sewage, diarrhoea and norovirus infections from poorly treated sewage
- amebiasis, giardiasis from untreated sewage

## Nearby communities

- increased infection from spray irrigation of poorly treated sewage

# 1989 Guidelines – Water Quality

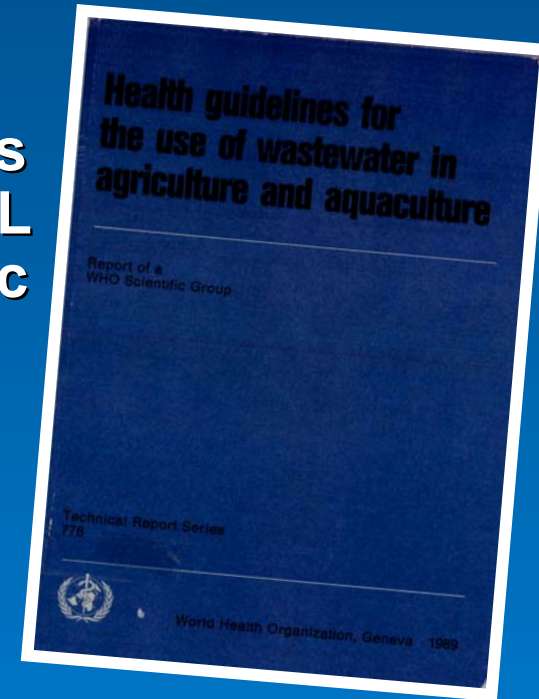
Provided numerical values for 3 categories

**A.** Crops eaten uncooked, sports grounds, parks  
≤ helminth/L, ≤ 1000 faecal coliforms/100 mL  
To protect workers, consumers and the public

**B.** Cereals, fodder, pasture and trees  
≤ helminth/L  
To protect workers

**C.** Localised crop irrigation with no exposure of  
workers or the public  
No microbial standard

Use of raw sewage not supported



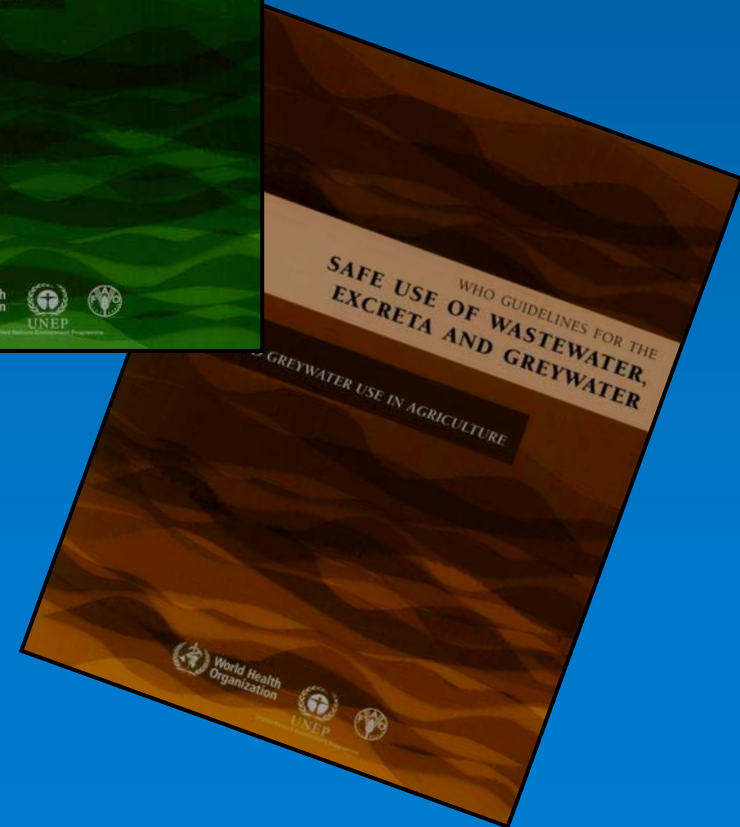
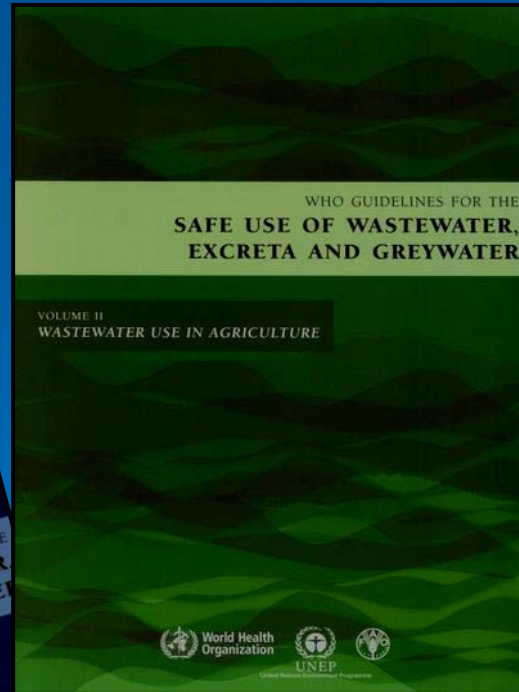
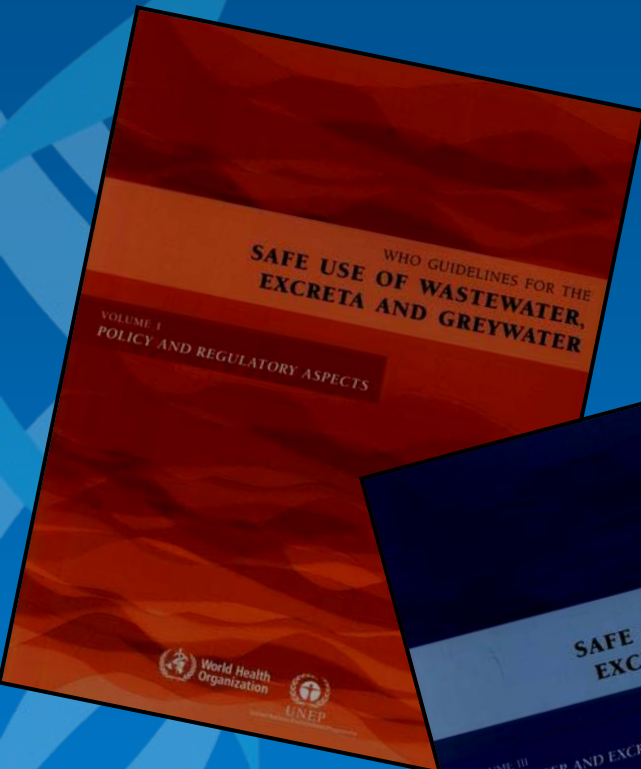
# ***1989 Guidelines – Health Protection***

## **Guidance provided on**

- **Treatment (focus on ponds)**
- **Crop selection**
- **Application controls (spray, drip, subsurface)**
- **Human exposure control (protective clothing)**
- **Integration of control measures**

**Lack of quantification of the various measures. Gaps from guidelines applied in some developed countries**

# 2006 WHO Guidelines



# ***New features***

- ◆ **Stronger focus on applying a risk management approach where risks are assessed and managed using combinations of treatment and on-site controls (e.g. methods of use)**
- ◆ **Application of QMRA to assess the likelihood of disease from enteric bacteria, protozoa and viruses present in sewage.**
- ◆ **Determining impact of disease using disability adjusted life years (DALYs) (considering what happens after infection e.g. diarrhoea, cholera, dysentery, death)**
- ◆ **Using DALYs to define safety and set health-based targets**

# *Achieving safety*

## **Step 1 Define safety**

WHO defines safety as  $\leq 10^{-6}$  DALYs /person/year (~ 1 case of mild diarrhoea/1000 person/year (global incidence 0.1 to 1 case/person/year)).

## **Step 2 Use QMRA**

Use QMRA to determine the pathogen concentrations associated with  $10^{-6}$  DALYs taking into account exposure

## **Step 3 Required pathogen reduction**

From sewage concentrations to compliance with DALYs

## **Step 4 Achieving pathogen reduction**

Treatment or exposure control

# *Adjusting health-based targets*

- **The definition of safety should consider local circumstances including cost and the impacts on public health.**
- **Less stringent definitions of safety can be applied e.g. it could be reduced to  $10^{-5}$  DALYs per person per year.**
- **This would increase the risk of illness to the equivalent of (~ 1 case of mild diarrhoea/100 person/year (global incidence 0.1 to 1 case/person/year)).**
- **Governments may decide that this is an adequate level of protection compared to local rates of disease.**
- **Cost and affordability important**

# QMRA

## Infection risks calculated for:

- Restricted irrigation involving ingestion of soil by **farmworkers and children** playing in fields. Two scenarios:
  - labour intensive with no gloves and often no footwear
  - highly mechanised using tractors *etc* and hygiene protection
- Unrestricted irrigation involving irrigation of lettuce or onions and consumption by the **public**

## Risks calculated for rotavirus, *Campylobacter* and *Cryptosporidium* using:

- Ratios of pathogens to numbers of *E.coli* in sewage
- Estimates of exposure associated with each use
- Dose responses from human volunteer studies

## Risks for helminths based on epidemiological evidence

# Log reductions

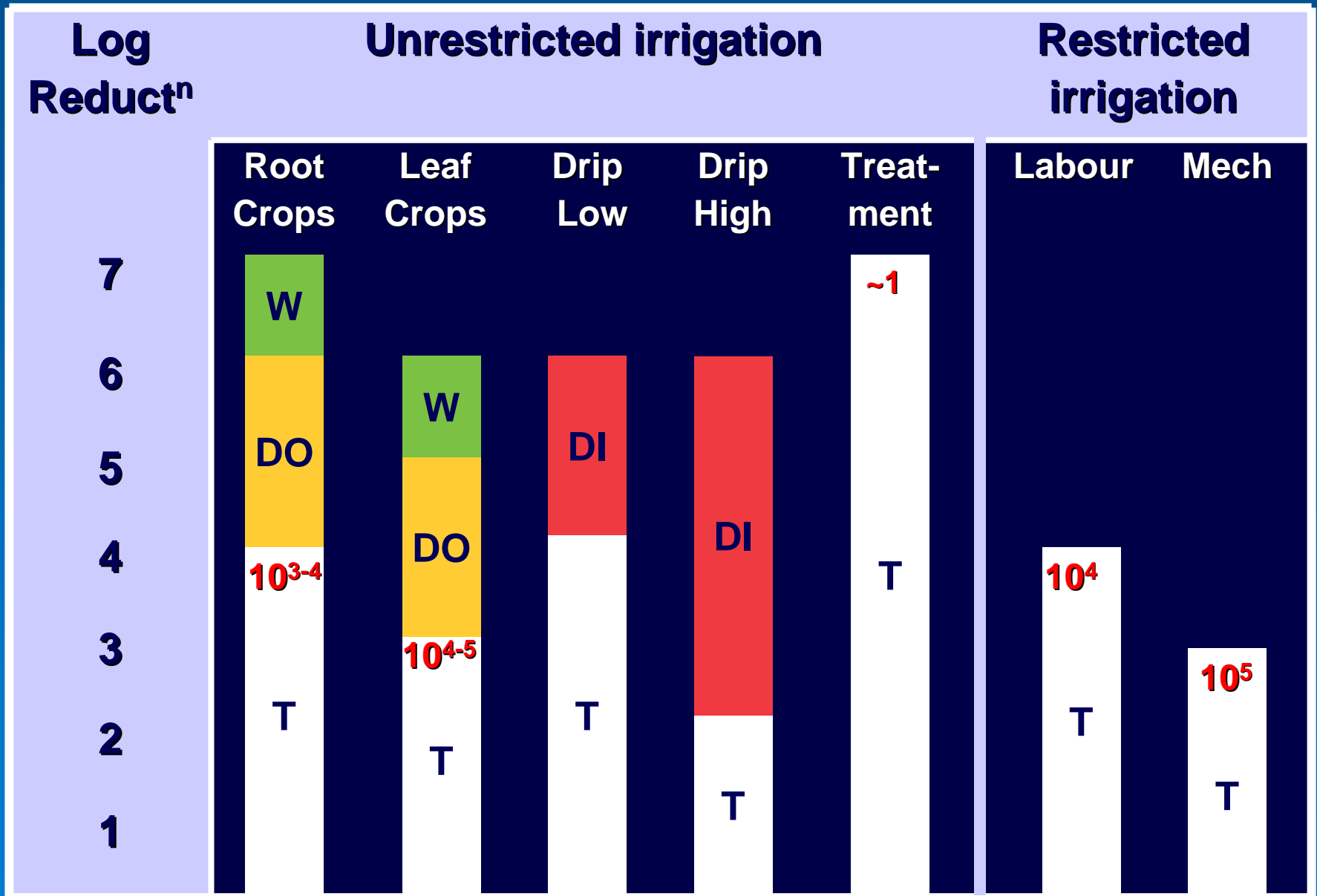
Use of wastewater	Log reduction needed	Helminths per L
<b>Unrestricted irrigation</b>		
Lettuce	6	$\leq 1$
Onions	7	$\leq 1$
<b>Restricted irrigation</b>		
Mechanised (1-10mg soil)	3	$\leq 1$
Labour intensive (10-100mg soil)	4	$\leq 1$
<b>Localised drip irrigation</b>		
High growing crops	2	no value
Low-growing crops	4	$\leq 1$

- Log reductions based on rotavirus (*Campylobacter* and *Cryptosporidium* represent lower risks )
- Greater protection from helminths required if children exposed

# *Achieving log reductions*

<b>Control measure</b>	<b>Log reduction</b>
<b>Treatment</b>	<b>1-6</b>
<b>Localised drip irrigation (low crops)</b>	<b>2</b>
<b>Localised drip irrigation (high crops)</b>	<b>4</b>
<b>Pathogen die-off</b>	<b>0.5-2 per day</b>
<b>Produce washing</b>	<b>1</b>
<b>Produce peeling</b>	<b>2</b>
<b>Produce cooking</b>	<b>6-7</b>
<b>Spray buffer zones</b>	<b>1</b>

# Health Protection Options



# Summary

- The guidelines identify how to ensure that the nutritional and food security benefits of wastewater-irrigation are achieved safely
- The guidelines provide a **numerical** definition of safety and a preventive risk management approach for achieving it.
- The guidelines **quantify** the effectiveness of health protection measures and describe how different combinations of health protection measures can be used to achieve safety
- Low technology and high technology solutions can be applied depending on circumstances

# Monitoring

**Operational monitoring** is the focus of risk management. Used to ensure effective performance of control measures (including treatment and on-site restrictions). Can include:

- regular testing of key processes (e.g. BOD and suspended solids for biological processes)
- observation of lagoons for algal growth, checking of flow rates
- checking of restrictions on crop type, methods of application, timing restrictions
- checking hygiene and access restrictions

**Verification** is testing undertaken to ensure that risk management plans are producing desired outcomes. Not used for short-term management

- E.coli in treated water
- Public health surveillance