

Stakeholder Analysis and Pilot Study for Safe Use of Treated Wastewater in Agriculture in Jordan (2014-15)

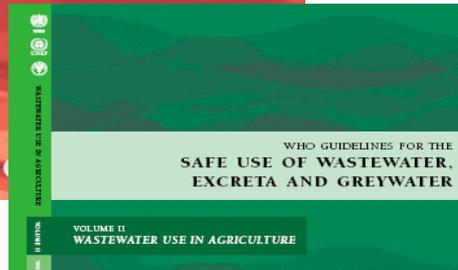
Conducted based on the WHO Guidelines for the Safe Use of Wastewater, Excreta and Greywater

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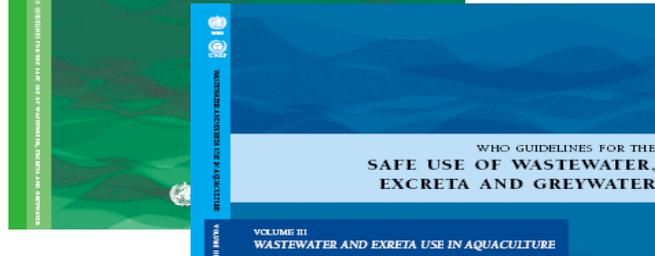
V1 Policy & Regulatory Aspects



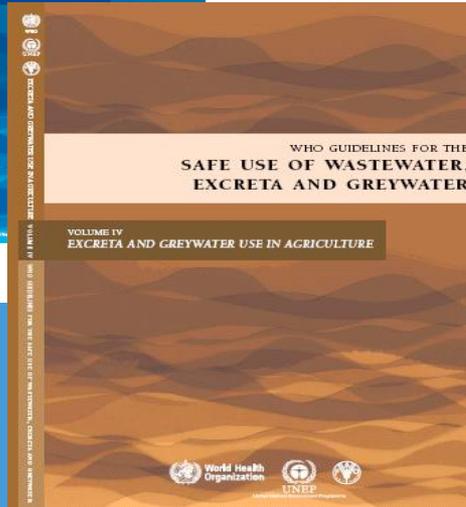
V2 Wastewater use in agriculture



V3 Wastewater & excreta use in aquaculture



V4 Excreta & greywater use in agriculture



SANITATION SAFETY PLANNING

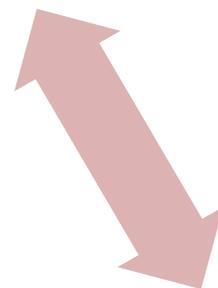
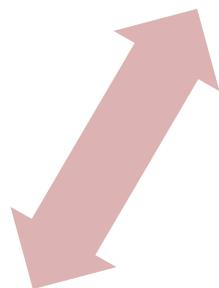
MANUAL FOR SAFE USE AND
DISPOSAL OF WASTEWATER,
GREYWATER AND EXCRETA



Assess Health Risks

Epidemiological Studies

QMRA



Risk Management

Measures and Interventions

Multi Barrier Approach



Health Based Targets

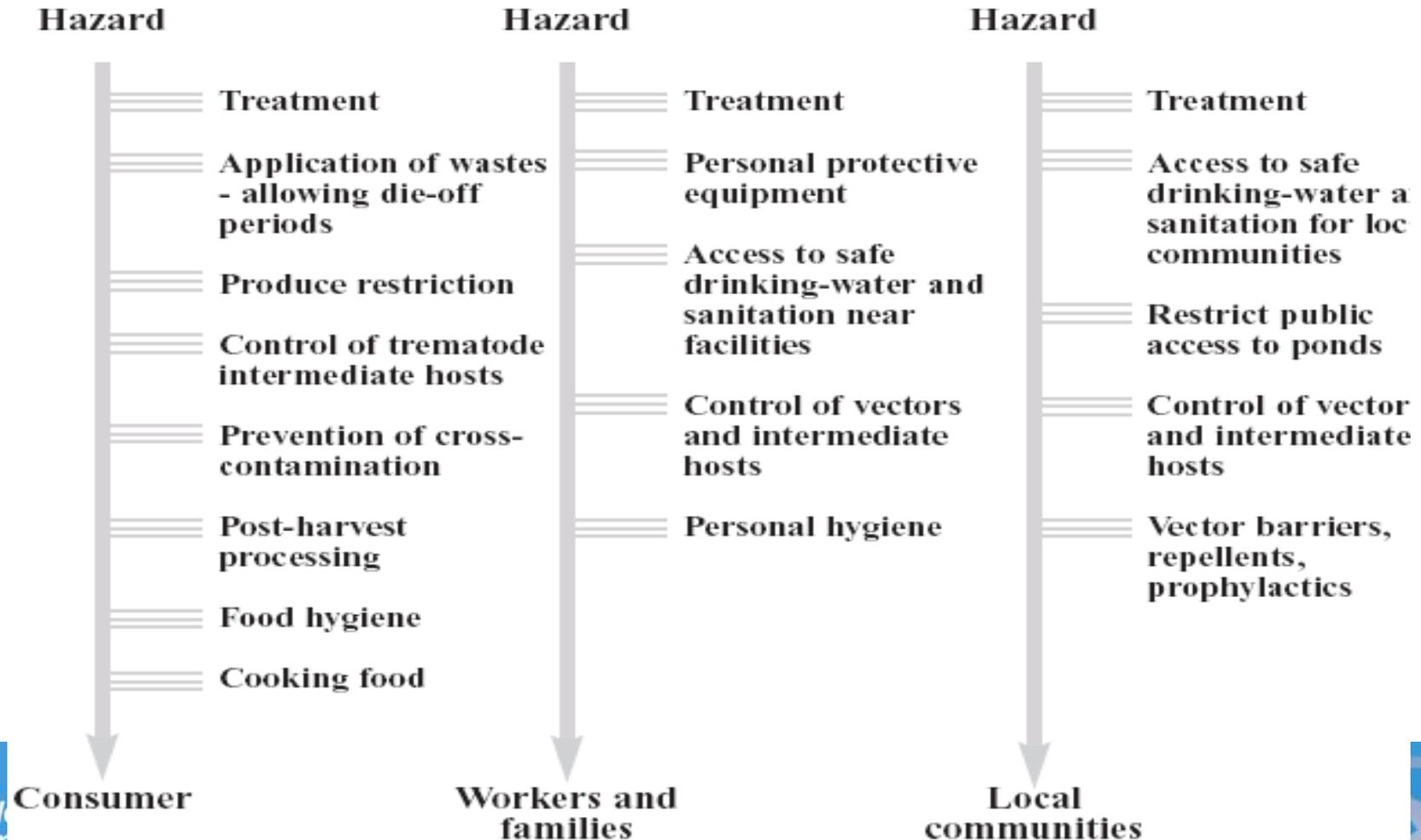
Realistic

Achievable

Health Based Targets for wastewater use in agriculture

Exposure scenario	Health Based Target DALY per person per year	Log ₁₀ Pathogen Reduction required	Number of Helminths Eggs/l
Unrestricted	$\leq 10^{-6}$	6-7	≤ 1
Restricted	$\leq 10^{-6}$	3-4	≤ 1
Drip Irrigation	$\leq 10^{-6}$	2-4	≤ 1

Risk Management through a Multiple Barriers Approach



Safe Wastewater Reuse is a Multi-Stakeholder Process

- Development of a sanitation safety plan (SSP) for agricultural reuse in Jordan was a complex task that requires involvement of multiple stakeholders:
 - Ministries of Health; Water and Irrigation; Agriculture; Environment
 - Water Users and Farmers' Associations.
- Other stakeholders were involved
 - Jordan Standards and Metrology Organization
 - Jordan Food and Drug Administration
 - Municipalities
 - Trade Chambers
 - Media
 - Academia



Pilot study (safe use of treated wastewater in agriculture) 2014-15

- The objective of the 1st experiment was to investigate whether irrigation with water contaminated with pathogenic microorganisms is the main source for contamination of raw vegetables. Or else, other agricultural practices are noteworthy sources of contamination, especially if irrigation is with clean fresh water
- The objective of the second experiment was to validate health protection measures established by WHO (2006) guidelines for the Safe Use of Wastewater, Excreta and Greywater.

The first experiment was conducted in two open field farms

- The first farm used reclaimed water from Khirbit As-samra wastewater treatment plant (irrigated with water discharged directly from Zarqa River, using above ground drip irrigation)
- The second open field was selected in Al-Mafraq governorate located in the north eastern parts of Jordan (irrigated with groundwater by means of above ground drip irrigation)



Conclusions from the 1st Experiment

- Results have shown that because **surface drip irrigation** applies water at surface of soil, it is less likely for high growing crops to be contaminated.
- Establishing periods of **no irrigation** have indeed contributed to the reduction of e-coli concentration on surface of crops to below permissible levels
- The results demonstrate clearly that **irrigation water is not the only source of contamination**. In the case of Mafrag farm, it is expected that the application of manure is the source of contamination



The 2nd Experiment

- A third farm was selected at Abu-Nussier WWTP (north of the capital Amman). A pilot farm was established where drip irrigation system was executed and irrigation system was covered with plastic sheets
- Three types of water quality was used for irrigation with qualities: (i) secondary treated effluent (SE), (ii) disinfected secondary effluent (DSE) and (iii) fresh water.
- Surface drip irrigation was used for cultivation of high growing tomato. Subsurface drip irrigation was used for cultivation of lettuce. Subsurface drip lines were placed in the center of each plant's row and buried at 10 cm depth.



Conclusions from the 2nd Experiment

- Results have shown that high growing cultivation, use of drip irrigation, use of plastic sheets and allowing for pathogen die off period of at least one day results in microbiologically safe crop
- For low growing crops use of surface drip irrigation combined with the use of plastic sheets and allowance of withheld period of 3 to 4 days was adequate to obtain produce complying with enforced standards.

Main Conclusions

- Management of health risks associated with the reuse of treated wastewater **is a multi-stakeholder issue.** There should be **clear roles** identified as per the sanitation safety plan
- Risks associated with using **treated wastewater in agriculture cannot be separated from the consequent farming practices** are influenced by many factors:
 - Weather conditions and season variation;
 - Fertilizers and pesticides application practices and timing;
 - Irrigation water quality (reclaimed water in the present case);
 - Receiving and storage practices;
 - Sanitation and hygiene;
 - Handling of produce; and
 - Applied irrigation system