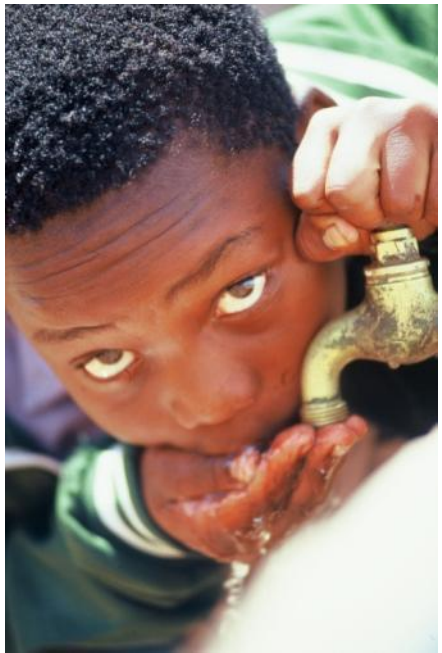
Water management and water-related disease (diarrhoea)

Thor Axel Stenström

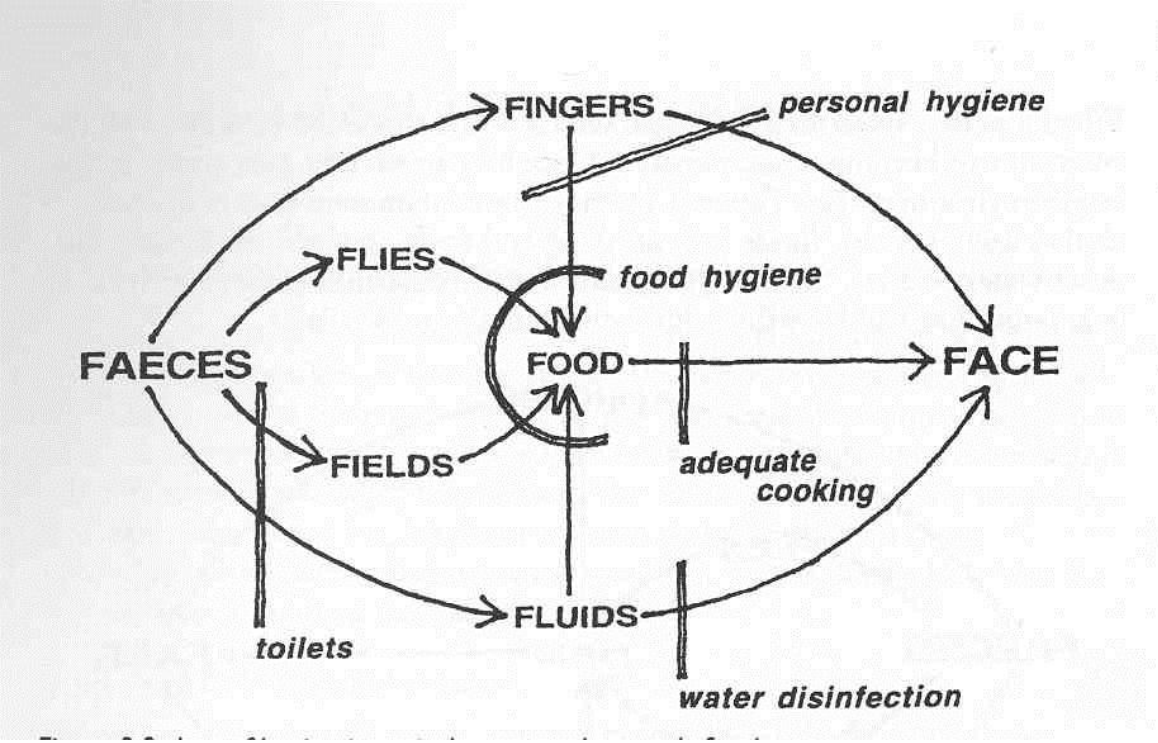
Aquaguard

Drinking water

- bulk water production
- distribution
- storage
- consumption

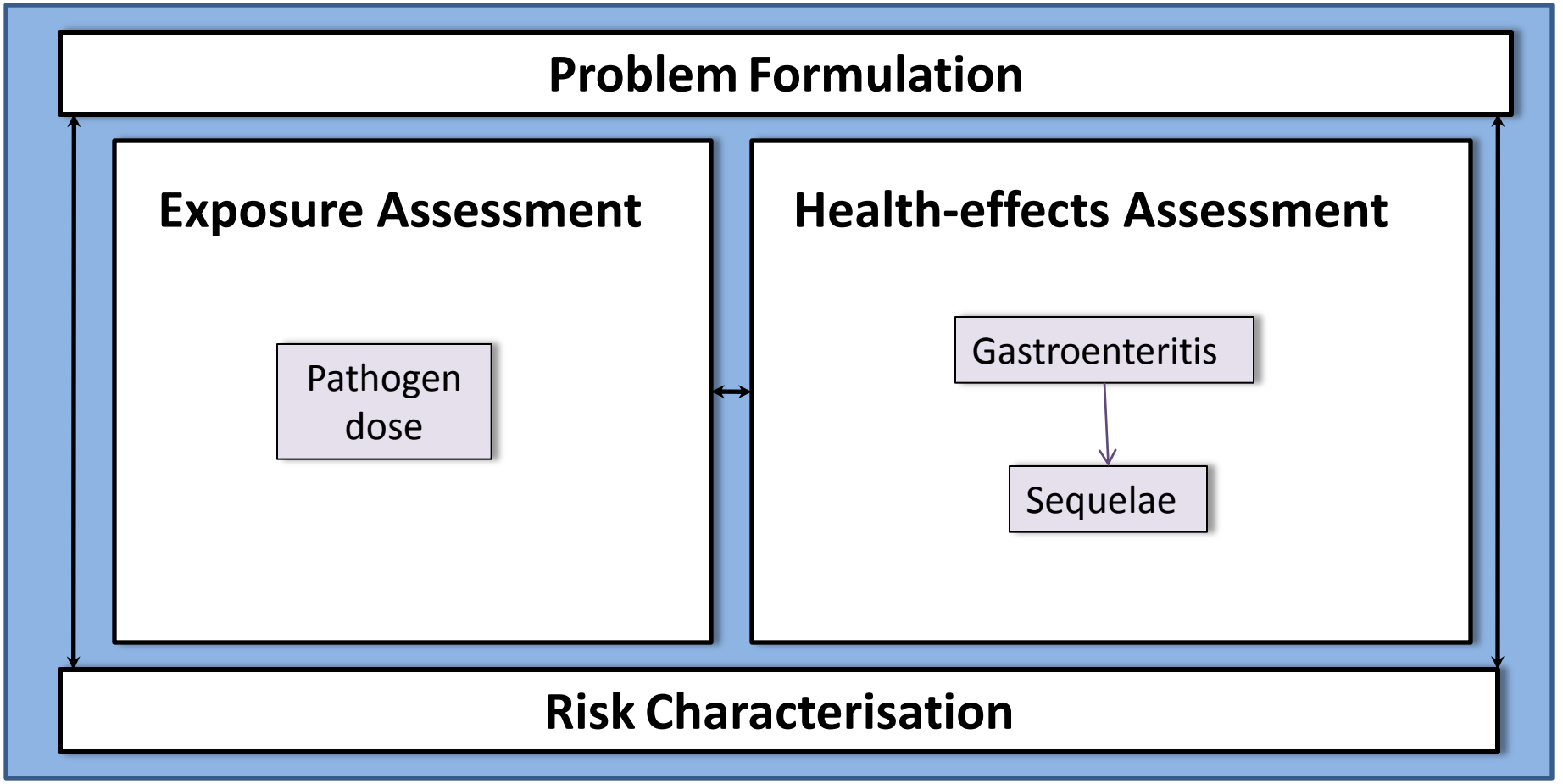


Barriers required to prevent the spread of pathogens

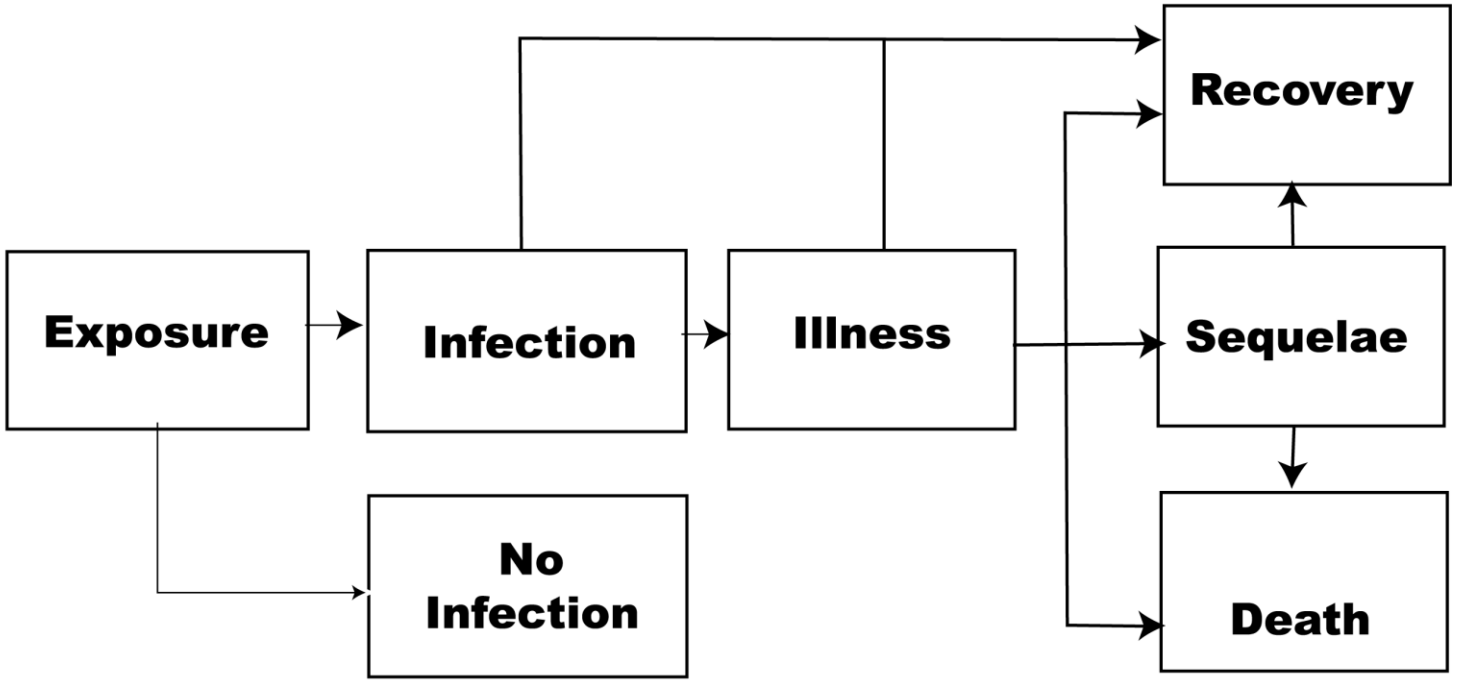


(Esrey et al. 1998)

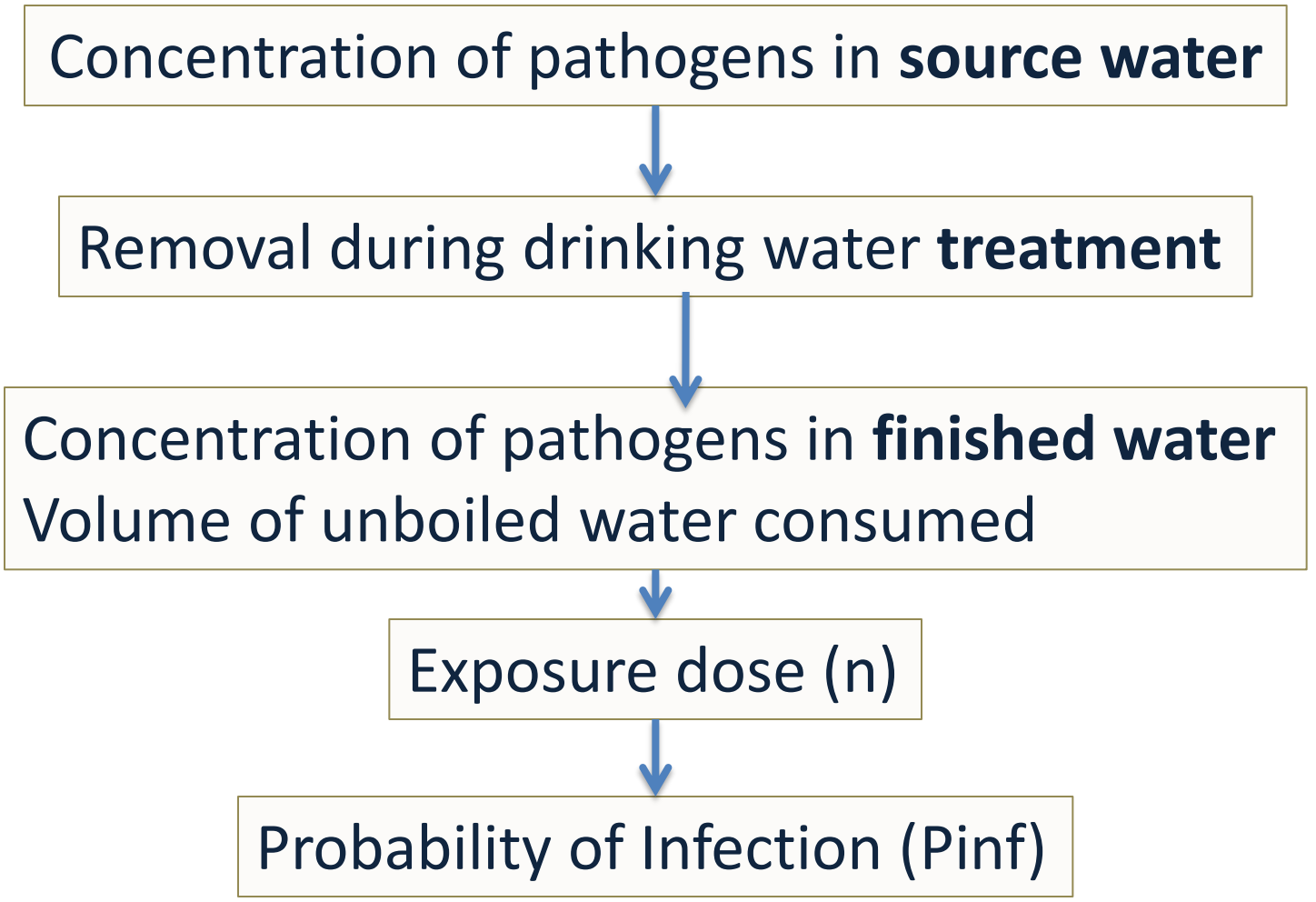
QMRA Framework



Health Outcomes and DALYs



Background: QMRA drinking water



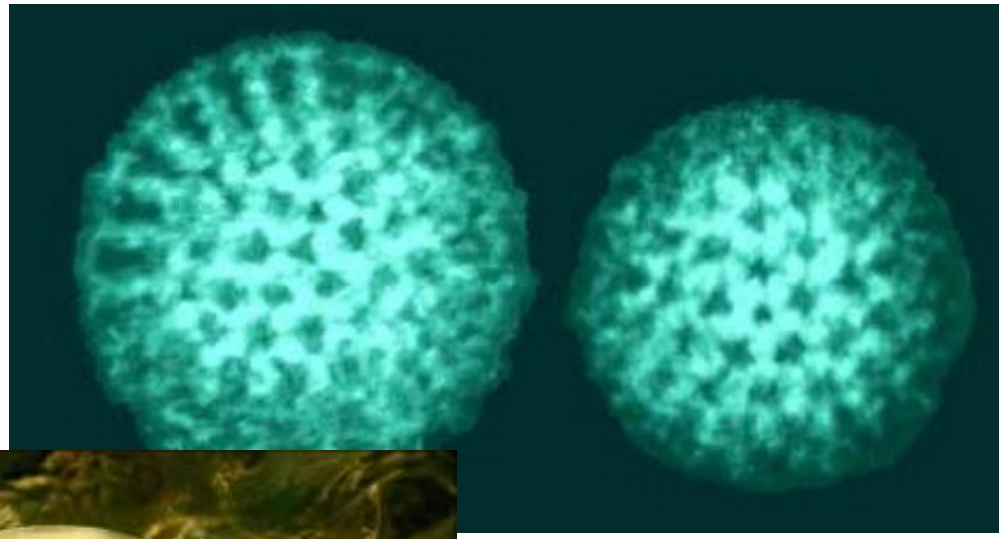
Leading DALYs in 1990 & 2020

Disease/Injury	1990		2020	
	Rank	%DALYs	Rank	%DALYs
Lower respiratory	1	8.2	6	3.1
Diarrhoeal	2	7.2	9	2.7
Perinatal period	3	6.7	11	2.5
Depression	4	3.7	**2**	**5.7**
Heart disease	5	3.4	**1**	**5.9**
Tuberculosis	7	2.8	7	3.1
Road accidents	9	2.5	**3**	**5.1**
HIV	28	0.8	10	2.6
Lung cancers	33	0.6	15	1.8

Murray *et al.* (1996) Science 274:740-

Which pathogens do we consider?

- Differences between pathogen groups: Bacteria, viruses and protozoa



Waterborne pathogens

- **Bacteria**
  - The leading cause of gastrointestinal infections according to surveillance systems
  - *Salmonella*, *Shigella*, *Campylobacter, E. coli (toxinprod.)*
  - EHEC
  - *Legionella*
  - Opportunistic e.g. *Aeromonas hydrophila*

- **Virus**
  - Probably the cause of many outbreaks, difficult to detect
  - Noroviruses (Calici-, Norwalk like), rotavirus, hepatitis A

Waterborne pathogens

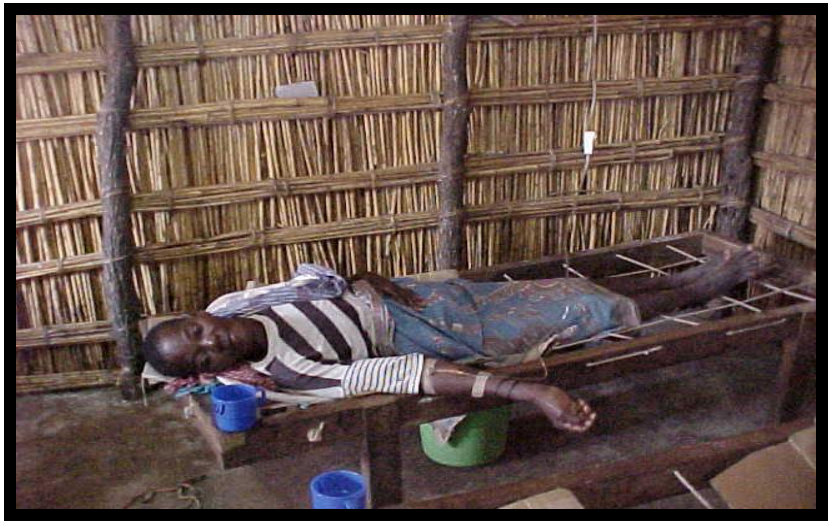
- **Protozoa**
  - Complicated life cycles with resistent stages (chlorine)
  - *Giardia*, *Cryptosporidium, Entamoeba*
  - Low infectious dose
  - Milwaukee (USA) 1993, 400 000 individuals
- **Helminths (worms)**
  - Varying transmission routes, e.g. soilborne
  - *Ascaris, Trichuris, Schistosoma (bilharzia), hookworm*
  - A large problem in many developing countries

Diarrhoeal diseases Outbreaks

- Cholera
  - many outbreaks: 53 outbreaks detected in 2002, affecting 27 countries
  - different problems: rural/urban; endemic/epidemic
- Typhoid fever
- Shigellosis

Cholera epidemic

- Acute watery diarrhoea, very deadly without rapid treatment
- Affects adults as much as children, especially informal caretakers
- High political profile : can be used as a political leverage

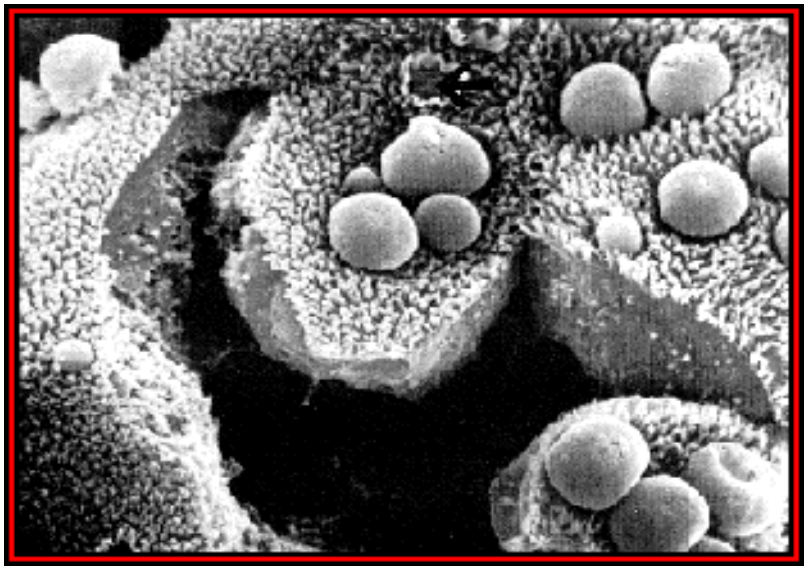


Viral gastroenteritis

- **What is viral gastroenteritis?**
  - Inflammation of the stomach and small or large intestines. Viral gastroenteritis is an infection caused by a variety of viruses that results in vomiting or diarrhea. It is often called the "stomach flu," but not caused by the influenza viruses.
- **What causes viral gastroenteritis?**
  - Many different viruses can cause gastroenteritis, including rotaviruses, adenoviruses, caliciviruses, astroviruses, Norwalk virus, and a group of Norwalk-like viruses. Viral gastroenteritis is not caused by bacteria, parasites or by medications.

Cryptosporidium

- *Cryptosporidium* is a small parasite, about 3-5 µm. It lives on the surface of the cells lining the small intestine and oocysts are passed in the feces. Transmission of the infection occurs via the oocysts. Many human infections have been traced to the contamination of drinking water with oocysts from agricultural "run-off" (i.e., drainage from pastures), so it is considered a zoonosis.



Giardia

- The trophozoites adhere closely to the lining of the small intestine, and in heavy infections much of the lining can be covered with trophozoites. The giardiasis symptoms range from none (in light infections) to severe, chronic diarrhea (in heavy infections), but not dysentery.

Ascaris

- *Ascaris lumbricoides*, fertilized egg. The egg is covered with a thick shell that appears lumpy approximate size = 65 µm in length.

- The adult worm

EXPOSURE - THE CENTRAL ISSUE!!

- No exposure – no risk!
- Environmental exposure:
  - By direct contact
  - By water
  - By food
  - By aerosols
  - Secondary transmission –hygienic practises

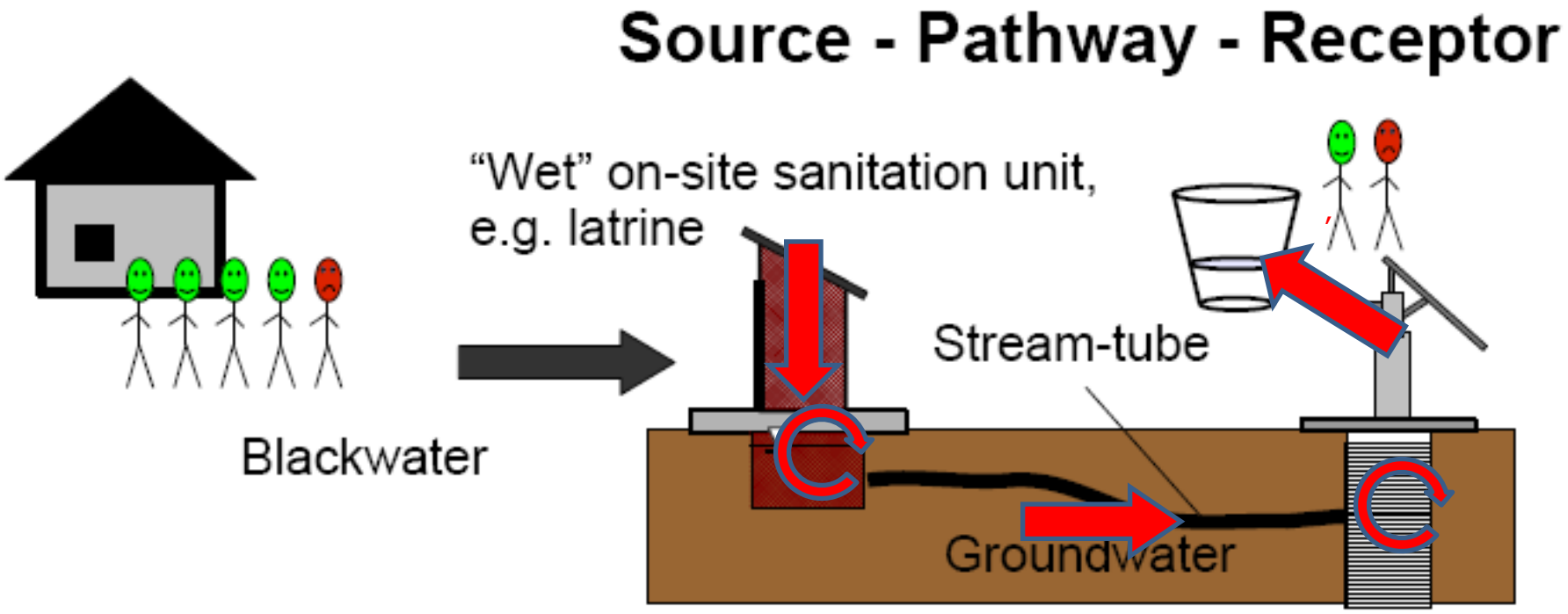
CONSIDER!

- Transmission pathways!
- Exposure! (Central)
- Quantity of organisms! (Vectors!)
- Type of organisms! (Here limited to indicators which limit conclusions).
- Reduction efficiency/Barriers/Die-off!

Surface Water Sources Close to Sewage Farms-How Close? Any Contamination?

Stop it !! You are Polluting our Water!!

Source – Pathway - Receptor

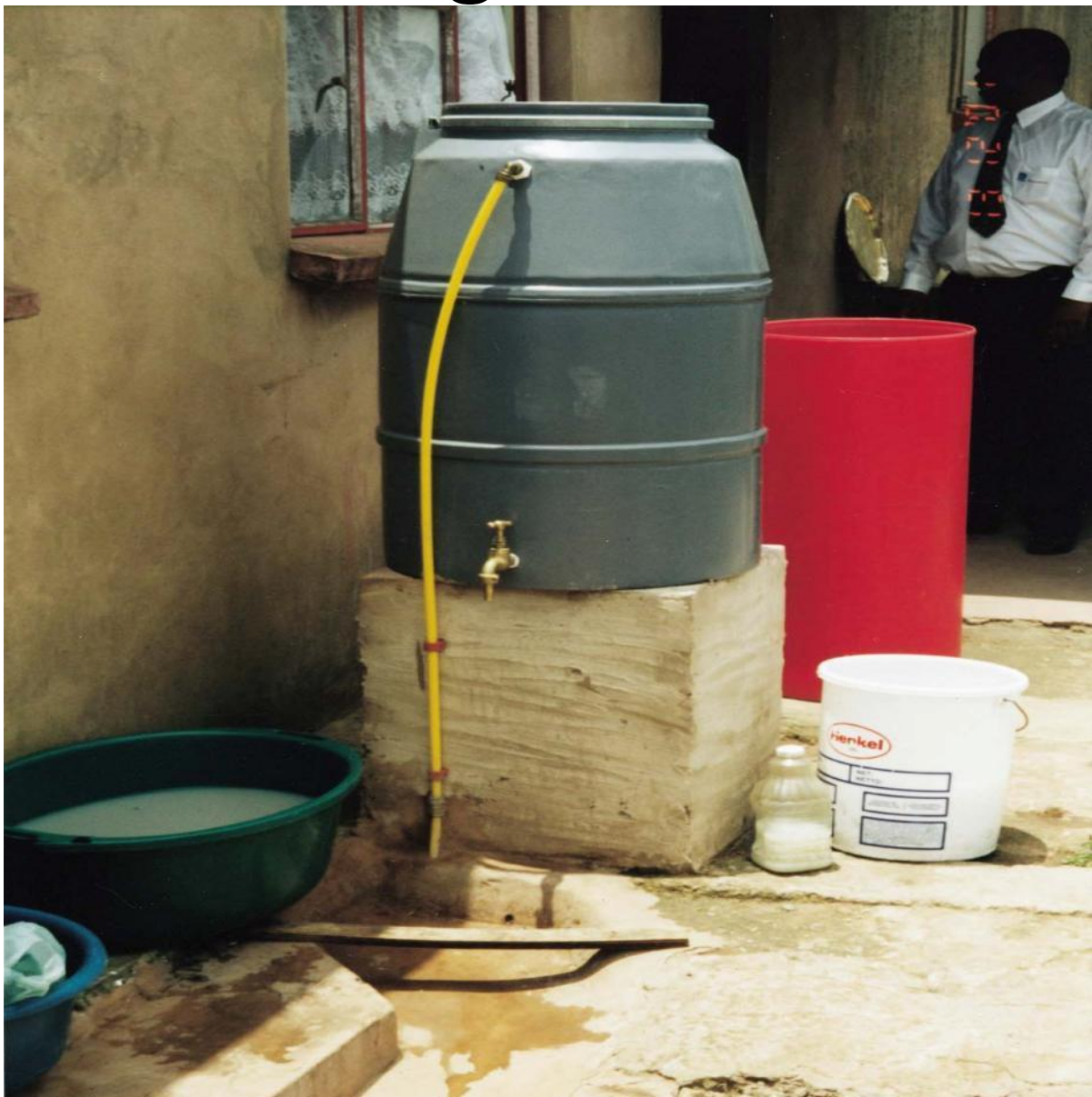


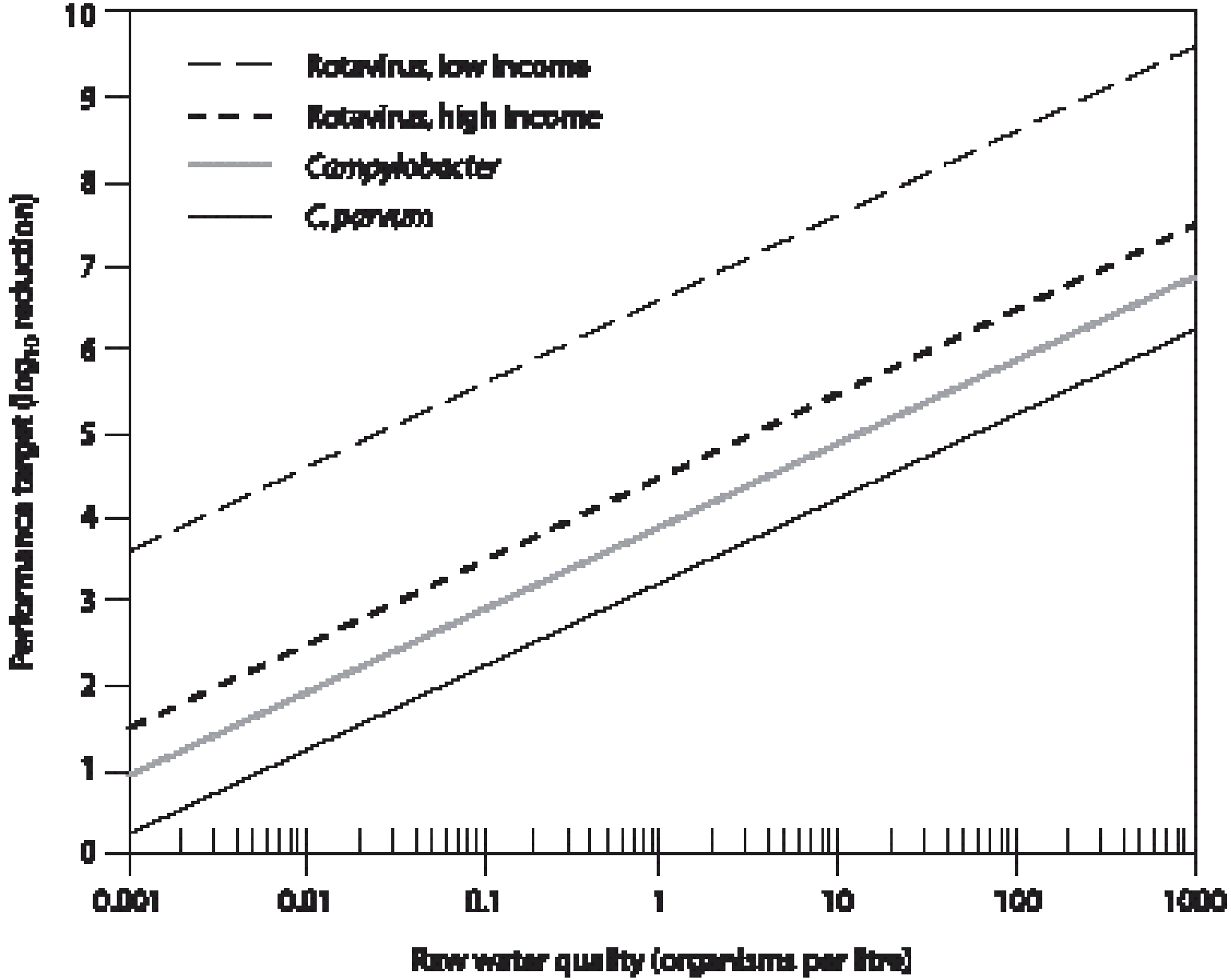
Standpipes

- water supply
- containers
- households
- storage
- fingers

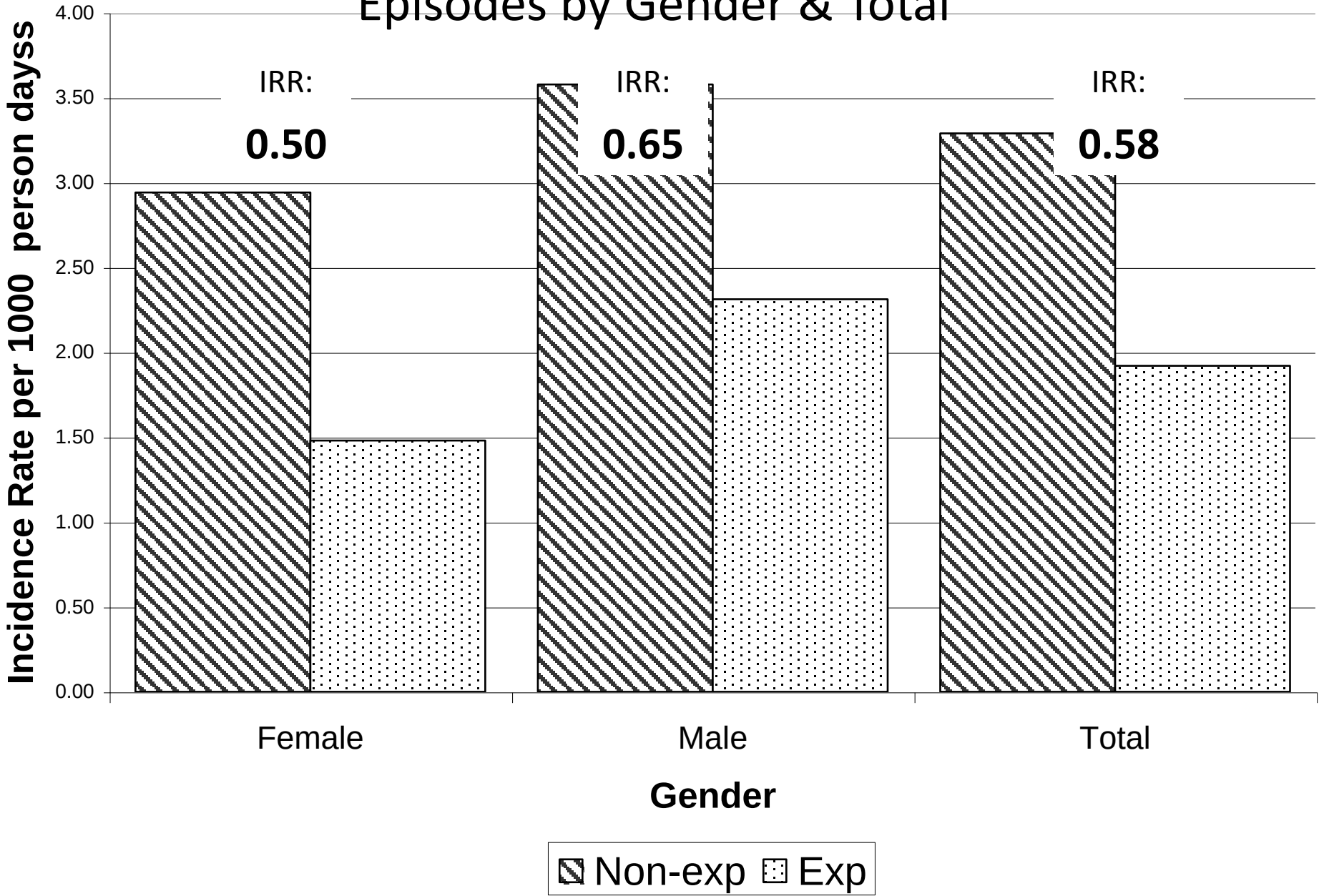
On-site storage

- potable supply
- potable storage
- potable transfer
- grey water production
- grey water disposal




Rotavirus, low income
Rotavirus, high income
Campylobacter
C.parvum
Performance target (log_{10} reduction)
0
1
2
3
4
5
6
7
8
9
10
0.001
0.01
0.1
1
10
100
1000
Raw water quality (organisms per litre)

Incidence Rate & Incidence Rate Ratio of Diarrhoea Episodes by Gender & Total



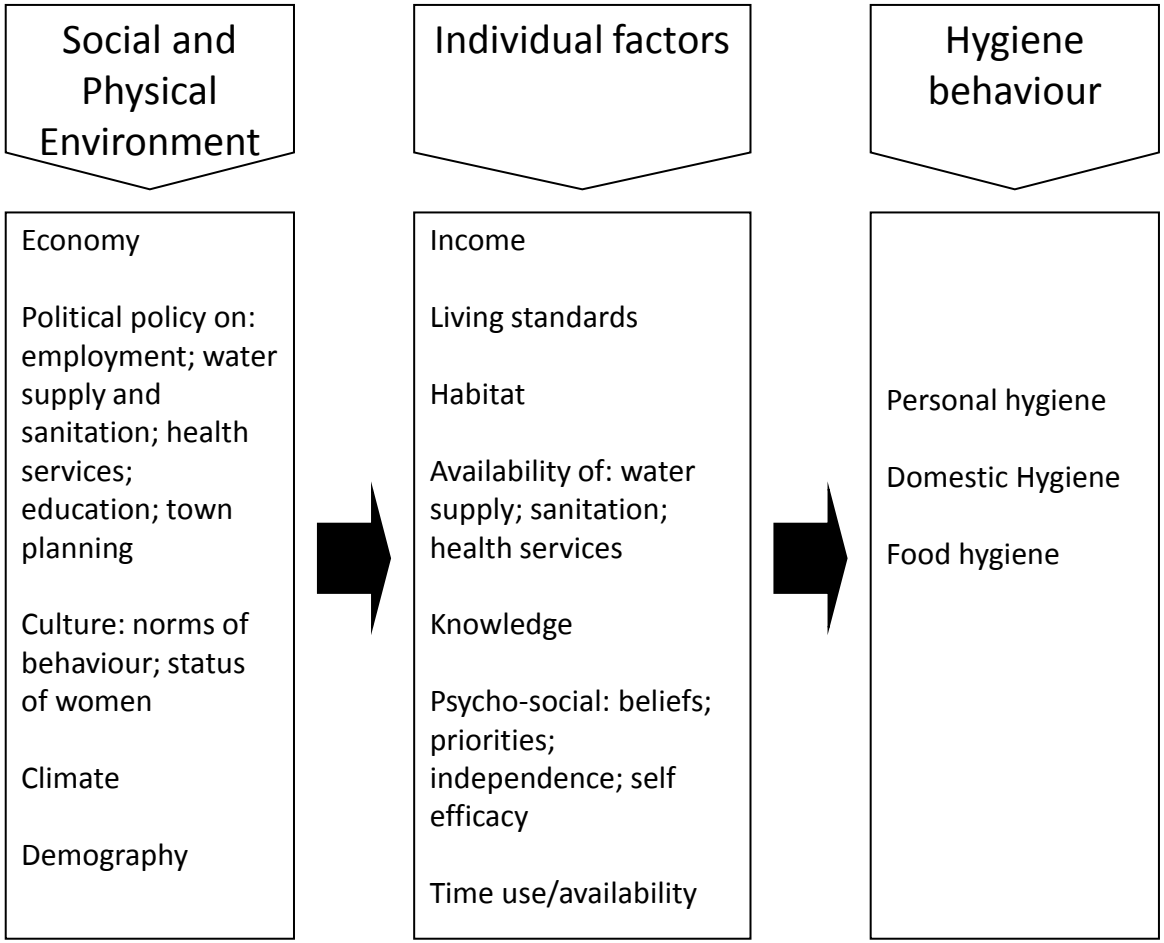
Household treatment/rainwater

- Source – quality variability
- Contamination on route
- Contamination at the household level
- Storage effects – growth of opportunistic pathogens
- Storage effects as treatment

Household Treatment Processes

- Termal Processes
- UV-disinfection/SODIS Processes
- Disinfection Processes
- Filtration Processes
- Coagulation Processes

Conceptual framework for categorizing factors which are potential determinants of hygiene behaviour (Curtis et al., 1995)



Demographic information

- **Sex distribution**
- **Age distribution**
- **Household information**

1. People in household (age grouped)
2. Ownership
3. Permanent/transient
4. Socioeconomic indicators/house and people related
5. Water availability
6. Sanitation availability
7. **Health vulnerability** (nutrition status, diseases, age groups).
8. *Missing (animals/type/number)*

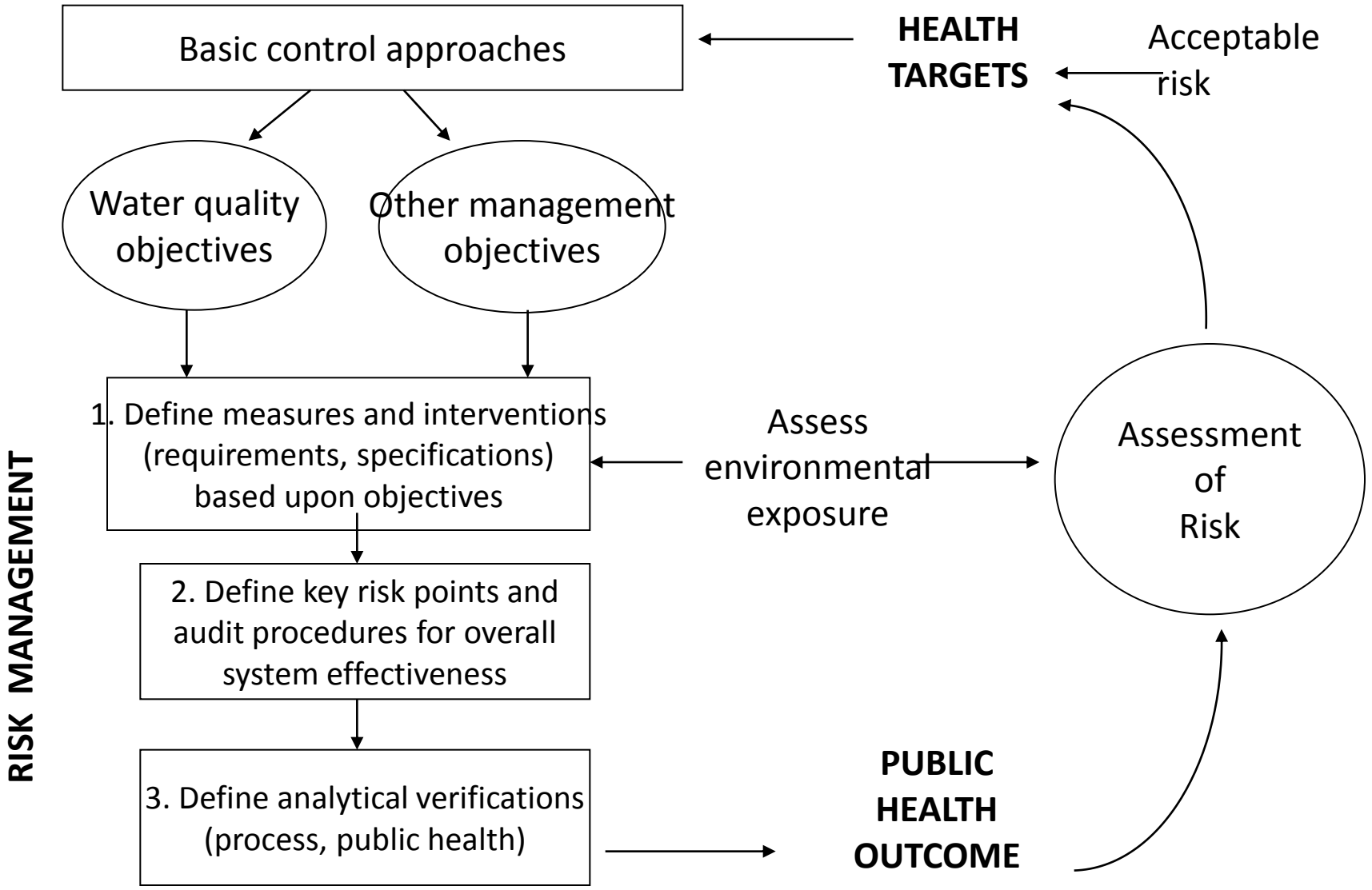
Sanitation

- Type of toilet/access to toilet
- Own/communal/”bush”
- Emptying/responsibility/practise
- Cost/cleanliness/actual use (by whom)/privacy
- Greywater disposal
- Stagnant water/waste handling

Outbreak versus general surveillance

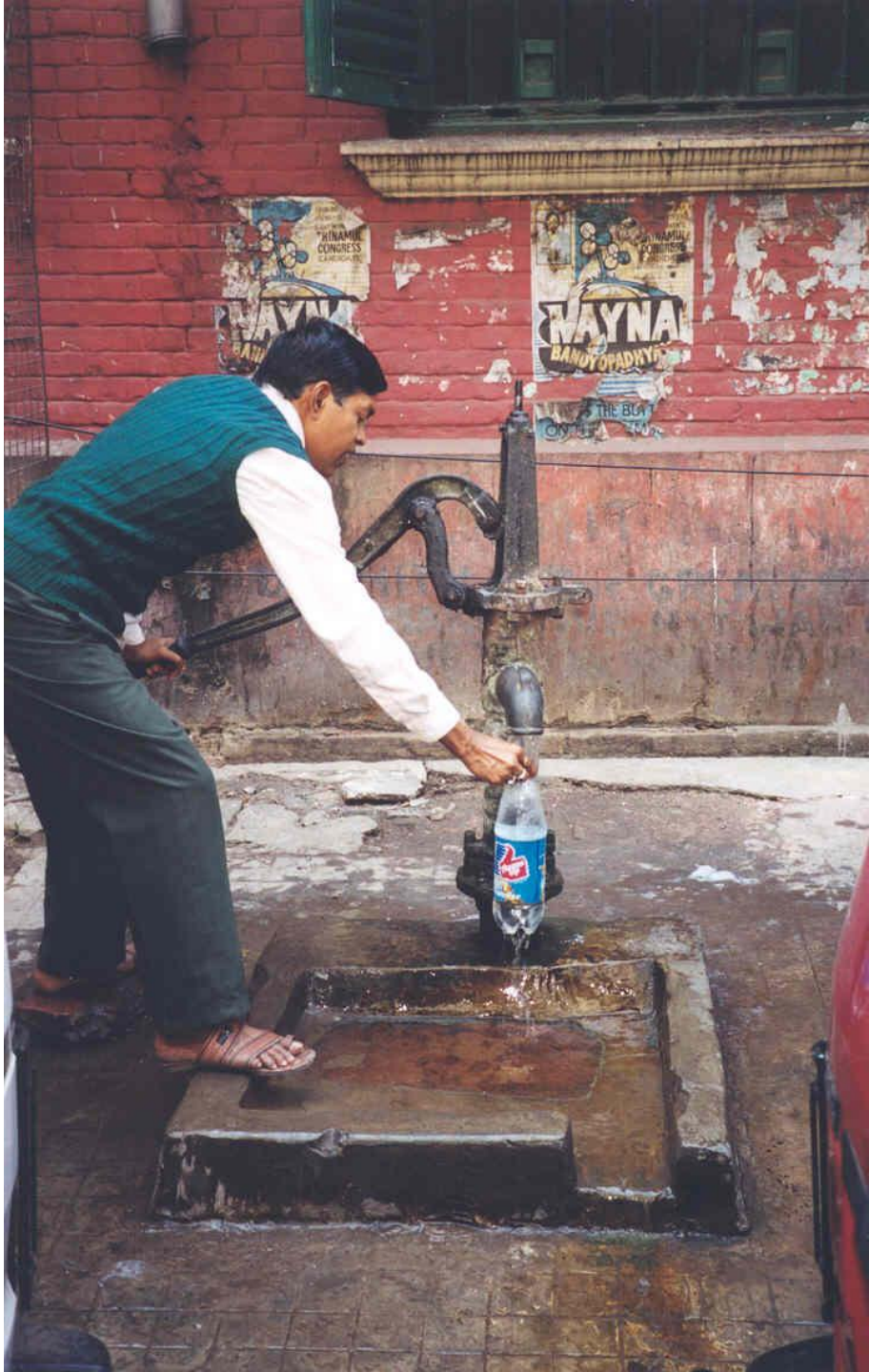
Thermotolerant coliform grade				
D				
C				
B				
A				
	0	1 – 30	31-70	>70
	Sanitary risk			

WHO Proposed Framework



- “We shall not finally defeat AIDS, tuberculosis, malaria “(added dengue)”, or any of the other infectious diseases that plague the developing world until we have also won the battle for safe drinking water, sanitation and basic health care.”
  Kofi Annan, former United Nations Secretary-General

Why outbreak investigation?


DYNAMIC CONGRESS
NAYNA
BANDYOPADHYAY

Oeustionnaires

OCCURRENCE OF ILLNESS
(Completed every 2 weeks from the period of excreta collection to harvesting)

- Household ID No:……
- House No/Name:……
- Community:……
- Interviewer:……
- Contact No:……
- Visit No:……
- Date:……

Input parameters

- **Name Sex M=1 F=2 Age**
- **Self-reporting YES/NO**
- **No. of days in household in last two weeks** (1-14)
- **No of Diarrhoea Episodes in last two weeks (Episodes is 3 or more loose stools per day)**
- **How long did the episode last**
- **What type of treatment was used for the diarrhoea**

Input parameters (additional)

- **No. of Vomiting Episode in last two weeks**
- **How long did the episode last**
- **Does the person have worms. Yes-1. No-2.**
- **What kind of worms? Round 1 Flat 2 Pin 3 Guinea 4**
- **Does the person have skin sores Yes 1 No 2**
- **What kind of sores Septic 1 Scabies 2**
- **Itches (Skin irriations) Yes 1 No 2**

Name	Sex Male 1 Female 2	Age	Self Report Yes 1 No 2	No. of days in household in last two weeks	No of Diarrhoea Episodes in last two weeks (Episodes is 3 or more loose stools per day)	How long did the episode last	What type of treatment was used for the diarrhoea	No. of Vomiting Episode in last two weeks	How long did the episode last	Does the person have worms Yes-1 No-2	What kind of worms Round 1 Flat 2 Pin 3 Guinea 4	Does the person have skin sores Yes 1 No 2	What kind of sores Septic 1 Scabies 2	Itches (Skin irriations) Yes 1 No 2	Foot rot Yes 1 No 2

History of Wastewater Use and Knowledge on Benefits

- WW 7 Do you work with children on the farm? 1. Yes 2. No. If Yes,
- WW 8 Which of the following activities do you involve your children (<15 years)?
- Irrigation of vegetables 1. Yes 2. No
- Application of manure 1. Yes 2. No
- Transplanting 1. Yes 2. No
- Weeding 1. Yes 2. No
- Harvesting 1. Yes 2. No
- Nursing of seeds 1. Yes 2. No

GENERAL HOUSEHOLD QUESTIONNAIRE

- Name of Community:…….
  HouseNo/Name:…….
- Date of Interview:……
- Name of Respondent:…….
  Name of Interviewer:……
  Contact No of Interviewer:……
- Respondent's position in household:……
- Interview Starts (Time):……Interview Ends (Time):……

SOCIO-DEMOGRAPHIC BACKGROUND

- **HC Household Characteristics**
- **HC1** How many people are in this house?……..
- **HC2** How many households are in this house?.....
- **HC3** How many people are in your household?.....

	4. Household Members (Name)	**5. Age (year)**	**6. In household for the whole season** 1. Yes 2. No	**7. Education** 1. Read &Write 2. Can't Read &Write	**8. Highest Education level achieved** 1. Primary 2. JSS 3. SSS 4. Tertiary 5. Other	**9. Still in School**1. Kindergarten 2. Primary 3. JSS 4. SSS 5. Tertiary 6. Other	**10. Major Employment** 1. Agric 2.Bussin 3. Service 4. Industal 5. None	**11. Minor Employment** 1. Agric 2. Bussine 3. Service 4. Indust 5. None	**12. Estimated income per Season (old cedis)**	
									Major	Minor
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										

E Expenditure

E 2 How much does your household spend on the following items per month?(Give ranges)

E.2.1 Education (Fees/books etc)……..

E.2.2 Clothing:……..

E.2.3 Food:……

E.2.4 Transport:…….

E.2.5 Electricity:…….

E.2.6 Rent:……..

E.2.7 Health (Drugs etc)……

E2.8 Other (specify)……

HT Housing Characteristics

- **HT1** What type of housing unit/s does this household occupy (Observe)?
- [1] Traditional [2] Modern [3] Modern/Traditional [4] Other (Specify)…….
- **HT2** How many rooms are in this house?.....
- **HT3** How many rooms are used for sleeping in this house?.....

H Household Items

HI 1. Do you have any of the following in working condition?

HI1.1. Radio	[1] Yes	[2] No
HI1.2 Television	[1] Yes	[2] No
H1.3 Telephone	[1] Yes	[2] No
H1.4 Bicycle	[1] Yes	[2] No
H1.5 Car	[1] Yes	[2] No
H1.6 Refrigerator	[1] Yes	[2] No
H1.7 Cell Phone	[1] Yes	[2] No
H1.8 Motorcycle	[1] Yes	[2] No

W1 Water Sources

- **W.1.1.** What water facilities/sources are used by the household in the rainy season and dry season? (Allow Multiple Response)

Water Source	**Season**	
	Wet Season	**Dry Season**
	1. Yes 2. No	1. Yes 2. No
1 Piped water	……	…….
2 Bore hole	……	…….
3 Well	……	…….
4 Rainwater	……	…….
5 Stream	……	…….
6 Dam/Pond	……	…….

W2 Seasonal Water Usage

- **W.2.1** Complete the table below for the household. Codes Use: **1** for Yes and **2** for No.
- Allow Multiple Response

Facility / Activity		Bore hole		Well		Rainwater		Stream		Dam/Pond		Pipe Water	
		Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
1	Drinking												
2	Hand Washing												
3	Bathing												
4	Washing Clothes												
5	Food Prep												

W2.2.1 How many times do you collect water with the following per day?

	Dry	Wet
1. Garawa (large) 1*		
2. Garawa (small) 2*		
2. Jelly Can		
3. Pot		
4. Other(specify		

(Measure the litres for the collection container available to the household) *Large =25litres *Small= 20litres

W2.3 How much water **is used** by your household for the following per day (Use the number of collection containers used per day for the following purposes)?

W2.3.1 Drinking (Specify in litres) Wet [ ] Dry [ ]
W2.3.2 Washing Hands (Specify in litres) Wet [ ] Dry [ ]
W2.3.3 Bathing (Specify in litres) Wet [ ] Dry [ ]
W2.3.4 Preparing food (Specify in litres) Wet [ ] Dry [ ]
W2.3.5 Washing Clothes (Specify in litres) Wet [ ] Dry [ ]
W2.3.6 Washing Utensils (Specify in litres) Wet [ ] Dry [ ]

W3 Water Collection

W4.1.1. What distance do you have to cover to the water source in the **wet season**?

[1] Less than 500meters [2] More than 500 meters

W4.1.2. What distance do you have to cover to the water source in the **dry season**?

[1] Less than 500meters [2] More than 500meters

W4.1.3 How much time do you spend to fetch water from the source in the **dry season**?

[1] ≤ 30mins [2] 31-40min [3] 41-50min [4] 51-60min [5] >1hour

W4.1.4 How much time do you spend to fetch water from the source in the **wet season** [1] ≤ 30mins [2] 31-40min [3] 41-50min [4] 51-60min [5] >1hour

W4.1.5. What is used to collect the water (Allow multiple Response)?

[1] Jelly Can [2] Garawa [3] Pot [4] Other (Specify)…….

W4.1.6. Do you cover/close this container when transporting the water?

[1] Yes [2] No

W4.1.7. Do you use the container for anything else?

[1] Yes [2] No

W4.1.8. If yes, what else do you use it for (allow multiple response)?

[1] Washing Clothes [2] Bathing [3] Carrying foodstuffs [4] Other…….

W5 Water Storage

W.5.1.1 What kind of container do you use to store your drinking water (allow multiple response)?

[1] Pot /Kula [2] Garawa [3]Other……

W5.1.3 How do you fetch the water from this container?

[1] Pour it out [2] Scoop it out

W5.1.3.1 What do you use to scoop the water out (allow multiple response)?

[1] Cup [2] Calabash [2] Other (specify)…….

W5.1.3.2 Is the scooper (eg. Calabash, cup etc) used only for this purpose?

[1] Yes [2] No

W5.1.3.3 What else do you use the scooper for?.....

W5.1.4 Do you do anything to your water before drinking ?

Wet Season : [1] Yes [2] No

Dry Season: [1] Yes [2] No

W5.1.5 If **yes**, What do you do to your water before drinking (allow multiple response)?

Wet Season [1] Boil [2] Filter [3] Add Alum [4] Other (Specify)

Dry Season [1] Boil [2] Filter [3] Add Alum [4] Other (Specify)

W5.1.6 If **no**, why?

Wet Season [1] Water is very clean [2] Water does not taste good after boiling [3] It is time consuming [4] Other (Specify)……

Dry Season[1] Water is very clean [2] Water does not taste good after boiling [3] It is time consuming [4] Other (Specify)……

H Health and Hygiene

H.1.1.4 How often do members of the household use soap when bathing?

[1] Always [2] Most of the time [3] some of the time [4] Never

H.1.1.5 How often do the children use soap when bathing?

[1] Always [2] Most of the time [3] Some of the time [4] Never

H.1.1.6 Which members of the household use sponge when bathing?

H1.1.6.1 Adults [1] Yes [2] No

H1.1.6.2 Children [1] Yes [2] No

H1.1.6.3 Toddlers [1] Yes [2] No

H.1.1.7 How is the usage of the sponge (DO NOT READ OUT)?

[1] All members of the household use the same sponge

[2] Only children use the same sponge

[3] Each child has his/her own sponge

[4] Only Adults use the same sponge

[5] Each adult has his/her own sponge

H2 Hand Washing

- **H2.1** When do you think hand washing is necessary (allow multiple response and DO NOT READ OUT)?
- [1] After eating [2] Before eating [3] After toilet [4] After Cooking [5] Before Cooking [6] Other (Specify)……
-
- **H2.2** When would you use soap in addition to water (allow multiple response and DO NOT READ OUT)?
- [1] After eating [2] Before eating [3] After toilet [4] After Cooking [5] Before Cooking [6] Other (Specify)……

H3 Hygiene Behaviour

H3.1 Do you eat outside? [1] Yes [2] No

H3.2 If yes, which of the following places do you eat (Allow Multiple Response)?

[1] Chop bars [2] Vendors [3] On farm [4] Other ……

H3.3 Would you say there is always enough water for handwashing before eating on the farm?

[1] Yes [2] No

H3.4 Do you send soap to the farm? [1] Yes [2] No

H3.5 If yes, what do you use the soap for?

[1] Washing clothes [2] Handwashing [3] Bathing [4] Other ……

H3.6 Are there any babies in this household? [1] Yes [2] No **go to Food Hygiene**

Nappies

H**3.7** Do you use nappies for the babies? [1] Yes [2] No

H3.7.1 If yes, what kind of nappies are used?
[1] Old Cloth [2] 'Shop' Nappies [3] Both

H3.7.2 When you change the nappy, how do you clean the baby (Do not read out)?

[1] Washing only water [2] Washing with water and soap [3] Dry cleaning only

[4] Other :……

H3.7.3 Where is the faeces from the nappies thrown away (allow multiple response DO NOT READ OUT)?

[1] Pit latrine [2] Dustbin [3] Backyard [4] Other ……

H3.7.4 After the person has changed the babies' nappies would you say they wash their hands

[1] Always [2] Most of the time [3] some of the time [4] Never

H3.7.5 When the person washes their hands after changing the babies' nappies would you say they use soap

[1] Always [2] Most of the time [3] some of the time [4] Never

FH- Food Hygiene

- **FH 1** Where does the household store it's left over food/soup?
- [1] Refrigerator [2] Kitchen [3] Sleeping room [4] Other (Specify)…….
- **FH.2** Is the left over food/soup covered when left in the room/kitchen?
- [1] Yes [2] No
- **FH.3** How do you handle your left over food before eating?
- [1] Heat All [2] Heat only Soup [3] Heat only TZ/Rice etc
- [4] Boil only Soup [5] Boil TZ [6] Other (specify)…….
- **FH4** When does the household clean its utensils after cooking and eating?
- [1] Immediately after eating [2] Next day's Morning
- [3] Any day before cooking [4] Other……..

S - Sanitation

(**Toilet Facilities and Use**)

S1.1 Does this household have a household toilet facility?

[1] Yes [2] No

S.1.1.1 Are there any toilet facilities in your community?
[1] Yes [2] No

S.1.1.2 If yes, which type of toilet facility is in your community?
[1] KVIP [2] Pit VIP [3] Pit [4] Other…….

S.1.1.3 Does everyone in the family use the toilet facility indicated above?
[1] Yes [2] No

If no,

S.1.1.4 Who does not use it?

S.1.1.5 Why do they not use it?

S**.1.1.6** Where do they mainly go to toilet while at home?
[1] Bush [2] Other (Specify)…….

.3 Where do they go to the toilet? [1] Bush [2

S.1.2 Does everyone in the household use the household toilet?

[1] Yes [2] No

If no,
S.1.5.1 Who does not use it?
S.1.5.2 Why do they not use it?
S.1.5.3 Where do they go to the toilet?
[1] Bush [2] Community KVIP
[3] Other (Specify)

S.1.3 Do the children of your household [under 15] use the household toilet most of the time?

[1] Yes [2] No [3] Not Applicable

If no,
S.1.6.1 Why do they not use it?

S.1.6.2 Where do they go to the toilet whilst at home?
[1] Bush [2] Community KVIP [3] Other (Specify)

S1.4 Do you always have water to wash your hands after toilet? [1] Yes [2] No

S1.5 If yes, do you use soap in addition to water when washing? [1] Yes [2] No

S1.6 If yes, how often do you use soap when washing?
[1] Always [2] Most of the time [3] some of the time [4] Never

S1.7 Do the children [<15years] always have water for handwashing after toilet (Check with children if any)?
[1] Yes [2] No [3] Not applicable

S1.8 If yes, do they use soap in addition to water for hand washing (Check with children if any)?
[1] Yes [2] No [3] Not applicable

S1.9 If yes, how often do the children use soap for hand washing (Don't Read out. Allow multiple responses)?
[1] Always [2] Most of the time [3] some of the time [4] Never

Disease Occurrence

DO1. What would you say are the common diseases affecting members of your household (Don't Read out. Allow Multiple Responses)?

DO1.1 Adults

[1] Headache [2] Stomach Aches [3] Diarrhoea [4] Skin rashes

[5] Guinea worm [6] Other worms [7] Other (Specify)……

DO1.2 Children

[1] Headache [2] Stomach Aches [3] Diarrhoea [4] Skin rashes

[5] Guinea worm [6] Other worms [7] Other (Specify)……

DO1.3 Toddlers

[1] Headache [2] Stomach Aches [3] Diarrhoea [4] Skin rashes

[5] Guinea worm [6] Other worms [7] Other (Specify)……

HOUSEHOLD ID NUMBER:…….

OBSERVATIONAL CHECKLIST

	Observation	Yes-1 No- 2 NA-3	Comments
1	***Household has a Household Toilet Facility:***		
2	**HT1**) The toilet appears to be used by the family		
3	**HT2**)Other outside toilets appear to be in use		
4	**HT3**) The toilet door is broken or missing		
5	**HT4**) The toilet door is closed		
6	**HT5**) The toilet walls are clean		
7	**HT6**) The toilet floor is clean		
8	**HT7**) The toilet smells badly		
9	**HT8**) There are flies around the toilet		
10	**HT9**) The ground around the toilet is muddy		
11	**HT10**) There are hand washing facilities near the toilet		
12	**HT11**) There is soap provided for hand washing after toilet use		

	Household has other Outside toilets(s):		
13	**OT1**) The toilet smells bad		
14	**OT2**) There are flies around the toilet		
15	**OT3**) The toilet area appears clean		
16	**OT4**) There are hand washing facilities near the toilet		
17	**OT5**) There is soap provided for hand washing after toilet use		
	Household has no indoor piped water:		
18	**ST1**: There is a store of drinking water		
19	**ST2**: The store of water is covered		
20	**ST3**: The ground around the water storage facility is muddy		
21	**ST4**: Water storage facility is easily accessible to children		
22	**ST5**: The water storage facility looks dirty from outside		

	Yard Area		
23	**YA1**: There is grey/stagnant water in the yard		
24	**YA2**: There is domestic waste and litter in the yard		
25	**YA3**: There is animal/human faeces in the yard		
26	**YA4**: There is refuse in the yard		
	Food Hygiene (Kitchen)		
27	**FH1** Household has a refrigerator for food storage		
28	**FH2** Some cooking utensils are left unwashed		
29	**FH3** There are uncovered left over meals at the cooking area		
30	**FH4** There are houseflies in the cooking area		
31	**FH5**: Cooking area/Kitchen is clean with no food debris		