Water Research Commission
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FOOD SAFETY AND IRRIGATION WATER

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Presentation

- Projects
- Reasons for research
- Guidelines, Indicators + Index organisms
- Sampling sites and produce
- What have we found?
  - Microbial quality of selected SA rivers
  - Microbial quality of irrigated produce
  - Carry-over from water to produce
  - Linking water microbes to produce
- Recommendations

WRC Projects

WRC K5/1773/4

Link between irrigation water quality and food safety.

Project Leader: Trevor Britz

Research Team: Gunnar Sigge, Natasha Potgieter, Maureen Taylor, Elna Buys, Stefan Schmidt

WRC K5/1875/4

Link between water quality and safety of fruit and vegetables from farming to the processing stages and marketing.

Project Leader: Lise Korsten

Research Team: Bala Pillay, Maureen Taylor, Elna Buys

Research Consortium

Department Food Science, Stellenbosch University

Department of Microbiology and Plant Pathology, Pretoria University

Pathogenicity and Environmental Health Lab, Venda University

Department Food Science, Pretoria University

Department Medical Virology, Pretoria University & NHLS

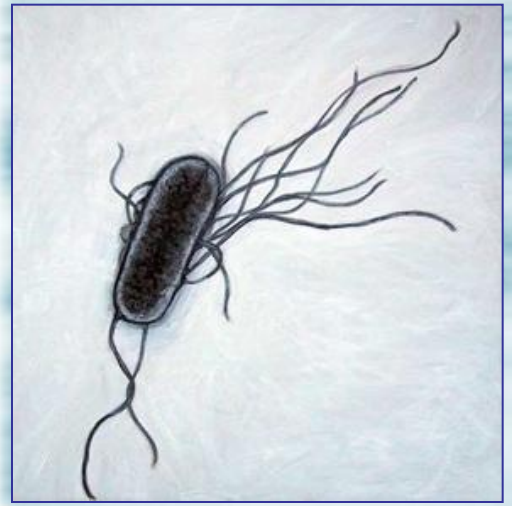
Department Microbiology, KwaZulu Natal University

Reasons for research

Safety of the final agricultural product

Little known on national level of contribution of irrigation water to carry-over of pathogens to fresh produce

E.coli O104:H4 Outbreak



>4000 confirmed cases
+823 cases of HUS
44 deaths

SOURCE = ??? (Specific *E.coli* isolated 10 years ago)

PRODUCE = cucumbers, lettuce, tomatoes, sprouts

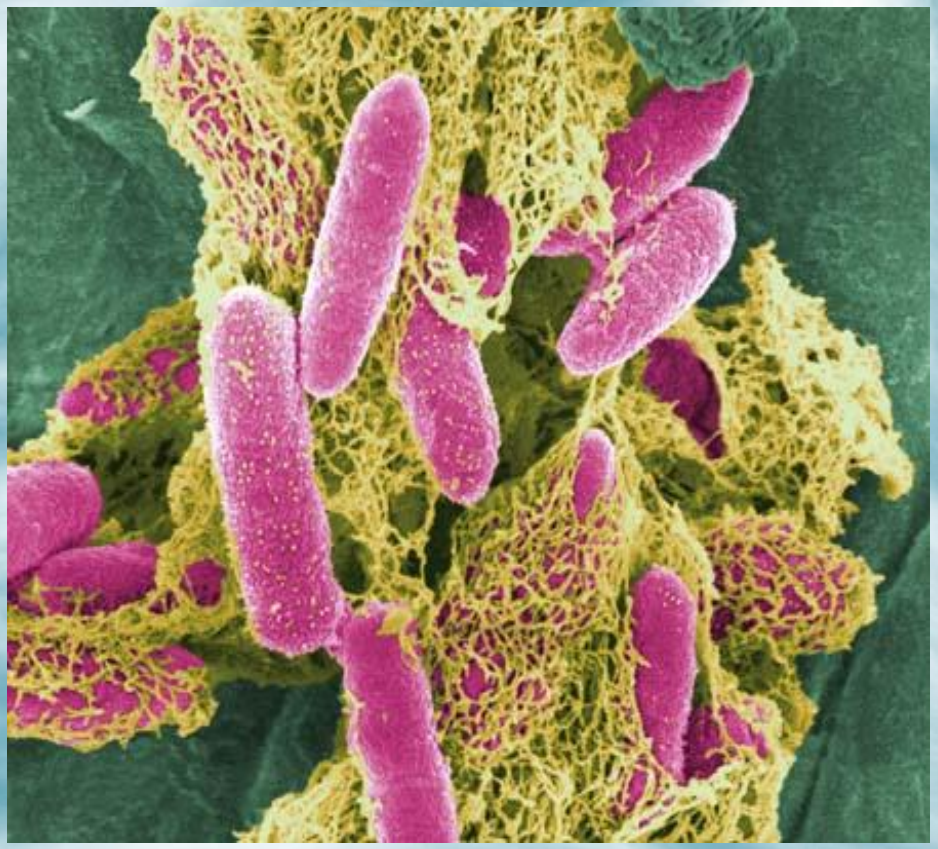
ECONOMICAL IMPACT
compensation to farmers = EUR 227m

Situation

virulent pathogen + high risk food
disaster

Escherichia coli

Free form in water



Presence in/on solids

Guidelines

WHO + EU guidelines for irrigation of crops to be eaten uncooked
= <1000 faecal coliforms per 100 ml

DWA guidelines for irrigation water
= <1000 faecal coliforms per 100 ml
= >4000 high risk when irrigating crops that are eaten raw

DoH Contact should be avoided at >2000 *E.coli* per 100 ml water

Indicator organisms

presence indicates faecal pollution

Coliforms, faecal coliforms, *E.coli*

Index organisms

evidence that related pathogen may be present

Salmonella, Staphylococcus, Listeria*, Enterococci, *Cryptosporidium, Giardia

Virology

Hepatitis A, Norovirus GII + GI,

Rotavirus, Sapovirus, Astrovirus, Mengovirus

Sampling Sites

Western Cape Province

Upper Berg, Eerste, Plankenburg, Mosselbank Rivers

Limpopo Province

Phadzima Nzelele, Nwanedi, Masisi Rivers

Mpumalanga Province

Crocodile, Loskopdam, Olifants, Wilge, Moses Rivers

Gauteng Province

Iscor, Klip River

North West Province

Hartbeespoort & Skeerpoort Rivers

KwaZulu Natal Province

Baynespruit, Msunduzi Rivers & Sobantu Township

Sources and Produce

SOURCES

rivers, irrigation water, community farms & gardens, subsistence farming, irrigation canals, workers gardens, gardens & bucket irrigation, small & large commercial, post-harvest produce, retail, markets, stalls, street markets

FRESH PRODUCE

grapes, pears, tomatoes, beans, peas, cabbage, broccoli, lettuce, spinach, rocket, cauliflower, strawberries, parsley, carrots

What have we found?

Microbial quality of selected SA rivers

Microbial quality of irrigated produce

Coliforms	Faecal coliforms	*E.coli*
0 – 1500 per 100 mL	0 – 500 per 100 mL	zero

Polluted river

Faecal coliforms	*E.coli*
3 500 000 per 100 mL	790 000 per 100 mL

What have we found?

River samples

Indicator organisms

coliforms, faecal coliforms, *E.coli*

(1000 to >4000000 cfu's per 100 ml) (97%)

Index organisms

Salmonella = present 84%

Staphylococcus = 0 - 15 000 cfu per ml (67%)

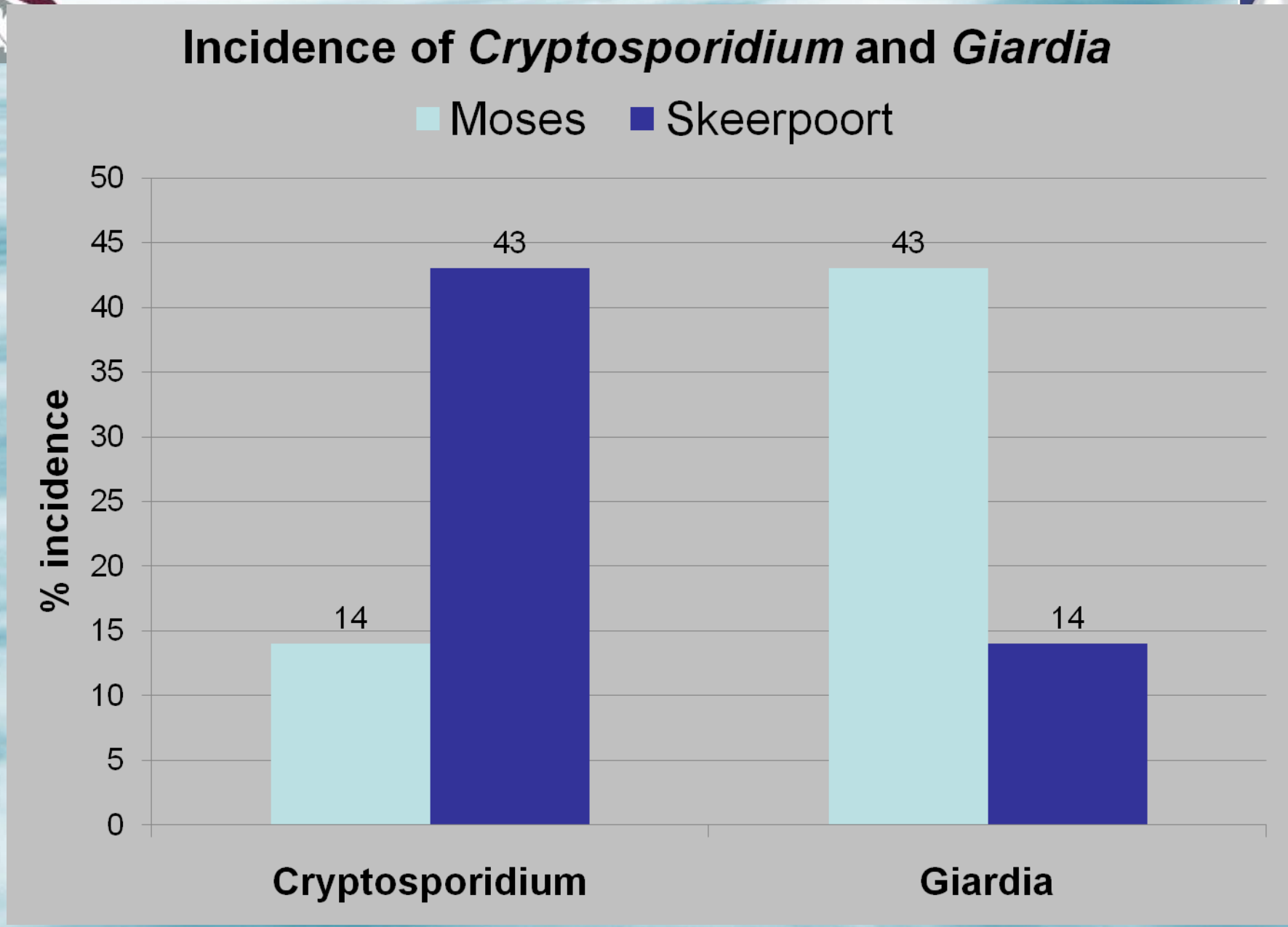
Enterococci = 0 – 1300 cfu per ml (71%)

Listeria = present 91%

Parasitic organisms

Cryptosporidium + Giardia = present 45%

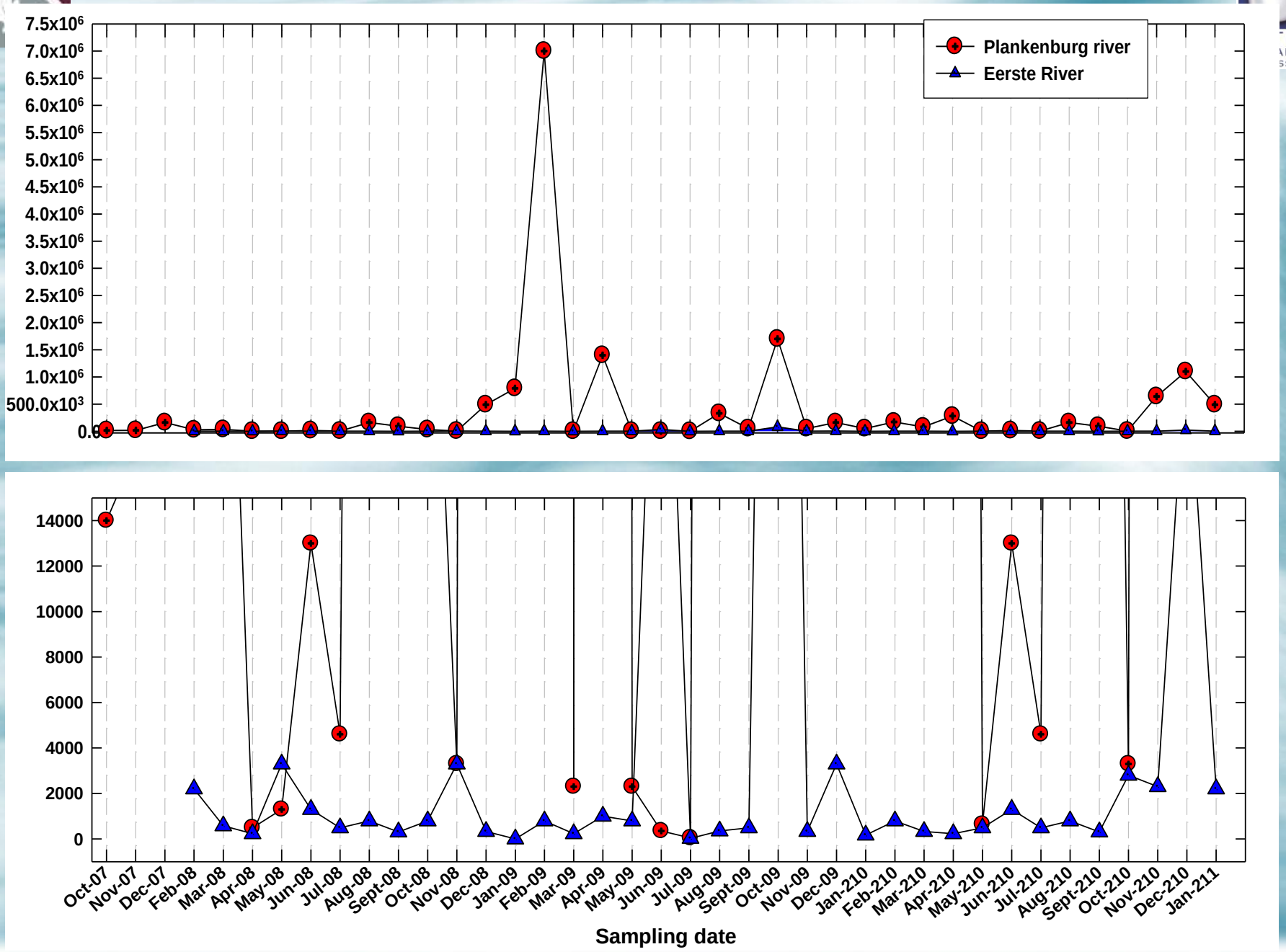
VirusesHAV + Noro + Rota + Sapo + Astro


Incidence of *Cryptosporidium* and *Giardia*
Moses
Skeerpoort
% incidence
50
45
40
35
30
25
20
15
10
5
0
43
43
14
14
Cryptosporidium
Giardia

Virological data from irrigation water and fresh produce

	Limpopo (n=20)	Mpumalanga (n=25)	Western Cape (n=64)
Norovirus GI	0%	0%	0%
Norovirus GII	10%	29%	19%
HAV	10%	18%	12%

E.coli counts per 100 mL



CONTAMINATION ON IRRIGATED PRODUCE AT-HARVEST

	ACC	Faecal	*E.coli*	*Salmonella*	*Listeria*
Lettuce	57000	400	ND	+	+
	970000000	5600000	2600000		
Beans	64000	12300	ND	+	+
	258000	133000	7900		
Peas	22000	ND	ND	+	+
	795000	1600000	46000		
Tomatoes	10400	500	ND	+	+
	112000	640000	ND		
Cabbage	34000	ND	ND	+	+
	2000000	53000	26000		
Broccoli	200	ND	ND	+	+
	22000	330	330		

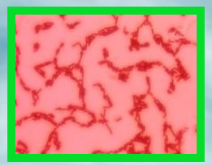
LINKING MICROBES IN IRRIGATION WATER TO PRODUCE

Organisms	River H_2O	Irrigation	Produce	Retail
Aerobic sporeformers	X	X	X	X
Aerococcus viridans	X	X	X	
Faecal coliforms	X	X	X	X
E.coli	X	X	X	X
Enterobacter aerogenes	X	X	X	
Enterobacter cloacae	X	X	X	X
Enterococci	X			
Klebsiella pneumoniae	X	X	X	
Listeria innocua	X		X	X
Listeria grayi	X	X	X	
Listeria welshimeri	X	X		
Listeria monocytogenes	X	X	X	X
Salmonella enteritidis	X	X		X
Salmonella typhimurium	X	X	X	
Staphylococcus aureus	X	X	X	X

What else is present on fresh produce post-harvest?

Pathogen	Produce
E. coli	celery, lettuce, radishes, peas, beans, cabbage, sprouts, parsley, mixed-vegetables
Staphylococcus	lettuce, parsley, spring onions, spinach, peas, beans
Clostridium	mixed raw vegetables, cabbage, broccoli, tomatoes, lettuce
Listeria	cabbage, sprouts, lettuce, radishes, tomatoes, beans, peas, broccoli, cucumber, mixed-salads
Salmonella	sprouts, carrots, beans, tomatoes, spinach, strawberries, lettuce, cabbage, cauliflower
Shigella	lettuce, celery, parsley, beans, peas, onions, carrots
Bacillus	sprouts, lettuce, carrots, beans, lettuce, chili, parsley

Carry-over irrigation water to produce



Experimental design

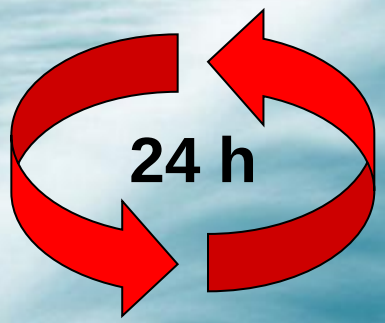
- 15 day trial

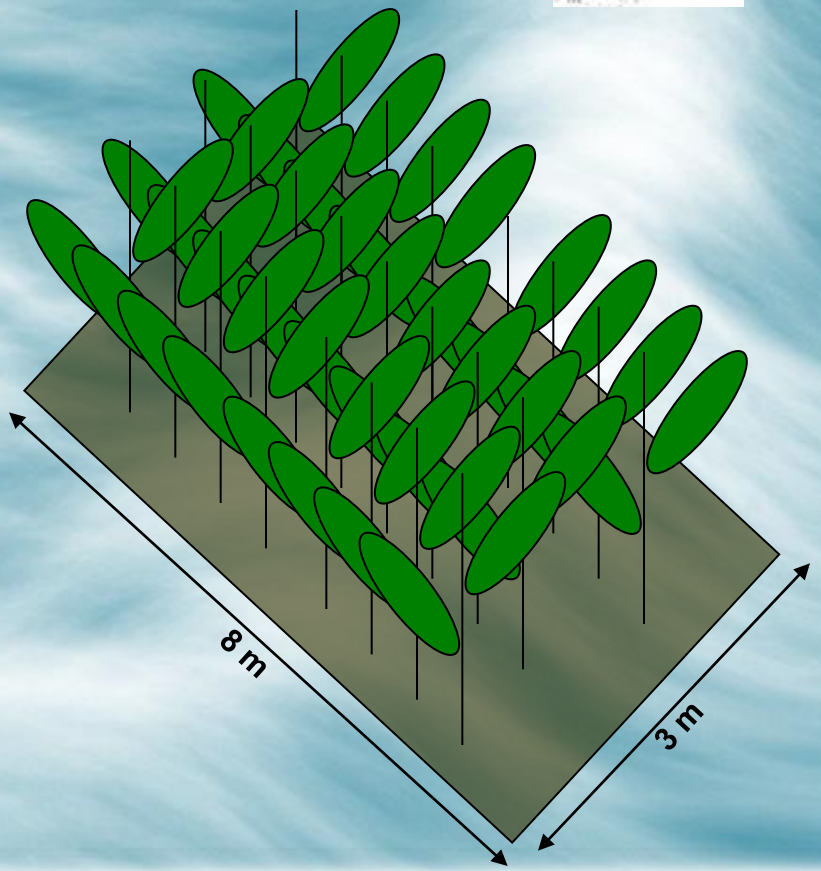
  Irrigated daily with water from Plankenburg -1

- Base-line value before first irrigation

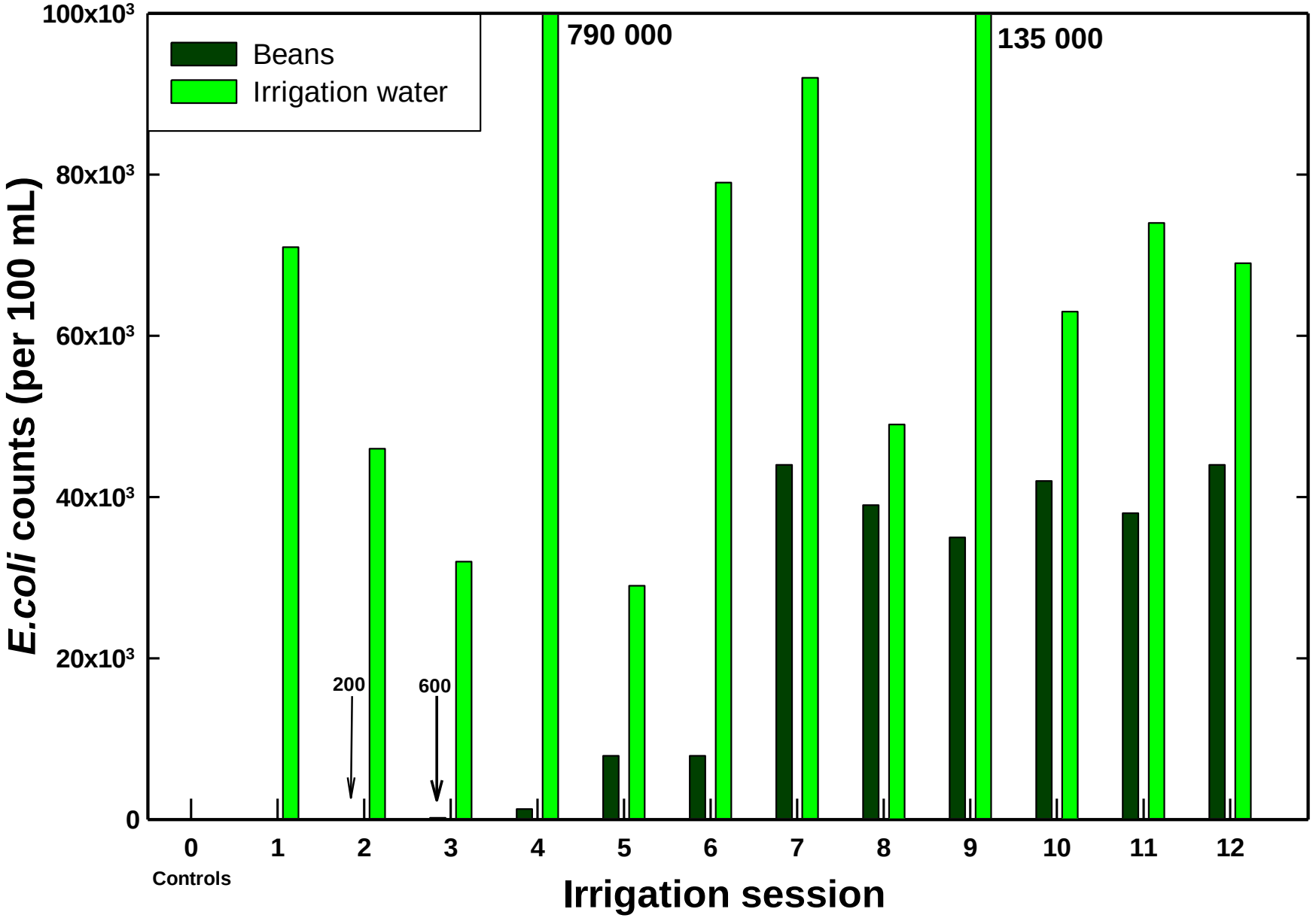
- Daily sampling of beans (300g) and irrigation water

- Standard methods

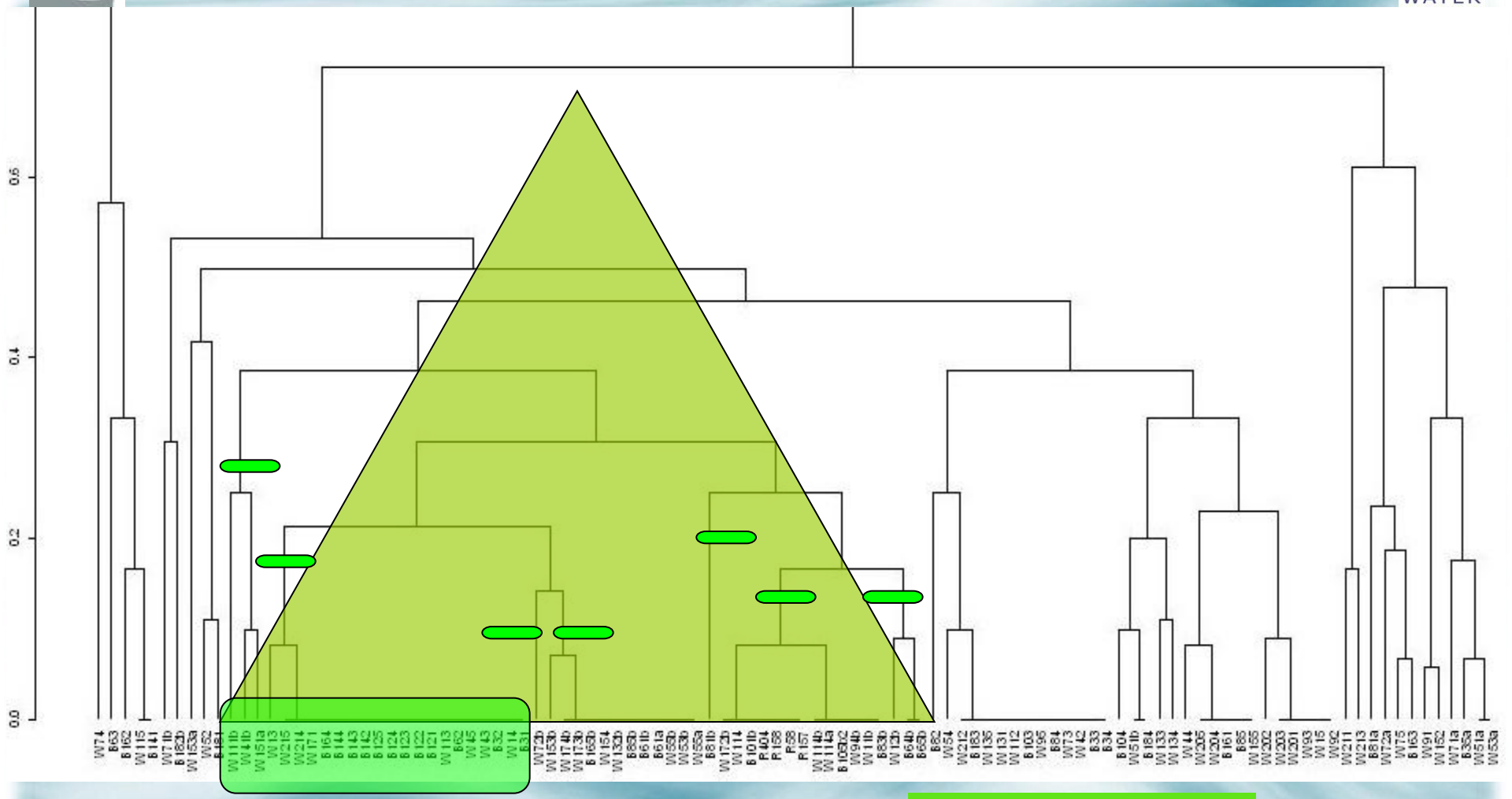




LINKING
E.coli in Irrigation water and on fresh produce



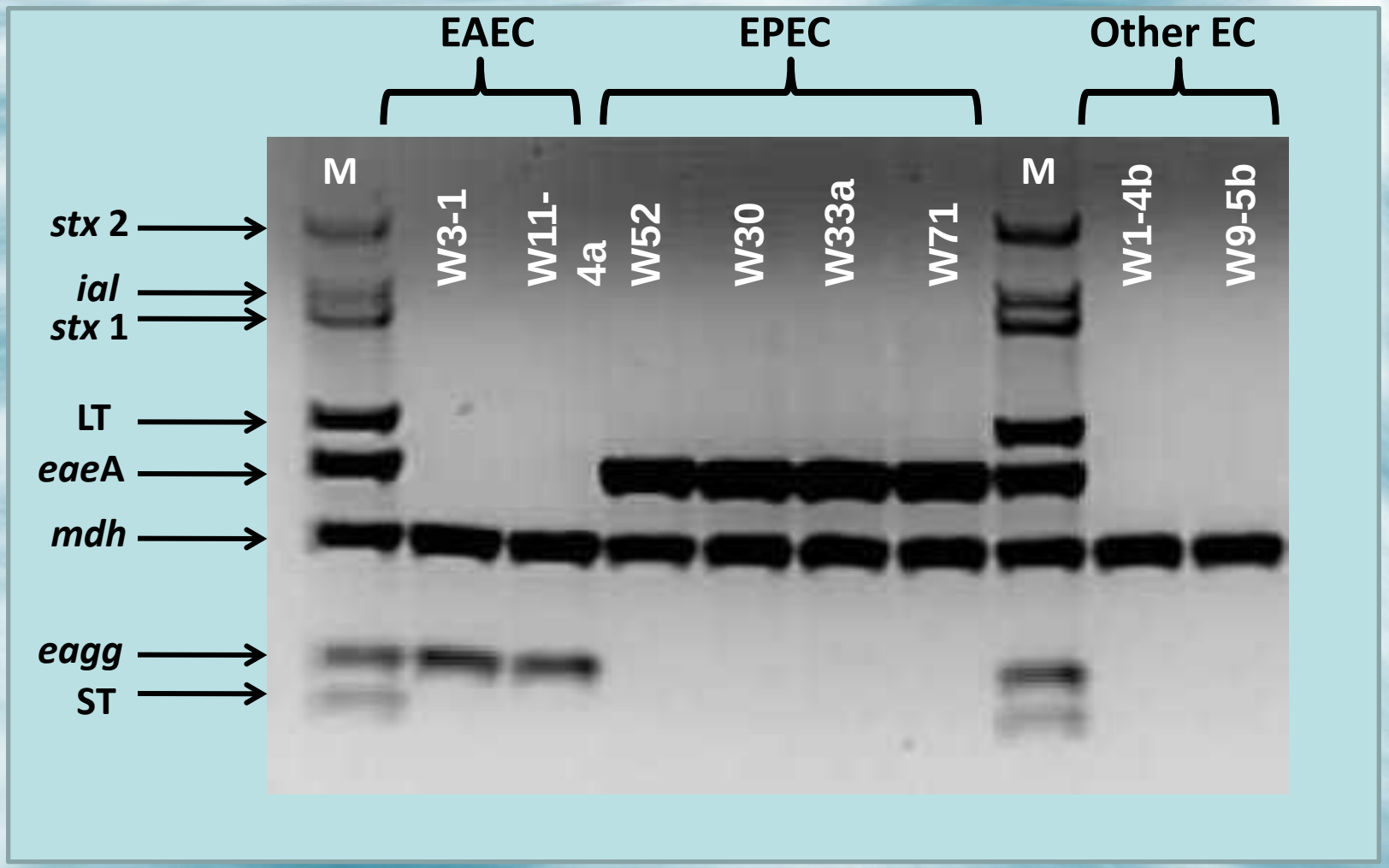
E.coli isolate dendrogramme



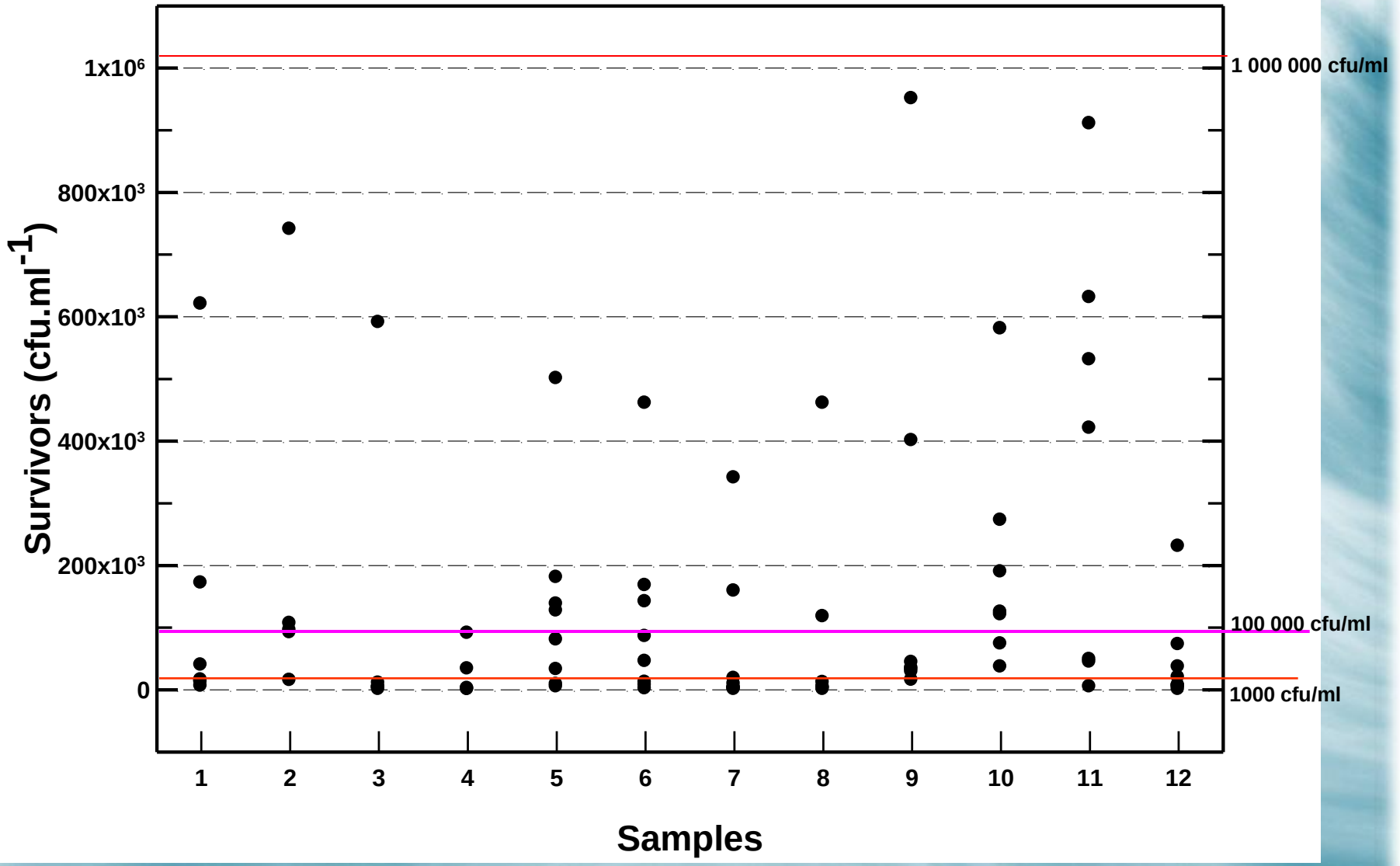
W1-1 = B2-1 + B9-3 + B11-4

100% biochemically
PCR
Ribosomal proteins
DNA sequencing

E.coli patho-types



Inoculum size = 1 000 000 *E.coli* per ml (n=72)
Produce = beans



GENERAL FINDINGS

Unacceptable microbial loads in most source waters

Unacceptable microbial levels on produce at-harvest

High counts on lettuce, cabbage, beans, after irrigation

Potential pathogens – in water and on irrigated produce

Evidence of build-up of microbial load after repeated irrigation

***"Direct links" - microbes* in irrigation water + irrigated produce**

Concluding thoughts

Impacts on health, economics and trading status

Short term	**= safety evaluation of produce** **= educate consumer (wash, disinfectants, etc)** **= upgrade waste systems in informal settlements** **= stricter enforcements**
Medium term	**= construct “relative risk” concept** **= evaluate treatment options** **= how big is the problem?**
Long term	**= upgrade treatment works** **= increase capacity of treatment systems** **= prevention**

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Thank you

These peaches are *E.coli* free