One Health and food safety and security in the 21st Century

Nigel French

One Health Aotearoa, Dec 14th 2017, Wellington

Collaborating Centre

OIE

Te Kunenga ki Pūrehuroa

MASSEY UNIVERSITY

Food

- Essential for survival
- One of our greatest pleasures
- In NZ:
  - Food production drives our economy and shapes our landscape
  - …but public health issues arise from food production

SUNDAY STAR•TIMES | NEWS A3

Superbug found in chicken

Scientists are alarmed at the unprecedented discovery of a strain that resists drugs and has crossed into humans around NZ, writes **Susan Edmunds**.

A new superbug has been found in chicken in New Zealand's four major poultry suppliers.

Groundbreaking research reveals the new antibiotic-resistant strain of campylobacter spreads to humans, which could make it hard to treat serious cases of infection.

Campylobacter is traditionally in the pic of ubiquity but is the leading cause of food poisoning, with about 7000 cases reported in New Zealand each year.

The antibiotic-resistant strain was first found in 2014 and has since been identified by Environmental Science and Research in Wellington.

The study, by Nigel French at Massey University and ESR microbiologist Debbie Williamson, found three of the major poultry suppliers in the North Island tested positive for the strain. A fourth in the South Island had results. The pair would not name the companies.

The resistance means two antibiotics – fluoroquinolones and tetracyclines – would fail in treating the infection, the

Which comes first?

The chicken or the campylobacter

Christchurch's pure drinking water could be contaminated due to farming

CHARLIE MITCHELL

Last updated 05:00, July 27 2017

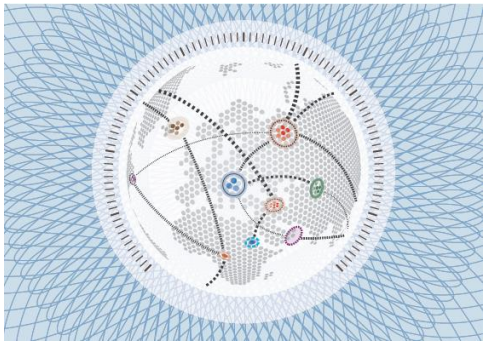
Going without food…

"A hungry world is a dangerous world
Without food, people have only three options:
they riot, they emigrate or they die"

Josette Sheeran, World Food Program

Source: www.dalaidiary.com.au
Images various sources, Google Images

Slide from Martin Cole



WORLD ECONOMIC FORUM

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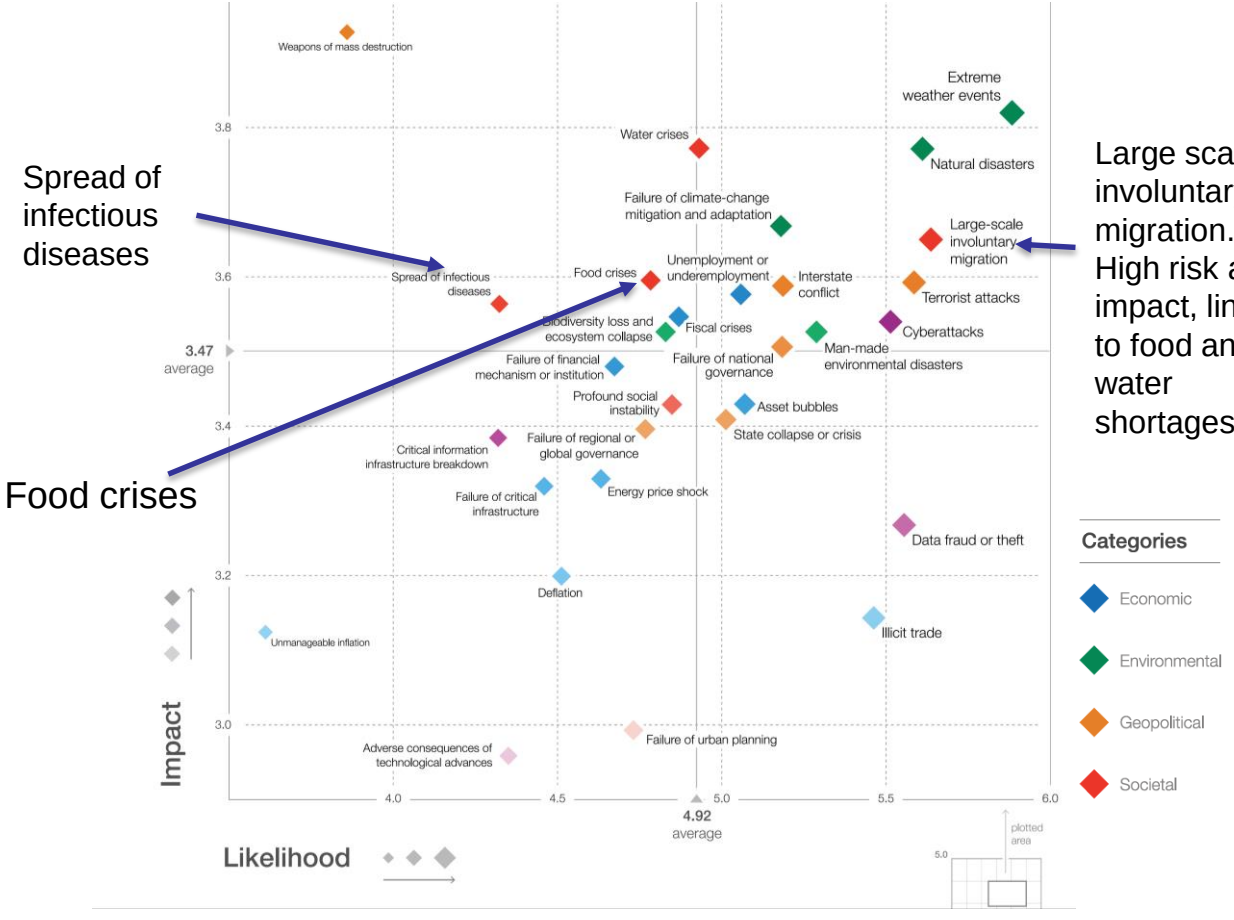
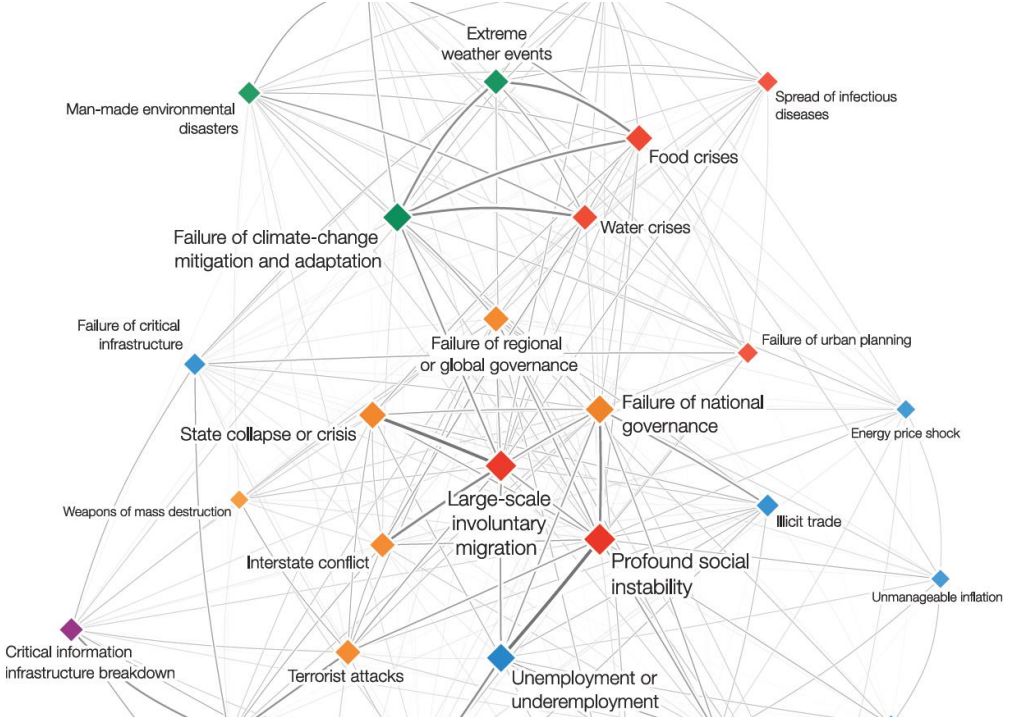
Insight Report

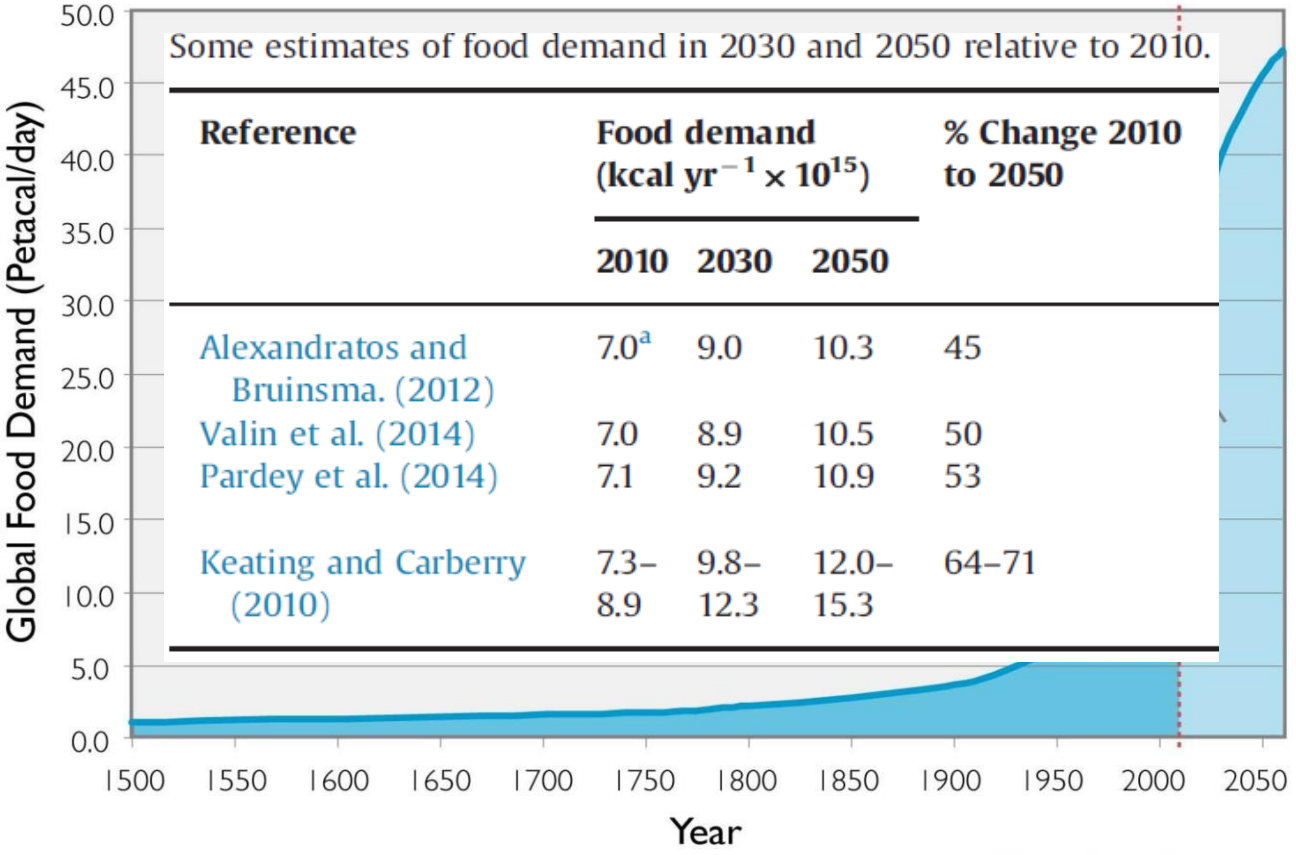
The Global Risks Report 2017

Global risks landscape and One Health

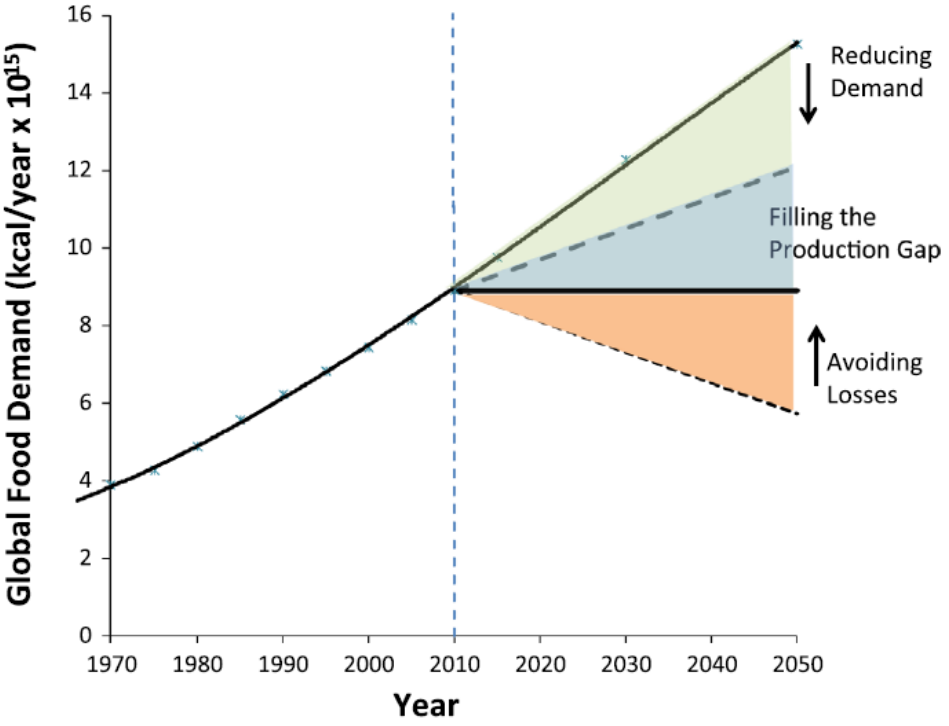


Issues are linked





Source: Brian Keating, CSIRO



Reducing waste and overconsumption

Better use of resources (land and water)
Synthetic food?

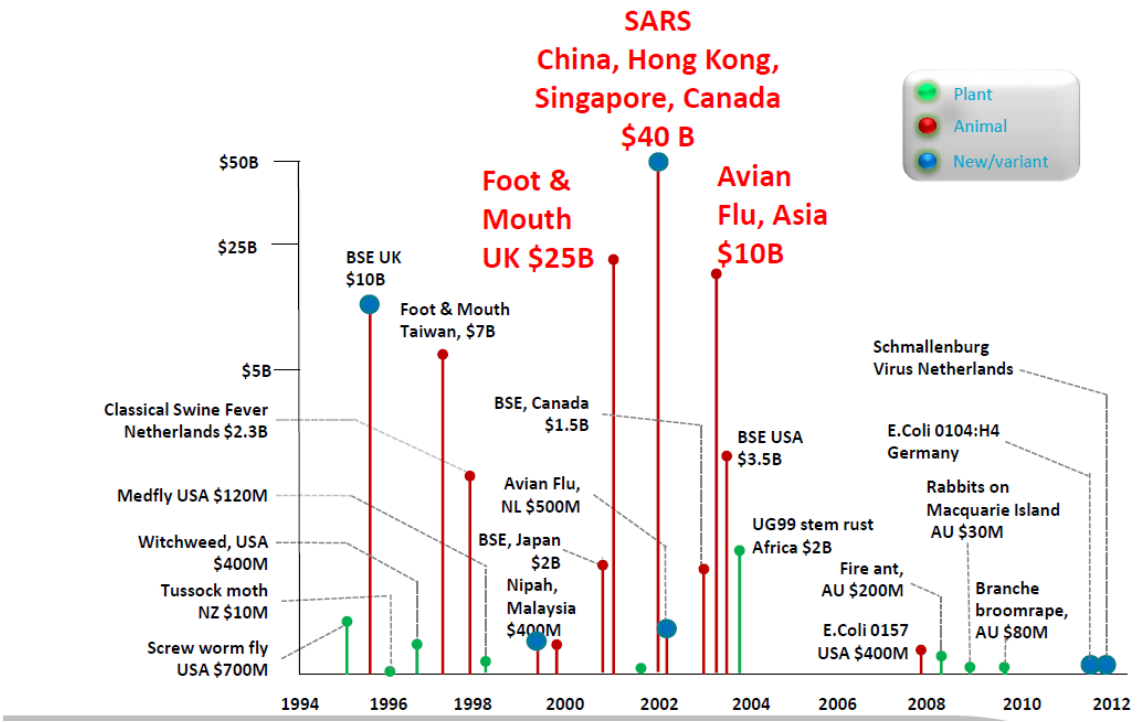
Biosecurity, disease control, food safety recalls
Minimising environmental impacts
Climate change adaptation

Keating, B.A., Herrero, M., Carberry, P.S., Gardner, J. and Cole M.B. (2014) Food wedges: framing the global food demand and supply challenge towards 2050. (Global FoodSecurity (2014) 125–132.)

Zoonoses (many foodborne) animal to human infection in numbers

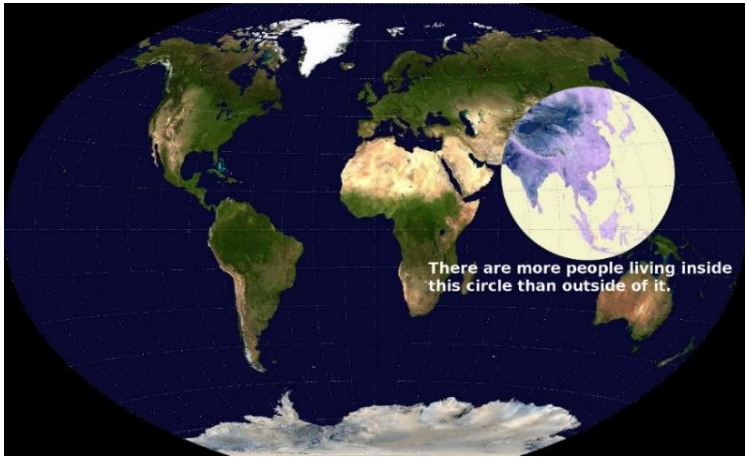
- >$120Bn p.a cost of epidemics
- >200 zoonotic diseases of critical importance to human health
- 60% of human infectious disease agents zoonotic.
- 75% of Emerging infections: over zoonoses (80% bioterror agents)
- 2.3 billion human infections in developing countries caused by zoonotic diseases
- 2.2 million deaths
- >50,000 rabies deaths, >150 countries

Economic impacts of (emerging) IDs can be large



Emerging Infectious Disease

- Human risk factors
  - Population density, urbanisation and growth
  - Increased global travel
  - Poverty
  - Changing dietary habits



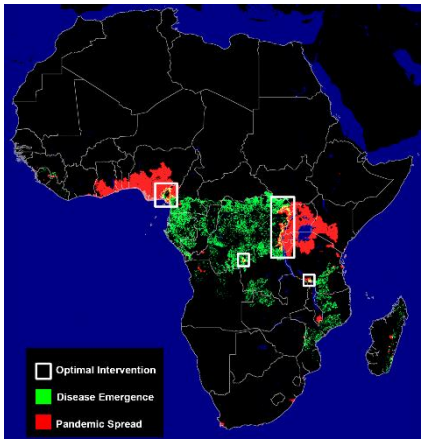
3908 cases (800+ HUS) 41 deaths

Emerging Infectious Disease

- Domestic animal risk factors
  - Expanding production, globalisation
  - Poor biosecurity, inadequate animal health
  - Antimicrobial use
  - Poor food safety practices
  - Environmental pollution
  - Occupational exposure

Emerging Infectious Disease: why the increase?

- Wildlife risk factors
  - Human encroachment
  - Habitat destruction
  - Climate change



Smil et al 2002; FOASTAT 2010

Real and perceived risks cost money

Under cooked burgers $160M

Popeye spinach $350M

Fonterra fined $183m over contamination scandal

01/12/2017 | Newshub staff Cleo Fraser

Danone had sued Fonterra as a result of the whey protein concentrate contamination scandal in 2013. Credits: Newshub.

More From Newshub

Food safety

- Global burden of foodborne infections
- Outbreaks down but recalls up
- A One Health approach to reducing the burden of foodborne disease
  - Interdisciplinary, whole of food chain approach
  - Source attribution – informing public health policy
  - Enteric zoonoses from the food production environment

Food safety and security in 21st Century

- Balancing food supply and demand
- Complex (and simple) supply chains
- Free Trade Agreements
  - Non-tariff barriers
- Emerging issues
  - Fresh produce
  - Fipronil in eggs in Europe

Food safety and security in 21st Century

Era of:

- Novel processing
- Novel foods
- Raw food
- Functional food
- Source attribution, traceability
- Rapid, cheap diagnostics
- Adulteration and bioterrorism
- Block chain technology

Food safety issues for all food sectors

- Primary production
  - Hazard entering the supply/value chain
  - Inter-sector pathways
- Supply chain management
  - Propagation of hazards along chain
  - Integrity and trust in supply chain
  - Reducing waste - safely

Dr Miranda Mirosa, UoOtago

Food safety issues for all food sectors

- Hazard detection technologies
  - Need to be rapid, sensitive, cheap… and approved
- Traceability and provenance
- Climate change
- Food safety culture
- Markets and consumer perceptions
  - Gene editing (perceived risk)
  - Novel technologies (HPP, PEF…)
  - Biocides

Dr Spock, SSE

Controlling foodborne infection requires:

- Understanding how pathogens propagate along the food chain
  - –Systems approach
- Identifying the most important animal reservoirs / sources
  - –Food animals (and wildlife?)
- Determining drivers for pathogen emergence and spread

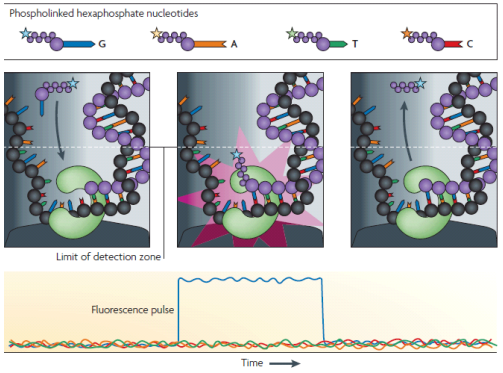
i.e. An interdisciplinary, One Health approach

Controlling zoonotic (foodborne) infections requires:

- Implementing the most effective control measures
  - Regulation, verification, intervention
  - Public awareness / education / behaviour and food safety culture
- Adoption of new tools and technology… (genomics, novel diagnostics, models, social science, block chain technology…)

Pathogen genomics and food safety

- Identifying ‘source’ and transmission of pathogens
  - Along production chain
  - Processing environments
  - Time and origin of incursions
- Diagnostic test development
- Establishing normal and abnormal ‘flora’ in supply chain
- Evolution and virulence

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Superbug found in chicken

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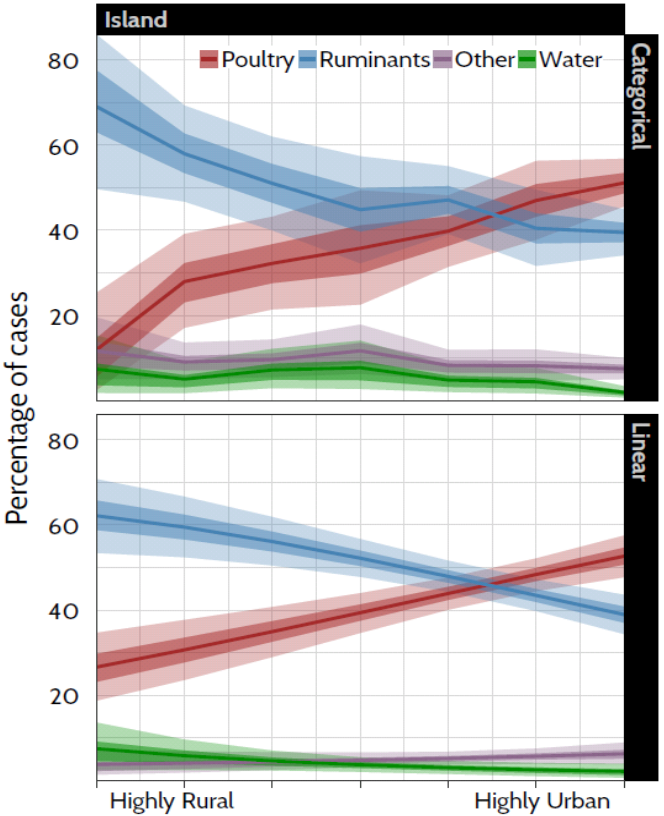
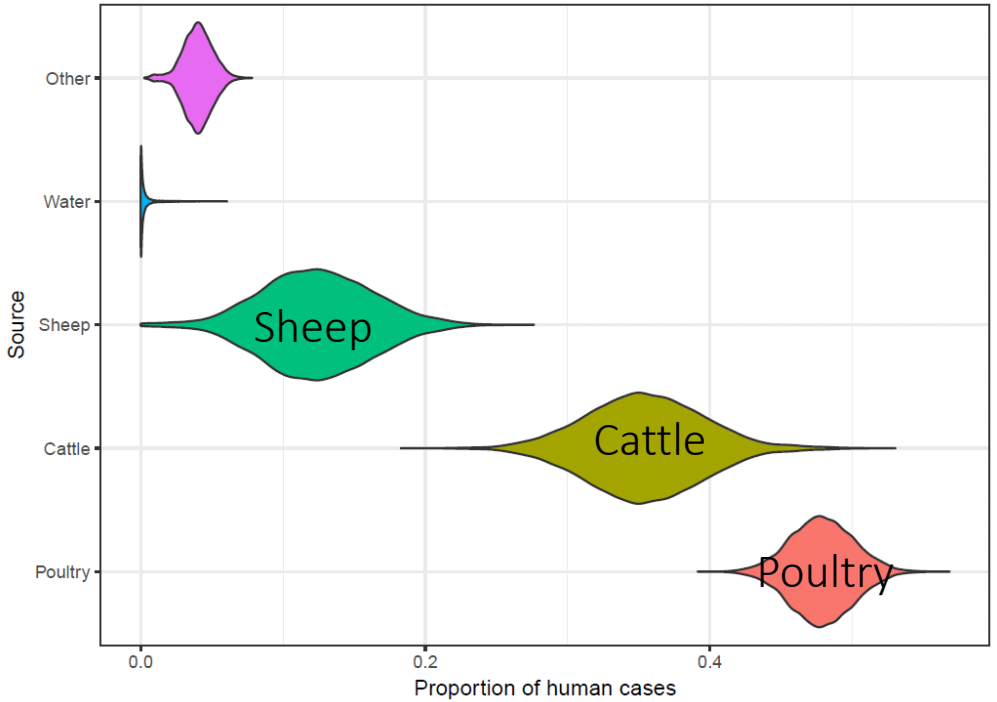
Determining the source of human campylobacteriosis



- Using MLST genotyping and evolutionary modelling

Jonathan Marshall, Jing Liao and Martin Hazelton

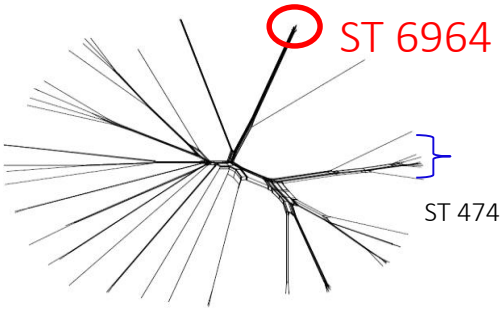
Distinguishing between ruminant sources: source attribution using whole genome MLST

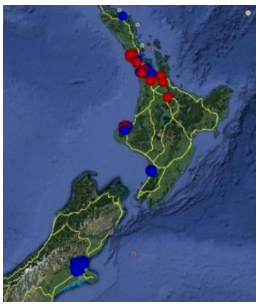


Emergence of resistant *Campylobacter jejuni* ST-6964

- Genetic basis for resistance to antibiotics?
- How long has it been in NZ?
- How has it been transmitted between poultry companies?
- What has driven the emergence?
- What is the main source of human infection?
- How is it evolving?

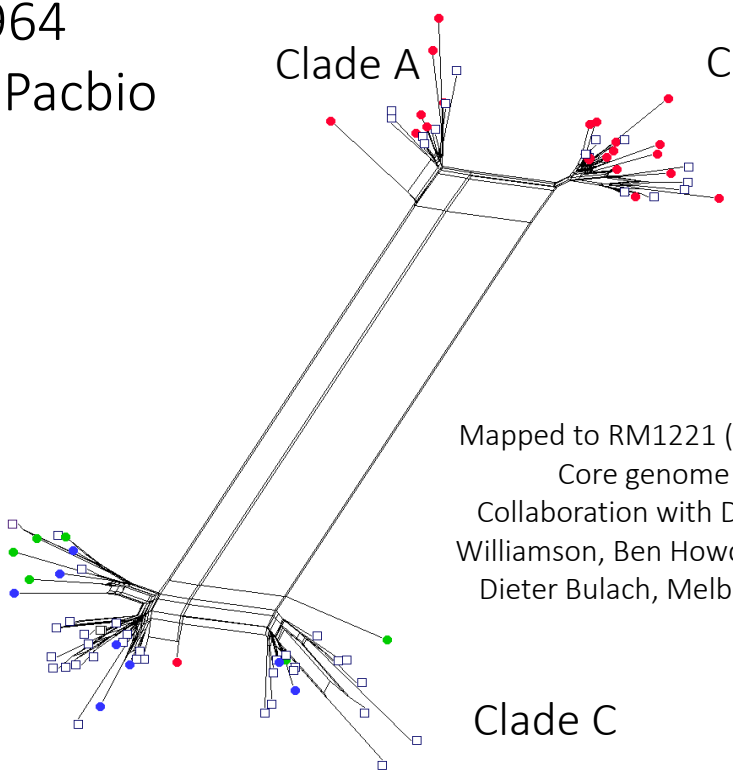
These can best/only be addressed by Whole Genome Sequencing





Sequencing of ST-6964 (N=230) including 4 Pacbio reference genomes

Red=Poultry A
Blue=Poultry B
Green=Poultry C
Squares=Human



Mapped to RM1221 (ST 354) Core genome
Collaboration with Debbie Williamson, Ben Howden and Dieter Bulach, Melbourne

Sabrina Greening poster

Key questions

- Genetic basis for resistance?
  - –*tet*O plasmid and C257T mutation in *gyr*A
- How long has it been in NZ?
  - –~mid-late 2013.
- What drove the emergence?
  - –Reverse zoonosis?
  - –Limited tetracycline use in breeder flocks?
- How has it been transmitted between poultry companies?
  - –Shared parent and grandparent stock? Feed?
  - –Local spread seems likely
- Source attribution
  - –All companies causing human infection

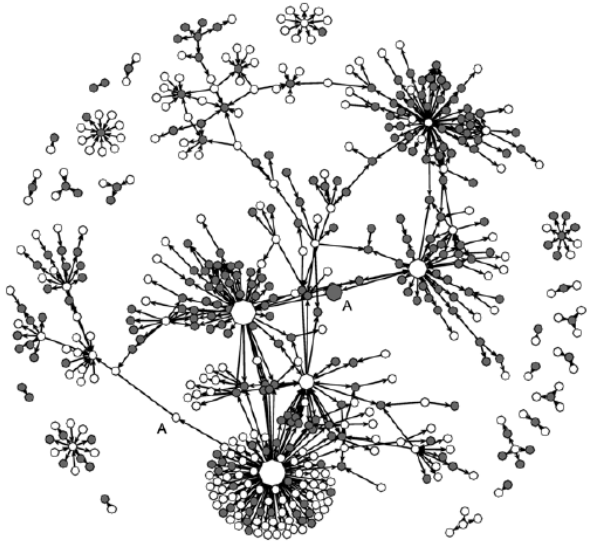


Fig. 2. Social network analysis of feed-related contacts in the New Zealand

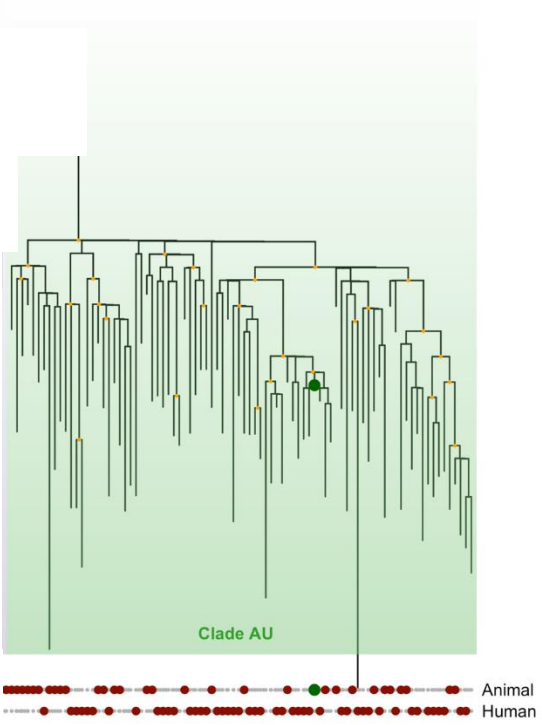
Poultry farm network
(from Lockhart et al 2010)

Required cooperation and support from poultry industry

Salmonella DT160 in Australia

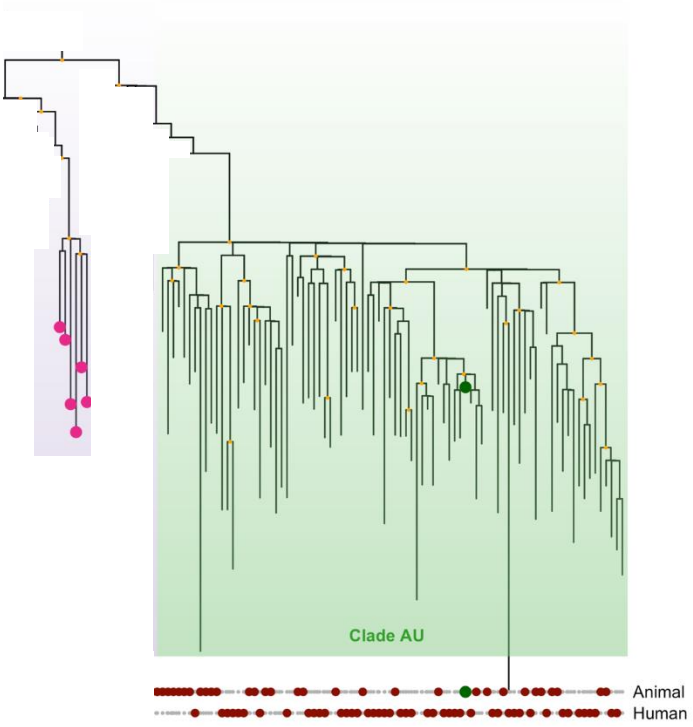
First locally acquired case in 2008. Associated with sparrows (predominantly in Tasmania).

Whole genome data from Dr Debbie Williamson, Melbourne Micro Diagnostics Unit



Salmonella DT160 in Australia

Cluster of cases in 2003



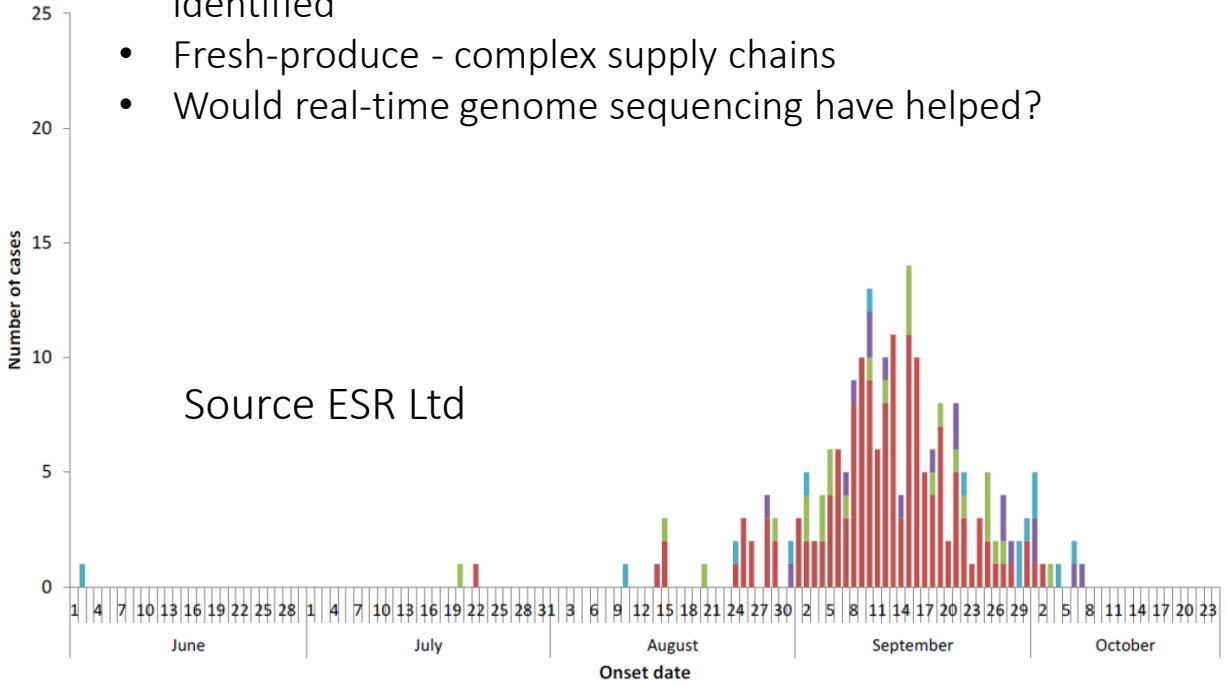
NZ isolates from humans, sparrows and livestock 1999-2010

Sharing genome sequence data confirms transmission pathway

Cluster of cases in 2003
Cruise ship from
Auckland to Sydney

Need for routine application of whole genome sequencing? Yersinia outbreak in NZ in 2014

- 217 cases, 65 hospitalised
- “highly unlikely that the source of contamination will be identified”
- Fresh-produce - complex supply chains
- Would real-time genome sequencing have helped?



Source ESR Ltd

Conclusions

One health, integrated approach essential for food safety and security:

- Food production impacts environmental health and public health
  - Foodborne, occupational and environmental zoonoses
  - Pollution and degradation
  - Antimicrobial resistance
  - Encroachment and EID
- Identification of 'source' and inter-host transmission of FB zoonoses
  - Crucial for effective public health policy
- Understanding hazards and risk requires whole of food chain approach and interdisciplinary research
- New technology helping to understand and control emerging risks

Acknowledgements

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