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Responding to globalised food-borne disease: risk assessment as post-normal science

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Abstract

Since the 1960s, global trade in food and feed has increased rapidly, and the number of countries at least partially reliant on this trade has sprouted into complex International Agrifood Trade Networks (IATN). IATNs have obscured the already-labyrinthine causal webs of food-borne diseases, and the usual methods for demonstrating causal links between IATNs and food-borne diseases yield results that are, at best, inconclusive. At the same time, responses are being offered which will, if implemented, likely to have unintended negative consequences. In this context, risk analysis (RA) is being used in situations for which it was not designed, in which facts are uncertain, values are in dispute and assessments are embedded in contested power arrangements, with heterogeneous consequences for diverse stakeholders around the world. To characterise and manage the most serious unintended food-borne disease consequences of globalisation, the most effective way forward will require reframing of RA as a post-normal science.

Keywords: food-borne diseases, globalisation, post-normal science, risk assessment

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1. Globalisation

Trade in food and feeds, a feature of human societies since the beginnings of agriculture, has expanded and intensified with the exploits of colonial empires, and accelerated with increases in population, urbanisation and migration. In this context, much food-related trade was driven by refugees and immigrants who carried with them preferences for 'home' foods, herbs and spices, from rice and curry to borscht and bread (Waltner-Toews, 1995).

Since the 1960s, global trade in food and feed, responding to increased demand, liberal regulations and improved technologies in preservation and transport, has increased at an unprecedented rate, and the number of countries at least partially reliant on this trade has sprouted into what have been called International Agrifood Trade Networks (IATN) (Ercsey-Ravasz et al., 2012; D'Odorico et al., 2014).

While stated motivations for trade have always included humanitarian and business considerations, the late 20th and early 21st century saw these two forces more explicitly come to prominence, often in concert with each other. Even as these changes were occurring, those managing agrifood systems have been asked to justify their activities to include considerations of climate change, environmental sustainability, eradication of poverty and hunger, natural disasters, and threats posed by trans-boundary movements of pests and diseases (FAO, 2017). These changes in rationale, scale and practice have driven further changes in how agriculture was practiced around the globe, often based on simplistic and outmoded input–output models borrowed from 19th century engineering, and often with negative impacts on human well-being (Waltner-Toews and Lang, 2000; Brijnath et al., 2014).

Systemic attempts to understand food trade have produced complex mathematical models and artistically stunning diagrams of agrifood fluxes, some of which are revealing. For instance, based on an examination of these 'hidden' trade-webs, a Swedish study concluded '74% of manufactured animal feed ArEAs [ecosystem areas appropriated] were from imported inputs'. (Deutsch and Folke, 2005). However, these and similar studies and diagrams are difficult to relate to food safety per se, and still more difficult to translate into policies and regulations.

2. Food-borne diseases: trends

Reported food-borne disease cases and outbreaks increased in parallel with the proliferation of IATNs, many of these involving emerging pathogens and/or old pathogens once thought of as meat-associated now associated with novel food vehicles, such as fresh fruits and vegetables, flour and nuts. If one steps back and considers a range of food-borne pathogens, many rates since the 1960s appear to have stabilised, but, despite concerted efforts of public health authorities, reductions in rates have been marginal (Rocourt et al., 2003; Havelaar et al., 2010; Tauxe et al., 2010; Callejón et al., 2015; Silva et al., 2017).

From a complex systems perspective, one might ask if these stabilised rates and novel food vehicles might reflect a new attractor, that is, that they are a function of ecological niches and transmission pathways inherent in the way in which the agrifood system is structured. If this is the case, then a focus on particular agents, while important from a putting-out-deadly-fires perspective, may be less useful for longer term preventive strategies (Waltner-Toews and Lang, 2000). Such longer term strategies would require undertaking the quixotic task of a global restructuring that is well beyond the control of food safety authorities.

3. Causal links and impacts

It seems common sense to argue that globalisation of agrifood webs has had an impact on food-borne diseases, yet it is not clear how such an impact might be assessed. Some of the common tools used by epidemiologists in other settings, such as calculating population attributable fractions, cannot be applied because, quite simply, the data cannot, even in principle, be gathered.

One might look at cases and outbreaks associated with imported foods. Specific outbreaks such as those associated with Shiga toxin-producing *Escherichia coli* in fenugreek seeds (EFSA, 2011) and *Salmonella agona* in infant formula (Anonymous, 2018) tend to grab the attention of both the media and public health researchers and managers. While investigations into outbreaks are informative, however, it is not clear how much one can generalise from these, or how they relate to overall trends. Nor is it clear how – apart from improving testing methods and surveillance, that is, gathering more data more quickly – one might best respond.

If one examines overall trends, the picture is also far from clear. In the USA, for instance, almost 20% of foods are imported, but reported outbreaks associated with imported foods only rose from 1%

in the period 1996–2000 to 5% in 2009–2014 (Gould et al., 2017). The authors suggest that, because foods associated with outbreaks are not always traced back to source, and because of shifting reporting requirements, this is likely an underestimate (Kase et al., 2017). Researchers using generally accepted investigative methods and linear causal models have, after half a century of diligent scientific work, returned with the less-than-definitive answer that such an impact is 'likely' (Quested et al., 2010).

4. Risk analysis

Given the insurmountable problems of using many of the epidemiological tools designed to study specific agents in specific populations and applying these at the global scale to what sociologists have termed wicked, that is multifaceted, ill-defined, problems, many regulators and researchers have adopted the language and approaches of risk analysis (RA). RA is conventionally broken down into risk assessment, risk management and risk communication. RA was originally designed as a way to characterise dangers associated with toxic chemical residues in food. The dangers at first were related to risks of cancer, and later expanded to include reproductive, neurotoxic, developmental and immunological effects. (National Research Council, 1983, 1993; Waltner-Toews and McEwen, 1994).

RA still struggles with many unresolved challenges, especially when applied to problems for which it was not designed, such as communicable and food-borne diseases. Some of those problems include the shaky foundations and 'perspectives and principles that could seriously misguide decision makers' (Aven, 2016).

While beyond the scope of this brief overview, two closely related issues are here worth emphasising: uncertainty and the often hidden and unrecognised role of values in the science.

Even when narrowly focused, the entanglement of science with value judgements in RA has been identified as a challenge: selection of species to study, relevant outcomes to measure, relative weight given to Type I and Type II errors, and extrapolation across species are all non-scientific, value-laden choices (Brunk et al., 1995). When risk-based approaches are applied to infectious agents, where cross-contamination is likely, and a few bacteria can quickly multiply to overwhelm control measures, declaring 'safe' thresholds based on already problematic estimated dose–response curves is unrealistic.

In the context of globalisation, with extensive and complex farm-to-fork webs, and globally heterogeneous, rapidly changing political and agricultural landscapes, the problems multiply exponentially. The ethically suspect core rationale for RA – minimising risks for consumers at the cost of shifting or increasing risks to producers – is already evident within countries, and reduces risk–benefit calculations into political gamesmanship masquerading as science. At a global level, RA as currently framed takes on a more stark and ethically indefensible character.

Addressing the role of values involves examining issues of trust in regulators, and requires not only more data, but different kinds of data, which food safety regulators seldom gather, and which lie beyond the mandates of most regulators (De Marchi and Ravetz, 1999; Wickson et al., 2017).

5. A way forward: RA as post-normal science

Given the role of values, and large areas of uncertainty, many of these are not resolvable through more data, how then might one proceed?

One response is to attempt to simplify the system (King et al., 2017). From a global perspective, this would be a version of clearing a highway through the rainforest to reach a distant, possibly unrealistic, destination. For instance, technical and formal solutions, such as blockchain technologies and whole-genome sequencing, are attractive to large private corporations in whose economic interests it is to simplify and manage agrifood systems from farm to fork. While such simplification may be welcomed by food safety regulators and large businesses, such simplifications of food complex food webs to simplistic food chains imply a centralisation of management and control. This would have many unexpected, cascading, and possibly devastating environmental, social, and political impacts (Splitter, 2018).

Peter Gluckman has argued that 'the issues for which scientific input is most needed by policy-makers are the very ones for which the science is often the most complex, multidisciplinary, and incomplete' (Gluckman, 2016). A 1993 paper by Funtowicz and Ravetz suggested that, in applied sciences, as uncertainty, risks and conflicts increase, we move away from what scientists have generally considered to be 'normal' (in a Kuhnian sense) to what has come to be called post-normal science (PNS). For laboratory scientists working on plasmids or genomics, their peers (those who assess the quality of their work) are generally people working in the same field.

For those outside the laboratory who are working on food safety risk assessments, facts and the relationships between them are increasingly uncertain, values are in dispute, assessments are embedded in contested power arrangements, regulatory and policy decisions are urgently called for, and decision stakes are high. These are exactly the conditions for which PNS was designed to address (Funtowicz and Ravetz, 1993). In fact, since PNS first emerged as a response to RA challenges in 1985, one might view this as an idea coming full circle (Funtowicz and Ravetz, 1985).

Some might consider this characterisation of food safety RA to be exaggerated, especially within national boundaries, where some consensus on 'right outcomes' may exist. Globalisation – in which acceptable outcomes may vary from country to country and among participants – challenges these consensuses.

An analogy might usefully clarify what is meant. What we are facing, when we consider globalisation and food-borne disease, is less like a scientific research problem and more akin to what veterinarians and physicians practice, and what Funtowicz and Ravetz, in their consideration of different kinds of applied science, labelled 'professional practice'. In these instances, there is some urgency to make decisions, but the situation is fraught with systemic uncertainties (there are no guarantees of desired outcomes) and ethical conflicts. The professionals are responding to situations presented to them which are, in a sense, manageable, but where the peer group has been extended to include not only fellow professionals, but also those most directly affected by the outcomes: patients, animals and farmers. The professional consultants bring together data from case histories, physical examinations, laboratory tests and an understanding of the epidemiological, social, psychological, economic and physical context, make a judgement call and propose interventions. Outcomes are monitored and adjustments are made accordingly. The work may be unimpeachable from a scientific viewpoint, but if the patient is permanently disabled, and their quality of life deteriorates, then one might question whether the 'right' actions were taken. In some cases, from certain points of view or in certain value systems, 'good science' might suggest that the patient should die.

Where the professional analogy differs from issues of food safety management in the context of globalisation is that for the latter this is a collective judgement, embedded in contested power arrangements, with heterogeneous consequences and often unrealistic recommendations for stakeholders in many parts of the world. It is not always clear that bacteriologically safe food for urban consumers, while defensible among scientific peers or corporate managers, is the only appropriate criterion on which to judge the quality of the work. To be sustainable, and scientifically and ethically defensible, RA in this context will need to be reframed as a multiperspective PNS, with risks and benefits characterised by, and for, producers, traders and consumers throughout the global food webs. In an age of strident calls for retreat to nostalgic nationalism, food-borne diseases in an age of globalisation offer us an important opportunity for trans-boundary collaboration.

What might such a post-normal RA look like? In the past, scholars and scientists from many different backgrounds have contributed information to policy-makers, who have then been asked to make integrative decisions. In this process, sources of knowledge have been divided and prioritised, and information from stakeholder consultations are pitted against results of laboratory-based experiments. Based on so-called 'hard' sciences, practices and ingredients have been declared 'safe,' safety being narrowly defined as not likely to result in specified medical outcomes such as cancer or neurological defects in consumers. These 'hard' sciences are often constrained and driven by available technologies and narrowly defined outcomes, and so evidence legitimised in the food safety decision-making process is similarly constrained and driven. This leaves decisions more vulnerable to manipulation by those owning or developing the technology. Other, equally legitimate kinds of knowledge, which one might term the 'difficult sciences', drawing on a variety of craft-based practices, social, ecological, political, and economic sources, are given lesser status. Debates over safety then degenerate into accusations that 'the science' (that is, one narrowly defined kind of science) is being ignored in favour of other sources of legitimate knowledge that are irrationally lumped together and termed, usually in a derogatory fashion, 'political considerations'.

Within a PNS version of RA, knowledge would not so quickly be fragmented. Having identified important food safety issues – from medical outcomes in consumers to ecological resilience of producers – those knowledgeable about the issues are brought together. The extended peer community in this process includes participants grounded in a wide variety of knowledge bases, from difficult as well as hard sciences, and from formal researchers to those with practical experience.

Those with practical experience often bring to the fore important issues of quality (fitness for purpose, how information is used and distributed under 'real world' conditions) that experimental scientists, responding to different peer groups, tend to marginalise. In a PNS process, a diversity of knowledge is considered essential, not only for ethical reasons, but to ensure the most resilient basis for decisions. No one source of knowledge can possibly encompass the multifaceted complexity of the issues being considered. Conflict among those bringing forward different kinds of knowledge is expected, healthy, and necessary and consensus may not be possible or even desirable. So conclusions drawn by the European Union might be different than those of, say, China or Guatemala. In the context of globalisation, the desired outcomes would be policies for each country or region that recognise local priorities and needs and, considering systemic feedbacks and dynamics, can accommodate reasonable trade-offs. All policies would be open to change as new information comes in or the context changes, which given recent political and climatic experiences, appears likely.

RA as PNS would, in the short to medium term, be something more rigorously managed than politics, less certain than laboratory science, more challenging than either of these, with decisions arising from it more equitable and resilient in the long run.

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Abbreviations

IATA	International Agrifood Trade Networks
PNS	post-normal science
RA	risk analysis