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Viewpoint

Building on scientific excellence *via* sharing of scientific expertise – The case study of food safety

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Many of the difficulties faced nowadays by society at large in maintaining a safe food supply can be effectively addressed by more and (preferably) better science. However, excellence in science will become more and more dependent on sharing of data and expertise – the nuclear idea emphasized in this viewpoint article, which conveys the major points presented and discussed by the senior author in the (invited) opening plenary lecture delivered at EFSA 5th anniversary scientific forum. Data and knowledge are usually shared within the scientific community itself – and are typically aimed at peers; however, the associated citing metrics do not often correlate with their applicability and usefulness. Funding bodies have for long recognized the value of networking and crossbreeding among scientists – in reinforcing complementarities and promoting synergies. Furthermore, these bodies have had a major effect in driving food scientists reach out of their cocooned, narrow communities toward embracing a wider spectrum of disciplines (e.g. in social and economic sciences). Web-supported databases of e.g. risk data and pathogen sequences have also revolutionized access to, and use of knowledge. Finally, a number of formal trans-European platforms have been launched by private stakeholders to promote sharing. In all cases, the thrust is to be put on trust – that what is shared is genuine and valid, and will not be subsequently adulterated or used inappropriately. Willingness to engage in free circulation of information and expertise will determine the extent of effective sharing on the long run, and of excellence of science derived therefrom – which is ultimately developed for the well-being and safety of the citizen, seen first of all as a food consumer.

Introduction

Society has for long recognized the need of science to support a safe supply of food; our scientific knowledge of the phenomena affecting food safety forms the basis of all actions that have contributed to make food supply as safe as it is today. Different countries and distinct economic areas may differ in the specific approaches to control the food supply, but they tend to act consistently in terms of stringency and efficacy of control; the trend is indeed to use science to underpin relevant decisions and global orientations.

Risk Analysis has meanwhile become the framework under which the major economic zones attempt to control food production and supply. As a concept, it is well established and defined – and its component *Risk Assessment* has a clear, well-defined science base (CODEX ALIMENTARIUS, 2007). The use of formal risk assessment exercises to inform policy decisions and specify control criteria is, however, a relatively recent development – and certainly not yet a completely mature endeavor. However, if science is important in supporting decisions at a societal level that assure safety *via* legislation and control, technology is no less crucial in making safety of the food supply – which is in turn supported by science.

The technologies relevant for food safety include: those pertaining to processing, packaging and distribution – which are intended to remove (or, at least, limit) hazards in the final products; and those employed to monitor and detect hazards. Science is hereby applied both to improve current technologies and to develop novel ones – which will frequently (but not always) be introduced into the food sector after they have been tested and applied in other sectors.

Building on scientific excellence

Scientific excellence is – even in general terms, a far from consensual concept (Polt, 2006). Current measures of excellence are mostly based on accessible quantitative parameters

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– e.g. number of scientific papers published, absolute impact factors and ranking of journals within subject areas, as well as statistical indicators based on the number of citations by peers. These bibliometric descriptions are undoubtedly measures of a scientist's positioning within the scientific community, but they bear no obligatory relation to the usefulness of the underlying work. However, they are comfortable targets for scientists and handy yardsticks for funding agencies. Even the number of patents obtained by a scientist may not be a reliable measure of the applicability of his work, as the vast majority of patents are hardly ever translated into exploitable technologies – and even fewer eventually meet with commercial success. Therefore, our current concept of scientific excellence does not directly help in knowing which science best serves society, specifically in terms of food safety.

Publicly funded science – with the explicit aim of contributing knowledge to aid in control of food-borne health risks, should bear an apparent impact on food safety; otherwise, there would be a mismatch between the rationale behind risk analysis (i.e. to apply resources according to need, in order to best reduce morbidity and mortality) and the intended application of research funding. Most responsibility in assuring that the most appropriate science is done rests nowadays on policy makers – either within the most relevant funding bodies, or hierarchically above but in a position to influence them. This trend has been strengthened in recent years, as funding programs become more and more focused on generating specific items of knowledge. As part of the relevant measures pertaining to food safety taken by the European Commission (EC), successive Framework Programs (FPs) have been gradually more explicit in identifying the type of research that can (and will) be funded. This approach of narrowing specificity is carried over from assessment of applications, through periodic evaluation of the projects contracted (while funding is still active), and eventually to the *ex post* evaluation of the programs themselves.

Therefore, funding bodies have assumed a higher share of responsibility for the appropriateness of the science developed; in a sense, the role of commissioner (who has an idea and seeks a contractor to develop it) is gradually taking up the role of research funder (who researchers apply to with their own original ideas). On the other hand, prioritizing and goal-setting policies are somewhat inaccurate and arbitrary, and thus imperfect processes *per se*; nevertheless, they are required to guarantee that research funds are used in more effective ways.

It is relatively simple to establish correlations between research spending and quantitative output – but it is far more difficult to ascertain the quality of that output, in terms of impact on food safety. This difficulty arises for a number of reasons: first of all, many measures that can impinge on the incidence of food-borne diseases are not based on true science. In fact, improvement or worsening of the supposed incidence of a disease can be due to local or widespread changes in the consumer, or to erratic clinical practices devoid of reference scientific findings. The reported cases of disease are also frequently not representative of the prevailing situation – as the total number of unreported, true positive cases is usually not known. Hence, official statistics may easily be biased with regard to the prevailing situation in the whole population. Data concerning diseases associated with the effects of specific food hazards are indeed notoriously inaccurate – especially in the case of diseases that do not lead directly to death. For food-borne bacterial pathogens, the numbers quoted are typically gross underestimates – i.e. 1–10% of actual cases (Motarjemi & Käferstein, 1997), yet these diseases are normally acute and undergo a relatively rapid onset. Improvements in surveillance – possibly supported by research outputs on diagnosis and by public awareness at large, will likely lead to an increase in the number of cases eventually reported; only in such a situation will scientific output correlate significantly with recorded incidence of each food-borne disease.

Although actual values of incidence of food-borne diseases are at present often unreliable, overall trends over time might represent more useful indicators of the performance of efforts developed to address them. Pathologies caused by low level, chronic exposure to chemical hazards raise other difficulties, owing to their typical delayed onset; in such cases, one has resorted to retrospective epidemiological studies to find their causes. However, the consumer-perceived risk of developing delayed onset, uncertain-gravity diseases is considerably high (Yeung & Morris, 2001) – and the results of control measures (when and if appropriate) are expected to translate much later into a reduction in incidence of a disease.

Overall, if control measures of food safety are to be underpinned by science (as they should be), the impact of science will be hard to establish with accuracy and/or expediency; hence, it is particularly difficult nowadays to relate science production to risk reduction.

In the case of research on technologies and practices aimed at improving safety throughout the food chain, the presence of the market environment brings about a discipline that is not usually present in public health-directed science. Both intervention technologies (i.e. processes, ingredients, packaging and distribution) and detection/monitoring methodologies can be included in this category. Companies will in fact execute intramural, or alternatively contract extramural research required by searching for, developing and maintaining competitive products – while the market will ensure that only the best solutions will strive, as if there were "an invisible hand" drawn by the consumer. The research investments made by the aforementioned companies will (hopefully) be recovered afterwards *via* product sales: if the science supporting those products is not of a high level, then the companies will experience major constraints in obtaining legal approval for, or in competing with similar products. The aforementioned discipline – rising from the market and impinging on science upstream, leads to an alternative concept of scientific excellence.

Therefore, the contributions to food safety from the private sector – at least those that are more technological in nature, are likely to be more efficient in terms of usefulness of research, because they are exposed to a competitive environment from the very beginning.

Sharing of scientific expertise

Many scenarios of expertise sharing have a direct impact on the efficiency of mobilization of the science community toward support of safety along the food chain. This statement appears odd, because (as discussed above) it is rather difficult to establish a convincing link between the science that is performed and the impacts on food safety that it actually brings about. However, sharing certainly assures that the right questions are asked in attempts to set priorities; it also plays an increasingly important role in guaranteeing that the best possible answers are obtained.

Many European countries maintain national and regional funding bodies, which are poorly articulated with each other – even within their own geographical and topical zones of competence. As a result, projects are often commissioned which partially (or fully) overlap. On the other hand, food safety is a broad concept, so studies relevant thereto will likely cover several distinct research disciplines – and hence will fall within the scope of different research funding bodies.

Such a lack of articulation is a general problem in research funding, and EC has addressed it in a number of ways. One initiative is the ERA-NET (European Research Area NETwork) scheme, which aims at improving cooperation between researchers, and coordination between research activities carried out at national or regional levels, in Member and Associated States. This scheme makes funds available to thematically oriented projects, which require national and regional public funders to be brought together under a common aim – for which networking is seminal (http://cordis.europa.eu/coordination/era-net.htm – July 31st, 2008). Pertinent examples are listed in Table 1, for illustrative purposes.

Another important initiative related to definition of research priorities takes the form of the European Technology Platform (ETP) program. These platforms are sector-oriented, industry-led frameworks – aimed at the definition of research and development priorities, and corresponding action plans, so as to actively contribute to future growth, competitiveness and sustainability of Europe as a whole (http://cordis.europa.eu/technology-platforms/home_en.html – July 31st, 2008). The EC has committed itself to giving a great consideration to the outputs of ETPs when designing its research calls in the 7th FP – but their impact is intended (and expected) to be much wider. More than 30 ETPs exist at present, at least four of which have a direct influence upon food safety – which are also tabulated in Table 1. These ETPs represent fora in which relevant issues are analyzed and research plans are designed – always in the context of competitiveness of the European industry, and which release proposals that are driven by all stakeholders jointly (which also aids in bringing the concept of "whole food chain" into play). The capacity of distinct stakeholder groups to articulate with policy makers in the area of food safety is considered to be of great importance, but subject to a significant uncertainty (Sargeant *et al*., 2007); it is clearly one of those areas in which trans-disciplinary studies are required, and new forms of communication need to be explored.

Modern science is unequivocally based on sharing (of human capital and equipments, as well as of knowledge at large). The way science is publicly funded promotes an intrinsic environment for sharing – and most collaborative projects must demonstrate sharing among partners. In the case of formal multi-centre projects, most consortia that

Table 1. Selected trans-European networking initiatives in the area of food safety

Name	Type	Focus	Goal(s)	URL address[a]
SAFEFOOD	ERA-NET	Strategic plans for relevant research	Avoid superimposition and repetition of research efforts	http://www.safefoodera.net/
SCAR: Standing Committee on Agricultural Research	–	Influence on agricultural pan-European research efforts	Raise issues of relevance for food safety	http://ec.europa.eu/research/agriculture/scar/index_en.cfm/
Microbiological Safety of Food Funders Group	–	Critical reviews of research, aimed at pinpointing gaps and overlaps	Potentiate research on microbial food-borne pathogens in UK	http://www.food.gov.uk/science/research/researchinfo/foodborneillness/microfunders/msffg/
Food for Life	ETP	Novel functional foods	Thematic chapter specifically on food safety	http://etp.ciaa.eu/
FABRE	ETP	Farm animal breeding	Horizontal theme on food quality and safety	http://www.fabretp.org/
IFAHSEC	ETP	Global animal health	Impacts upon safety of animal-based foods	http://www.ifahsec.org/
Plants for the Future	ETP	Plant-based foods	Effects of plant biotechnology on food safety	http://www.epsoweb.org/

[a] All sites accessed on July 31st, 2008.

are formed derive from, or lead to lasting (essentially informal) networks – which will exist and work beyond the time span of the project funding itself. Furthermore, academic and professional societies have a respected track record of work with food safety – selected examples are detailed in Table 2.

Such societies obviously differ in the specifics of their structure, scope and activities; however, they all employ mechanisms based on membership, academic journals, professional publications, seminars and conferences – and an ever increasing number makes also use of internet facilities to link their communities and maintain them updated.

Consequently, the overall food safety field appears to be well served by a number of professional and learned societies – dealing with essentially all aspects of this broad (and broadening) subject; as a whole, they represent invaluable resources for sharing at many levels. However, sharing is in essence dependent on trust – in the transparency and competence of partners and entities, who are responsible for exerting discipline, as well as assuring credibility, transparency and honesty. In the context of food safety, trust is usually discussed in terms of the consumer – but it should be established and maintained throughout the various communities that interact within and with the food chain (van Kleef *et al*., 2006).

It is widely accepted that trust requires a long time and effort to be built, but a little time and effort to be compromised. As a constitutive principle, one trusts that the data and conclusions conveyed in publications of credible bodies have been previously scrutinized – internally within the research group and externally *via* peer-reviewing; in this case, trust is supported by the reputation of the scientific community itself. In other cases, trust is not supported by such an ethically based, robust system – but rather by intangible, often fragile mechanisms.

Three examples of challenges in food safety – that require sharing, materialize the importance of trust. First, there is the need to share outside of classical discipline-related communities – and hence to believe in people and information that are frequently distant from one's own area of expertise (Siegrist & Cvetkovich, 2000). Second, information and expertise – that are freely and voluntarily exchanged across the interface between industry and public agencies, are always much richer than those that are compulsorily exchanged (e.g. exposure assessments would be greatly accelerated if companies' in-house data were made openly accessible). Third, the amount of information that is passively and actively available on internet supports raises critical problems; alarmist E-mail messages concerning spurious risks related to food lie at one end of the spectrum, but these can be quite damaging – even if they appear to the informed professional as unfounded. The non-specialist consumer may likely be tempted to believe in otherwise apparently credible language, and alter his habits accordingly. Even if (and when) the message is exposed to the recipient as a hoax, it is still possible that the consumer will either harbor some doubts as to the counter-arguments used (i.e. a putative cover-up) or distrust further messages broadcasted *via* the same route. In either case, trust will be damaged to some extent in the short and medium runs. Particularly relevant to the above arguments is the realization that internet is a particularly rich source of information, for both consumers and manufacturers – so the truth and transparency of the information provided should to be double-checked by default (http://www.ific.org/newsroom/reporting/index.cfm – July 31st, 2008).

Digitally supported expression of data, coupled with computational capacity and free dissemination *via* the internet, have indeed revolutionized sharing in many disciplines pertaining to food safety. It is nowadays difficult to imagine quantitative risk exercises (including formal risk assessments) without probabilistic modeling software and electronically exchanged datasets: e.g. DNA sequences maintained in web-held databases constitute the grounds of epidemiological monitoring of food bacterial

Table 2. Selected world organizations working in the area of food safety

Name	Focus	Goal(s)	URL address[a]
SAFE: European Association for Food Safety	Stimulate public debate on several scientific aspects of food safety	Develop interdisciplinary research projects and partnerships	http://www.safeconsortium.org/
IAFP: International Association for Food Protection	Provide food safety professionals worldwide with forum to exchange information on protecting food supply	Address food safety in various disciplines	http://www.foodprotection.org/
IFT: Institute of Food Technologists	Advance science and technology of food through exchange of knowledge	Offer: undergraduate and graduate fellowships; science-based communications; career guidance programs; and science awards	http://www.ift.org/
IFST: Institute of Food Science and Technology	Professionally qualify food professionals in Europe	Bring together academia, government and industry	http://www.ifst.org/
EFFoST: European Federation of Food Science and Technology	Enhance interaction among food science and technology societies	Maintain collaborative network of research organizations within European food industry	http://www.effost.org/

[a] All sites accessed on July 31st, 2008.

contaminants. Virtual tools based on mathematical models have also been developed to simulate dynamic, food safety-related phenomena in foods. The most common are dedicated to predicting the behavior of microbial pathogens in foods – although the approach also permits prediction of migration of compounds from food-contact packaging materials into the food matrices themselves.

Conclusions

Science is critical to assure a safe food supply, so efforts have been made worldwide to ensure that the most appropriate questions are being asked to and answered by the science community – in an increasingly more participated way. However, scientific excellence is not a direct measure of usefulness with respect to food safety; and uncertainties, coupled with lack of representativeness of data often hamper establishment of satisfactory relationships between generation of knowledge and reduction of risk. On the other hand, research priorities in the food area have been set in a more transparent and open manner – not only in geo-political terms, but also in scientific scope; however, improved strategies and novel means of networking between stakeholders and policy makers are urged.

To foster sharing within classical applied science, and with interfacial social science communities, trust must be built up and preserved – and preferably include volunteer sharing of data pertaining to food and relevant to public health. Although learned societies and professional bodies – which are flourishing in the traditional scientific areas pertaining to food safety, have trust inbuilt into their nature, the same cannot be said of the new wave of sharing *fora* based on the internet. As a whole, new information technologies represent a genuine revolution as enabling tools – the most respected and successful of which have already addressed the question of trust in their strategies. One way or another, those *fora* used by the food safety science communities have managed to contribute to making the world smaller – and in doing so, they are making the food supply safer and safer.

References

CODEX ALIMENTARIUS. (2007). *17th Procedural manual*. Available from ftp://ftp.fao.org/codex/Publications/ProcManuals/Manual_17e.pdf. Accessed July 4th.

van Kleef, E., Frewer, L. J., Chryssochoidis, G. M., Houghton, J. R., Korzen-Bohr, S., Krystallis, T., et al. (2006). Perceptions of food risk management among key stakeholders: results from a cross-European study. *Appetite*, *47*, 46–63.

Motarjemi, Y., & Käferstein, F. K. (1997). Global estimation of foodborne diseases. *World Health Statistics Quarterly*, *50*, 5–11.

Polt, W. (2006). Lost in excellence? The discourse on scientific excellence and its gender dimensions – some observations from Austria. In: *OECD workshop on women in science, engineering and technology*. September 28–29, Ottawa. Available from http://www.oecd.org/dataoecd/31/14/37845339.pdf

Sargeant, J. M., Ramsingh, B., Wilkins, A., Travis, R. G., Gavrus, D., & Snelgrove, J. W. (2007). Constraints to microbial food safety policy: opinions from stakeholder groups along the farm to fork continuum. *Zoonoses and Public Health*, *54*, 177–184.

Siegrist, M., & Cvetkovich, G. (2000). Perception of hazards: the role of social trust and knowledge. *Risk Analysis*, *20*, 713–719.

Yeung, R. M. W., & Morris, J. (2001). Food safety risk: consumer perception and purchase behaviour. *British Food Journal*, *103*, 170–186.