



ARTICLE DE SYNTHÈSE

Safe Food, Fair Food: Participatory Risk Analysis for improving the safety of informally produced and marketed food in sub Saharan Africa

D. GRACE ¹✉, K. MAKITA¹, E.K. KANG'ETHE ², B. BONFOH³

¹ International Livestock Research Institute, PO box 30709, Nairobi, Kenya

² University of Nairobi, Kenya

³ Centre Suisse de Recherches Scientifiques en Côte d'Ivoire, Abidjan

✉ Correspondance et tirés à part, e-mail : D.GRACE@CGIAR.ORG

Abstract

Millions of small-scale farmers efficiently supply the great majority of the meat and milk market in Africa. Surging demand for livestock products (the "livestock revolution") is an unprecedented opportunity for setting poor farmers on pathways out of poverty, but to gain maximum benefit they must be able to produce safe food of acceptable quality. Currently, most smallholder livestock products are sold in informal markets where conventional regulation and inspection methods have failed and where private or civil sector alternatives have not emerged: as a consequence, most livestock-derived food products contain high levels of hazards. Quantitative risk-based approaches for assessing and managing food safety offer a powerful new method for reducing the enormous health burden imposed by food borne disease, while taking into account other societal goals such as pro-poor growth. However, application to food safety problems in Africa has been limited. We discuss some of the constraints and a new approach which can help overcome these: Participatory Risk Analysis, and give examples of its current application in west, east and south Africa (*RASPA*, 8 (S) : 3-11).

Key – Words: Animal - Safety - Food - Risk analysis - Participation - Informal.

Résumé

Aliments sain, Aliments équitables : Analyse participative des risques pour l'amélioration de la sécurité des aliments produits et vendus dans le secteur informel en Afrique sub-saharienne

Les millions de petits producteurs offrent efficacement la viande et le lait à la majorité de la population en Afrique. La forte demande en produits animaux (révolution de l'élevage) est non seulement une opportunité sans précédent pour les paysans dans leur processus de sortie de la pauvreté, mais pour maximiser leurs bénéfices, ils devraient être capables de produire des aliments sûrs et d'une qualité acceptable. Aujourd'hui, la plupart des produits vendus dans les marchés informels où les méthodes conventionnelles réglementaires et d'inspection ont échoué et où les alternatives du secteur privé ou civile n'ont pas émergé. Comme conséquence, les denrées d'origine animale contiennent des niveaux élevés de dangers. En prenant en compte les objectifs sociaux émergeant comme le pro-pauvre, l'approche quantitative du risque utilisée dans l'évaluation et la gestion de la sécurité des aliments offre une nouvelle méthode robuste dans la réduction du fardeau des maladies imposées par les pathologies d'origine alimentaire. Pourtant, l'application aux problèmes de la sécurité alimentaire est très limitée en Afrique. Nous discutons de certaines des contraintes et les nouvelles approches : Analyse Participative des Risques qui pourraient aider à juguler ces problèmes et donner des exemples d'applications en Afrique de l'Ouest, Est et Sud.

Mots-clés : Animal - Sécurité - Aliment - Analyse de risque - Participation - Informel

Introduction

Population increase, urbanization and changing consumption habits are driving the so-called Livestock Revolution in which millions of small-scale farmers, many of them women, supply the surging demand for livestock products [11]. Most meat, milk, eggs, and fish is sold in informal markets where food safety regulation and inspection has failed and alternatives have not emerged. The result is high levels of unsafe food amongst poor consumers and increasing threats of constrained access to higher value markets for small-scale producers. In short, the food we consume is neither safe nor fair. Safer food can generate both health and wealth for the poor,

but attaining safe food and safe food production in developing countries requires a radical change in food safety assessment, management and communication. This review paper traces key issues of food safety in sub-Saharan Africa and argues that while risk analysis is in general linear and a promising approach it requires adaptation to the context of informally marketed food in poor countries.

The importance of the informal food sector in sub Saharan Africa

In developing countries, incomes are low, governments weak, and enforcement of regulation poor; as a result,

the informal sector is large, accounting for 39% of GDP [16]. Previously undervalued, the informal sector is now recognised as an important provider of employment and engine of economic growth.

During the 1970s and 1980s, the informal sector was widely defined as unregulated economic enterprises or activities [27]. Recent definitions have expanded to include small businesses, employment without worker benefits or social protection (both inside and outside informal enterprise); own account workers; unpaid family workers (in informal and formal enterprises); and members of informal producers' cooperatives [30]. In the food sector, informality has the additional meaning of escaping any systematic sanitary inspection [5] and tax payment. In Africa, agriculture, petty trading of agricultural products, and selling food have always been largely informal activities.

By these definitions, most food in Africa is produced, processed, and sold in the informal sector. For example, in Kenya, Uganda, and Mali, raw milk produced by smallholders and sold by vendors or small-scale retailers, accounts for an estimated 80%, 90%, and 98% of marketed milk in each country, respectively [8], [42]. This is an important source of income not only for small-scale producers (e.g. 600,000 farm households in Kenya) but also for intermediaries along the milk value chain such as transporters, hawkers and processors (365,000 intermediaries in Kenya) [49]. Food processing and vending is especially important for women: in Ghana and Mali, small-scale processors, exclusively female, produce a wide range of products including: ghee, soft cheese, hard cheese, fermented milk, yoghurt, and porridge [48]. Qualitative studies in east and west Africa showed the importance of informal sector production to poor households and how this varies by gender: In Bamako women are gradually marginalized in dairy sector and develop resilience to sustain their livelihood [48] while in Ibadan, Nigeria, men reared livestock to solve immediate problems like paying school fees or medical expenses, purchasing foodstuffs and paying house rent while women discussants said that they reared livestock to assist their husbands in feeding the household in times of hardship [41].

High levels of hazards in informally marketed food

As a rule of thumb, all studies that have looked for problems in informally marketed food have found them. A series of epidemiological studies on food safety in

domestic markets was conducted by the International Livestock Research Institute and national partners in East Africa, Institut du Sahel/Swiss Tropical Public Health in West Africa, Frei Universitat Berlin graduate students in Ethiopia and University of Pretoria graduate students in South Africa. In Kenya, Tanzania, Uganda, Ethiopia, Ghana, Mali and South Africa, studies on meat and milk products have confirmed significant rates of food adulteration, inadequate processing, high microbial loads and specifically evidence of hazards responsible for diseases, such as brucellosis, tuberculosis, listeriosis, salmonellosis, diarrhoeagenic coliosis, cryptosporidiosis, cysticercosis, staphylococcosis, as well as antimicrobial residues, chemicals and mycotoxins [1], [4], [7], [25], [31], [36], [37], [40], [43]. In Kenya, Ghana, Mali and South Africa, traditional products have been investigated (fermented milk, cheese, and biltong) – the finished product typically has lower levels of hazard than the raw ingredients, showing how food processing can be risk mitigating, but still a substantial proportion of products were not safe for human consumption.

And the burden of food-borne disease is high

Food-borne disease is one of the most important health problems in developing countries. Responsible for an estimated 2 billion annual episode of gastrointestinal disease each year (18), as much as 70% of deaths among children under 5 are linked to biologically contaminated food and water (51). In countries where detailed attribution data exists, most of the burden of food-borne disease is the result of zoonotic pathogens (35). For example, of the nine most important culture-confirmed pathogens in the USA, seven have an animal reservoir and more than 75% of identified illness is caused by just three zoonotic, food-borne pathogens: *Salmonella* spp., *Listeria monocytogenes*, and *Toxoplasma gondii*. Between 1998 and 2002, most (69%) food-borne disease outbreaks with an identifiable vehicle were caused by animal-source foods. Poultry was the food most often implicated (25%) but beef, pork, shellfish and finfish were also important, each causing over 10% of the total. In the United Kingdom a similar pattern is seen. There, food safety authorities have developed a method for estimating the relative risks associated with specific foods, dividing the number of cases due to a specific food (as derived from their outbreak database) by the estimated total servings of that food consumed in a year. In the four years from

1996 to 2000 most illness was attributed to eating poultry (30%), complex foods (27%), and red meat (17%) (2).

The impacts of food-borne disease include fatalities in vulnerable groups (e.g. malnourished infants and people with HIV/AIDS) and, in 2-3% of cases, severe and disabling long-term effects such as joint disease, kidney failure, cardiac, retinal and neurological disorder. The latter chronic sequelae, of which many policy-makers are unaware, probably represent a greater health and economic burden than the acute disease [33]. Evidence is growing that in developing countries, ill health can not only be a personal and household tragedy, but a major factor in causing and perpetuating poverty [13].

But hazards are not risks

All of above studies focused on the identification of hazards in animal-source foods, but did not estimate the impacts of the hazards in terms of human sickness and death. Without this information it is difficult for decision makers to rationally allocate resources for risk management. Furthermore, identification of hazards has led to media scares and consequent loss of confidence in livestock resulting in dramatic drops in consumption with negative impacts on the livelihoods of those engaged in the food value chain and consumer nutrition. Hence, the need for approaches that identifies risk to human health rather than the presence of hazards, and which include risk management appropriate for poor producers and other intermediaries.

For example, studies on milk in East Africa found that although zoonotic hazards were present in as much as 1% of household milk samples, infections in people were at least two orders of magnitude less common [23]. Consumers' widespread practice of boiling milk dramatically reduced the risk of disease, while the small volumes of milk produced and handled per informal sector agent decreased risk of cross-contamination. Another study on *Cryptosporidium parvum*, a zoonosis whose main reservoir is cattle, found that the major source of risk was not from consuming milk or direct contact with cattle but rather from eating vegetables [22]. These examples show how common-sense management which focuses on controlling the level of zoonotic hazards in milk and other foods may not have much effect on decreasing the risks to human health whereas other approaches that focus not on the hazard but on the risk to human health and its sources may be more fruitful.

And food safety can have high costs

While appreciation has grown of the high costs of food-borne disease, the costs of food safety are sometimes forgotten. Urbanisation, globalisation, technological change and agricultural intensification are changing the domestic markets for livestock products on which the poor depend [11]. As markets evolve, formal standards will become more demanding and more widely applied; private sector standards will proliferate; the types and levels of standards will be influenced by the North rather than the South; and the costs of meeting standards will fall disproportionately on small producers [10]. This retail revolution is occurring more slowly in sub-Saharan Africa, but change is already evident - in Kenya supermarkets are growing at 18% per year and reached 20% of urban food retail by 2003 [39]. With changing markets and demand, quality and supply chain management are becoming key to market access and competitiveness [46]. Smallholder production is expanding, but there is little evidence of improvements in the market orientation or development of the appropriate market governance and institutions (organisations, practices, rules and procedures, norms and standards for quality and safety) needed for smallholders to exploit higher end markets [34]. Indeed, reviewing studies of hazards in informal markets suggests smallholder farmers are unlikely to produce food of adequate safety and quality in the absence of incentives and support [32]. This excludes poor farmers from the higher value niche markets (both international and domestic), which, although small, have potential to contribute to poverty reduction [12] and more importantly, raises the real possibility that poor farmers will lose market share, miss out on opportunities offered by the livestock revolution, and become increasingly marginalised [45]. As well as these opportunities lost, the inability of the smallholder value chain to meet safety standards exposes participants to recurrent transaction costs from rent-seeking behaviour by officials, and periodic shocks from draconian, but poorly implemented, campaigns to eradicate informal sector operators [9]. In Kenya, for example, the costs incurred by milk traders as the result of operating informally included bribes to police, discarded milk and confiscated milk cans: these amounted to 38% of the total market margins accruing to traders (total revenues less procurement costs) [47]. These 'command and control' regulations might be justified if they were demonstrably effective in improving

food safety. However, this may not be the case. A study on peri-urban dairying in Kampala, found that farmers' who (incorrectly) believed that urban dairying was legal, were more likely to carry out risk mitigating procedures such as use of metal milk containers and washing with hot water and disinfectant [21]. This paradoxical effect of food safety legislation was also found in a Brazilian study of the meat sector: the rationale being that illegality chills investment, blocks access to information on, and reduces social incentives to follow good practices [5].

Risk analysis is a promising approach to improving food safety

Faced with this complex challenge of high levels of hazards in informal food, but little understanding of the risks these represent to human health along with the empirical evidence that small scale food production and processing is an important pathway out of poverty and that existing food safety regulation is often ineffective and anti-poor, we argue new approaches are needed. Historically, hazards associated with livestock and animal-source foods were managed through 'command and control' regulation involving inspection of production, transformation and sale backed with litigation in the event of harm. This approach was increasingly unable to deliver food safety, as demonstrated by highly-publicized tragedies (such as the E. coli outbreak in USA in which four children died and the BSE epidemic in the UK) [3]. This led to a shift in approach from compliance with procedures enforced by external inspection to self-management of risk by empowered organizations. Risk-based approaches brought new insights and are now standard for food-safety issues in developed countries,

as well as being the basis of rules governing international trade in food products and are endorsed by the Food and Agriculture Organisation (FAO), World Health Organisation (WHO) and World Animal Health Organisation (OIE). One of the first risk-based methodologies was Hazard Analysis Critical Control Point (HACCP), a structured approach to assessing potential hazards, deciding which points are critical to safety, monitoring these and taking specified remedial action in the event of deviations [29]. HACCP is widely recognized as an effective and economically efficient approach to food safety control in food processing operations, predominantly because it is based on risk assessment and process control rather than end-product testing: it is starting to be applied to traditional food production systems in developing countries and preliminary results are encouraging [52]. Microbial risk assessment (MRA) is an emerging tool for evaluating the safety of food and water supplies; it takes a systems and pathway approach (farm to fork) allowing an assessment to be made of the health risk to the population of interest from specific pathogens, foods or pathogen/food combinations [20].

For the last decade risk analysis has convincingly dominated food safety and trade in animals and animal products. It offers a science-based, structured, transparent method for answering the questions that matter to policy makers and public alike: Is this food safe? Is the risk big and important? What efforts are appropriate to reduce the risk? Risk analysis has three components: risk assessment, risk management, and risk communication (Figure 1). The first step is risk assessment, which provides both an estimate of harm and the probability of harm occurring.

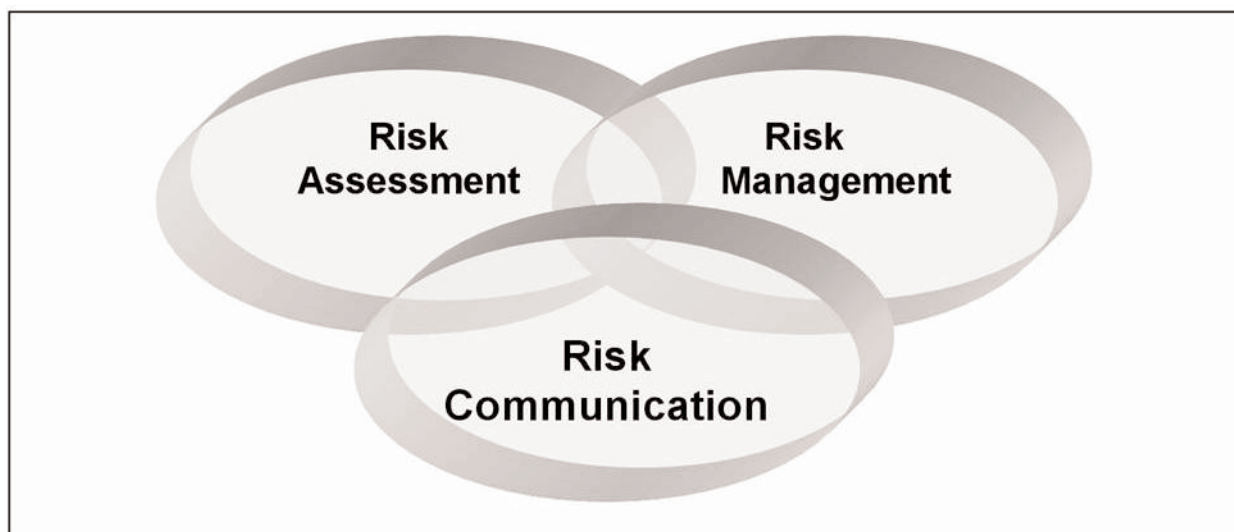


Figure 1: Components of risk analysis

To be useful, risk assessment must be followed by action to mitigate those risks which are unacceptable to stakeholders. Risk management uses pathway approaches (from stable to table) and probabilistic modelling to identify critical control points and apply strategies to remove or minimise risk. The third component and integral component of risk analysis, is risk communication – the iterative process of communicating risk to those affected by it and incorporating their feedback into risk assessment and management. Risk analysis offers a new approach to managing food safety. Not only is it more effective at decreasing risks, but it can also be a bridge joining food safety and livelihood concerns. The first component of risk analysis, risk assessment, generates an estimate of negative health impacts of a hazard as well as the likelihood of their occurrence. This information can then be compared with economic data on the costs and benefits of smallholder production and marketing (including externalities such as income opportunities for poor women or environmental degradation from abattoirs), and the costs and benefits of risk mitigation. This allows decision-makers to set appropriate levels of protection based on evidence rather than anecdote and subjective preference. Moreover, the focus on a ‘farm to fork’ pathways approach allows the identification of risk mitigation points along the food value chain. This can help identify interventions that maintain market access for smallholders.

Risk analysis is also compatible with the development aims of African governments as shown by a recent regional conference in which African countries, recognising the importance of food safety and their limited capacity to assure it, called for a risk analysis approach and capacity building at national level [17].

Quantitative microbial risk analysis (QMRA) is a new discipline but it is grounded in the disciplines of chemical and toxicological risk analysis which were developed around the middle of the last century. The first papers applying these methods to the problem of human health risks from exposure to pathogens were published in the 1970s [19] and since then the methods have been extensively applied to problems of food and water safety [14], [26].

Criticisms of risk analysis

Like all dominant ideas, risk analysis is not without its critics. These vary from those who think risk analysis is a sound methodology but requires some improvements, to those who regard it as deeply flawed and liable to abuse.

In the latter category, are some citizens groups that oppose a particular industry or decision and frequently criticize the methods and results of risk assessment. They argue that risk analysis is overly quantitative and reductionist and doesn't take into account people's legitimate concerns and that information emerging from risk assessments are meaningless or invalid. Some go even further, believing that risk assessment is part of a conspiracy organized by agro-business. While many of these concerns refutable on technical grounds, this does not address the underlying fears and concerns that lead many to reject, for example, vaccines, genetically modified foods, pasteurized milk or fluoridated water.

This is partly a problem of lack of trust in authorities and is symptomatic of exclusion of stakeholders from decision making and power. Based on previous analysis and research, we believe that incorporating participatory methodologies can improve stakeholder engagement in risk analysis. Since their introduction in the 1970s, participatory methods and techniques have become central tools for community development and have been applied in a variety of contexts and sectors. They are promoted on the basis that they are more effective, more sustainable and less costly and more ethical in their inclusion of the poor in the planning and decisions that affect them [15], and have been extensively used by in livestock research. Sophisticated participatory methods acknowledge power imbalances, vested interests and incentives and employ methods such as stakeholder analysis, outcome mapping and various participatory tools such as power mapping and triangulating with different groups to better incorporate viewpoints while preventing capture of the agenda.

Another objection to risk analysis, which is commonly encountered in discussions with food safety experts in developing countries, is that risk analysis is a method for making improvements at the margins. That is, when food standards are already quite high it may be useful, but at the very low levels of hygiene and safety found in the informal sectors of most poor countries, attention should focus on basic hygiene and good practices. Although there is some merit in this, we have earlier in the paper argued that without a structured, systematic and risk-based decision making process, stakeholders may make decisions which are obvious, but wrong. It has been long known that people are very poor at assessing probability and risk [44], [50]: to highlight just a few of the commonly identified biases we exaggerate spectacular but rare risks and downplay common risks (food poisoning versus cancer); we underestimate risks we feel in control over and overestimate those we can't control (microbial hazards versus chemical hazards in food); and we are more concerned by visible, dramatic signs (cysticercosis

versus salmonella in pork).

We occasionally hear that in countries which are food insecure, food safety cannot and should not be a priority. This attitude is being replaced with a more holistic perspective that sees food security and food safety as inter-dependent. However, there is a plausible case that attitude towards risk depends upon stage of social development. In *Risk Society*, BECK [6] argued that modern science and technology have created a society in which the creation of wealth has been overtaken by the production of risk; the primary concerns of “industrial” or “class” societies - the production and equitable distribution of wealth - have been replaced, he said, by the quest for safety. In the former risk is seen as natural or intrinsic while in the latter risk is often viewed as man-made or extrinsic. The implication is a) the current attitude towards food safety in post-industrial societies is often dysfunctional even for them and b) this is not a model which it will be useful to extend to developing countries.

Applying risk analysis

Despite these objections, in rich countries risk analysis is current best practice and the keystone of both domestic food safety regulation and international trade. However, its use in developing countries has been limited. In particular, it has not been applied to the domestic markets where most poor people sell and buy food, yet where levels of hygiene and safety are lowest, and vulnerability to food-borne disease highest. The failure to put risk analysis into practice, despite support from the highest levels, has been attributed to lack of appropriateness for developing country circumstances [24]. Microbial risk assessment originated in the very different context of food- production in developed countries. These systems tend to be large-scale, high-volume, mechanised, standardised, and well-documented, while developing countries have diverse, non-linear, shifting, and data-scarce systems in which formal and informal (or traditional) food supply systems co-exist and overlap; views of various stakeholders on food safety objectives diverge; there is low consumer willingness or ability to pay among consumers for improved food quality, and low enforcement capacity. It is hardly surprising that radical adaptation is needed for risk-based approaches to work in these environments.

Recent years have seen much interest in adapting risk analysis for developing countries. In Africa, two research groups are currently working on this: one at the Centre Suisse de Recherches Scientifiques en Cote d'Ivoire and the other at the International Livestock Research Institute in Kenya.

The project aims to support intensifying livestock production by improving the management of safety of livestock food products, thus maximising market access for the poor dependent on livestock while minimising the food borne disease burden for poor consumers, by adapting the risk-based approaches successfully used for food safety in developed countries and international trade to domestic informal markets where most livestock products are sold. The main strategies are: building capacity in risk analysis through post graduate training linked to proof of concept studies; winning-over key decision makers through participation in project activities; raising awareness of stakeholders through workshops and generation and dissemination of research results on food safety.

A central concept of the project is that capacity building is only effective when people get the chance to put their knowledge and skills into practice. Hence the project links training in Participatory Risk Analysis with proof of concept studies that not only build core capacity in risk analysis but produce evidence that can convince decision makers of the value of this approach. Table 1 shows the research topics being covered; the projects range from risk assessment to management to communication and include quantitative and qualitative (including participatory methods). Multi-disciplinarity and transdisciplinarity are key to this new approach to risk analysis: anthropologists, economists, sociologists, microbiologists, veterinarians and food chain stakeholders have all been involved in these projects. Although the project is still in the implementation phase some interesting research results are already emerging, as the following examples show. A study on game meat sold by street food vendors in South Africa found microbiological quality was adequate: a reminder that even though there are often problems in informal markets they can deliver safe food. It also showed that although price was the most important criterion for poor consumers around half were also concerned over meat freshness, a proxy for safety [28]. A study on brucellosis in peri-urban Nairobi found that although brucellosis was present, the risk to human health was very low because of the universal practice of boiling before consumption. However, consumption of fermented unboiled milk was identified as a potentially risky practice requiring further investigation [38]. A study on home produced dried meat in South Africa found that changing consumer preferences (for moister meat) was driving changes in processing (to increase moisture content). This means that previous understanding of the safety of dried meat and existing regulations are no longer relevant.

Table 1: Participatory Risk Analysis topics in Africa

Country	Title
Kenya	1. A beef value chain risk analysis using HACCP principles at 3 abattoirs in Nairobi, Kenya
	2. Assessment of milk from smallholder dairy farms in Nairobi and Eldoret based on the pH and the bacteriological quality
	3. Risk assessment for <i>Escherichia coli</i> in beef value chain in Nairobi
	4. Risk assessment for brucellosis in dairy value chain in Kasarani Division, Nairobi
Tanzania	5. Food safety in milk markets of smallholder farmers in Tanzania: A case study of Temeke Municipality
	6. Food safety risk analysis and marketing access of beef in Arusha Municipality, Tanzania
Ethiopia	7. A risk assessment of <i>Staphylococcus aureus</i> poisoning through consumption of raw milk produced by Ada Dairy Corporative farmers in Debre Zeit, Ethiopia
Côte d'Ivoire	8. Bifidobacterium inhibition potential of pathogens isolated from cow milk in Côte d'Ivoire
	9. Analysis and management of contamination risks from pathogens in Abidjan : case of <i>Bacillus cereus</i> , <i>Staphylococcus aureus</i> , <i>Salmonella</i> and <i>Escherichia coli</i> O157
	10. Risk analysis of Polycyclic Aromatic Hydrocarbon in smoked fish in Côte d'Ivoire
Mali	11. Brucellosis risk analysis with regard to small ruminant milk consumption in Cinzana, Mali
	12. Vulnerability to, representation and perception of quality and risk among pastoral communities in Cinzana, Mali
Ghana	13. Risk assessment of <i>Listeria monocytogenes</i> in raw milk from the informal market in Ghana
Mozambique	14. Pre-requisites for Hazard Analysis Critical Control Points in abattoirs
South Africa	15. Hazard analysis of local meat products (biltong)
	16. Risk assessment and animal welfare of slaughtering in tribal rituals in South Africa
	17. Risk assessment of game meat and formal-informal value chain crossover in South Africa
	18. Risk assessment of informal poultry value chain in Pretoria, South Africa
	19. Participatory risk assessment on game products marketed through formal and informal chains: Hazard identification and risk assessment

A situational analysis of food safety in Ghana confirmed that the great majority of food consumed escapes inspection and that, as in many countries, multiple and overlapping responsibilities for food safety hinder public sector effectiveness.

Developing country informal markets are characterised by non-linear, unregulated, heterogeneous and self-organising food value chains. In this difficult context, conventional food safety based on command and control regulation often fails and risk-based approaches are considered better bets. The challenges we encountered of applying risk-based approaches included: the lack of pre-existing information; great diversity of structures and practices; difficulties of working with informal sector participants due to poor relations with officials; and problems of carrying out laboratory analyses given extreme environmental conditions and lack of equipment and skilled staff. We responded to these challenges by extensive use of qualitative analyses to capture

uncertainty, diversity and complexity; incorporation of Participatory Learning and Action methods to engage study respondents and generate ownership; and adoption of novel rapid and robust laboratory tests for quality assessment.

The results generated, though with wide margins of error and limitations to generalisation, represented a major improvement on the pre-existing situation, where stakeholders had essentially no information on the harms present in informally marketed foods and base regulations on practices at best on the presence of hazards and more commonly on the basis of opinion and tradition. The case-studies mentioned in this paper, though not yet completed, support the hypothesis that risk-based approaches may be a useful way of addressing food safety problems in informal markets. However, these approaches will need continued adaptation, testing and dissemination.

References

1. ABOGE G.O.; KANG'ETHE E.K.; ARIMI S.M.; OMORE A.O.; MCDERMOTT J.J, et al., 2000.- Antimicrobial agents detected in marketed milk in Kenya. Paper presented at 3rd All Africa Conference on Animal Agriculture and 11th Conference of the Egyptian Society of Production, 6-9 November 2000, Alexandria, Egypt.
2. ADAK G.K.; MEAKINS S.M.; YIP H.; LOPMAN B.A.; O'BRIEN S.J. 2005. - *Emerging Infect. Dis.*, 11:365.
3. ANON, 2001. - Defining incidents leading to changes in food safety policy. Food Safety Policy, Science, and Risk Assessment: Strengthening the Connection: Workshop Proceedings Food Forum, Food and Nutrition Board, National Academies Press, USA.
4. ARIMI S.M.; KOROTI E.; KANG'ETHE E.; OMORE A.O.; MCDERMOTT J.J. 2005.- Risk of infection with *Brucella abortus* and *Escherichia coli* O157:H7 associated with marketing of unpasteurised milk in Kenya. *Acta Tropica* 96(1):1-8.
5. ASVEDO P.F.; BANKUIT F.I. 2002.- When Food safety concern decreases safety: evidence from the informal meat market. *International Society for New Institutional Economics*.
6. BECK U. 1992.- Risk Society: towards a new modernity. Sage: London.
7. BONFOH B. ; FANE A. ; STEINMANN P. ; HETZEL M. ; TRAORE A.N. et al., 2003.- Qualité microbiologique du lait et des produits laitiers vendus au Mali et leurs implications en santé publique. *Etudes et recherches sahéliennes* 8-9:19-27.
8. BONFOH B., FOKOU G., OULD TALEB M., FANE A., WOIRIN D., LAIMAIBAO N., ZINSSTAG J. 2007.- Dynamiques des systèmes de production laitière, risques et transformations socio-économiques au Mali. *Revue Elev. Méd. vét. Pays trop.*, 2007, 60 (1-4) : 67-76.
9. BRYLD E. 2003.- Potentials, problems, and policy implications for urban agriculture in developing countries. *Ag Hum Values* 20: 79-86.
10. CASWELL J.A. 2003.- Food safety in food security and food trade: Trends in Food Safety Standards and Regulation: Implications for Developing Countries. Brief 4, International Food Policy Research Institute, Washington DC.
11. DELGADO C., ROSEGRANT M., STEINFELD H., EHUI S., COURBOIS C. 1999.- Livestock to 2020: the next revolution. Food, Agriculture, and the Environment Discussion Paper 28, a joint publication of International Food Policy Research Institute (IFPRI), Food and Agriculture Organization of the United Nations (FAO), and International Livestock Research Institute (ILRI), Washington DC, 72 pp.
12. DFID 2004.- Agricultural trade and poverty reduction: opportunity or threat? Agriculture and Natural Resources Team. Department for International Development, London, UK.
13. DFID, 2001.- Better health for poor people: Target Strategy Paper. Department for International Development, London, UK.
14. DUFFY et al., 2006.- A review of quantitative microbial risk assessment in the management of *Escherichia coli* O157:H7 on beef.
15. DURAIAPPAH A.K.; RODDY P.V.; PARRY J.E. 2005.- Have participatory approaches increased capabilities? IISD Publications Centre. International Institute for Sustainable Development, UK.
16. ENSTE D.; SCHNEIDER F. 1998.- Increasing shadow economies all over the world - fiction or reality? A survey of the global evidence of their Size and of their Impact from 1970 to 1995. IZA: Discussion Paper No. 26.
17. FAO/WHO. 2005.- Food safety risk analysis, an overview and framework manual. FAO (Food and Agriculture Organisation of the United Nations)/WHO (World Health Organisation), Rome, Italy and Geneva, Switzerland.
18. FLINT J.A. ; VAN DUYNHOVEN Y.T. ; ANGULO F.J. ; DELONG S.M., et al. 2005.- Estimating the burden of acute gastroenteritis food borne diseases and pathogens commonly transmitted by food: an international review. *Clinical Infectious Diseases*, 41, (5) 698-704.
19. FUHS O.W. 1975.- A probabilistic model of bathing beach safety. *Sci Total Environ.* 4(2):165-75.
20. GIACCONE V.; FERRI M. 2005.- Microbiological quantitative risk assessment and food safety: an update. *Veterinary Research Communications*, 29 (Suppl. 2) (2005) 101-106.
21. GRACE D.; NASINYAMA G.; RANDOLPH T.F.; MWINE F.; KANG'ETHE E. 2008.- City dairying in Kampala: integrating benefits and harms Cole D., Lee-Smith D., Nasinyama G. (Eds) Healthy city harvests: Generating evidence to guide policy on urban agriculture. International Potato Center (CIP) and Makerere University Press.
22. GRACE D.; OMORE A.; KANG'ETHE E.; NASINYAMA G.; RANDOLPH T. 2008.- Risk analysis – an emerging ecohealth perspective? International EcoHealth Forum 2008 (IEF 2008), Merida, Dec 1st -5th, 2008.
23. GRACE D.; OMORE A.; RANDOLPH T.; MOHAMMED H.; 2006. - An assessment of the risk of acquiring *Escherichia coli* O157:H7 from consuming informally marketed milk in Kenya. Proceedings of the KARI Scientific Conference, November 2006, Nairobi, (in press).
24. GRACE D.; RANDOLPH T.; OLAWOYE J.; DIPELOU M.; KANG'ETHE E. 2008.- Participatory risk assessment: a new approach for safer food in vulnerable African communities. *Development in Practice*, Volume 18, Issue 4 & 611 – 618.
25. GRACE D.; RANDOLPH T.; OMORE A.; SCHELLING E.; BONFOH B. 2007.- Place of Food Safety in Evolving Pro-Poor Dairy Policy in East and West Africa. *Revue d'élevage et de médecine vétérinaire des pays tropicaux*. 60 (1-4) : 153-162.
26. HAAS C.N.; ROSE J.B.; GERBA C.P. 1999.- Quantitative microbial risk assessment. John Wiley & Sons, Inc., New York.
27. HART K. 1973.- Informal income opportunities and urban employment in Ghana. *Journal of Modern African Studies*, 11, 61–89.
28. HEEB ALEXANDER W. 2009.- Participatory risk assessment on game products marketed through formal and informal chains: Hazard identification and risk assessment. Master Thesis, University of Hohenheim.
29. HULEBAK K.L.; SCHLOSSER W. 2002.- Hazard analysis and critical control point (HACCP) history and conceptual overview. *Risk Analysis*, 22(3):547-52.
30. ILO. 2002.- Women and Men in the Informal Economy: A Statistical Picture. Geneva: ILO.
31. KANG'ETHE E.K.; ABOGE G.O.; ARIMI S.M.; KANJA L.W.; OMORE A.O.; MCDERMOTT J.J. 2005.- Investigation of the risk of consuming marketed milk with antimicrobial residues in Kenya. *Food Control*, 16(4):349-355.
32. KANG'ETHE E.K.; GRACE D. 2007- Overview of urban agriculture. (Accepted East African Medical Journal).
33. LINDSAY J.A. 1997.- Chronic sequelae of food-borne disease. *Emerging Infectious Disease*; 3 (4):443-52.
34. LUOGA W. 2004.- Effect of Market Access on dairy performance and market orientation of smallholder farmers in Rungwe District, Mbeya. M.sc. Thesis. Department of Animal Science, Sokoine University of Agriculture, Tanzania.
35. LYNCH M.; PAINTER J.; WOODRUFF R.; BRADEN C. 2006. - MMWR CDC Surveill. Summ., 55:1.
36. MENGISTIE A.Z. 2003.- Molecular epidemiology of *Staphylococcus aureus* and *Streptococcus agalactiae* isolated from bovine mastitis in Ethiopia. Dissertation Free University Berlin, Berlin, Germany.
37. MOHAMMED A.; BECKER H.; TERPLAN G. 1996.- Vergleichende Untersuchungen zum Nachweis von Salmonellen in äthiopischem Hüttenkäse (Ayib) mit verschiedenen kulturellen Verfahren. *Archiv für Lebensmittelhygiene*. 47, (4): 83-90.
38. NDONGO FLAVIEN K., 2009.- Choice of breeds and husbandry practices influencing the safety of milk and milk products from

- smallholder dairy cattle farms around Nairobi, focusing on Brucellosis. Master Thesis, University of Hohenheim.
39. NEVEN D.; REARDON T. 2006.- The rise of Kenyan supermarkets and evolution of their horticulture product procurement systems: Implications for agricultural diversification and smallholder market access programs. *International Food and Agribusiness Marketing*, 18(3) (forthcoming).
40. O FERRALL-BERNDT M.M. 2003.- A comparison of selected public health criteria in milk from milk-shops and from a national distributor. *Journal Of The South African Veterinary Association* (74); 2, 35-40.
41. OLAWOYE J, 2006.- Improving benefits of urban and peri-urban livestock production through management of associated human and environmental health risks in Nigeria. Prepared for ILRI, Kenya Report of the Socio-Economic Study, International Livestock Research Institute, Nairobi, Kenya.
42. OMORE A.; ARIMI S.; KANGETHE E.; MCDERMOTT J.; STAAL S.; 2002.- Assessing and managing milk-borne health risks for the benefit of consumers in Kenya. Smallholder Dairy Project Research Report. International Livestock Research Institute (ILRI), Nairobi, 49 pp.
43. OMORE A.; STAAL S.J.; OSAFO E.L.K.; KURWIJILLA L.; BARTON D.; et al., 2004.- Market mechanisms, efficiency, processing and public health risks in peri-urban dairy product markets: synthesis of findings from Ghana and Tanzania. Final Technical Report for LPP Project R7321. International Livestock Research Institute, Nairobi, Kenya.
44. PAUL SLOVIC. 2000.- The Perception of Risk, Earthscan Publications Ltd, 2000.
45. PERRY B.D.; NIN-PRATT A.; SONES K.; STEVENS C. 2005.- An appropriate level of risk: balancing the need for safe livestock products with fair market access for the poor. Pro-poor Livestock Policy Initiative Working Paper No. 23, a joint publication of Food and Agriculture Organization of the United Nations (FAO) and International Livestock Research Institute (ILRI), Rome, 73 pp.
46. REARDON T.; TIMMER P.C.; BARRETT C.; BERDEGUE J. 2003. - The rise of supermarket chains in Africa, Asia and Latin America. *American Journal of Agricultural Economics* 85, 1140-6.
47. SALASYA B.; RICH K.; BALTENWECK I.; KAITIBIE S.; OMORE A.; FREEMAN A.; STAAL S. 2006.- Quantifying the economic impacts of a policy shift towards legalizing informal milk trade in Kenya. Markets Theme Discussion Paper No. 1. International Livestock Research Institute (ILRI), Nairobi, Kenya.
48. SCHNEIDER M., KOUYATE H., FOKOU G., ZINSSTAG J. TRAORÉ A., AMADOU M., BONFOH B. 2007.- Dynamiques d'adaptation des femmes aux transformations des systèmes laitiers périurbains en Afrique de l'Ouest. *Revue Élev. Méd. vét. Pays trop.*, 2007, 60 (1-4) : 121-131.
49. SDP, 2004a.- Employment generation in the Kenya dairy industry. SDP Policy Brief No. 2. Smallholder Dairy (R&D) Project.
50. TVERSKY A.;KAHNEMAN D. 1974.- "Judgment under Uncertainty: Heuristics and Biases," *Science*, 1974, 185: 1124-1131.
51. UNNEVEHR L.; HIRSCHHORN N. 2000.- Food safety issues in the developing world. World Bank Technical Paper No. 469. The World Bank, Washington DC, 72 pp.
52. ZAKHIA N. 2000.- Adaptation of a quality assurance methodology to traditional fish drying in Mali in food safety management in developing countries. Proceedings of an international workshop, 11th -13th Dec, 2000. Montpellier, France.

