

# **FOOD SAFETY IN THE CGIAR**

## IFPRI-CGIAR Science Council Roundtable on Food Safety

Report and Recommendations  
arising from a joint IFPRI-  
Science Council sponsored  
Roundtable on possible  
approaches to Food Safety  
Research in the CGIAR

DECEMBER 2007



SCIENCE COUNCIL

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**CGIAR**



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## Science Council Commentary on Food Safety Research in the CGIAR

The Science Council continues to study and support approaches which enhance the CGIAR's scientific research agenda for the alleviation of poverty, hunger and malnutrition. Food safety is an important research area that has direct or indirect relevance to a number of CGIAR's System Priorities, especially Priorities 2A (germplasm improvement of staples), 2C (enhancing nutrient quality and safety), Priority area 3 (value addition in various commodities), and Priority 5B (research on markets). In particular, it was suggested that the CGIAR should consider undertaking research to assist poor producers to be competitive, as increasingly stringent food safety standards, such as demanded by supermarkets or for the export market, will leave the small producers out of opportunities for improving incomes.

The SC has worked in consultation with IFPRI, and co-organized an *Expert Roundtable on Food Safety Research in the CGIAR*, which was held in May 2007 with the objective of identifying priority research in food safety that would advance a pro-poor agenda. Over 20 experts attended the meeting, and two background papers, as well as a number of presentations on selected topics, served to catalyze the discussions. A report has been prepared identifying the issues discussed at the workshop and the major conclusions reached.

The Roundtable's working groups identified some possible priorities for research by commodity or segment of the production to market chain. The Science Council notes the utility of these for developers of specific research. However, the Science Council highlights the following guidance from the Roundtable in terms of roles and preferred approaches:

- Food safety has to be treated as a cross-cutting issue.
- The CGIAR could have a comparative advantage in combining the outcomes from different types of research and applying best practice in case studies to potential markets/niches where products from developing countries have an opportunity for entry.
- There is a need for a systematic review of experiences involving poor producers, food safety and markets, whether export or local and regional. Such an assessment should include methodological review to understand the value of published case studies and to help evolve best practice methodology for the CGIAR and its partners.
- With any identified commodity/product/or market opportunity, the first approach should be to conduct a risk ranking exercise in relation to poor producers and consumers. For example, the developing Challenge Program on fruits and vegetables will need to address gaps in food safety research.
- To conduct research on factors affecting the poor, it would be better to focus on domestic and regional markets in the first instance (in the expectation that export markets could be treated later once the primary risks and constraints for the poor were understood).
- Whilst research may focus on production risks, approaching research from consumer behavior to production allows the capture of the demand side of food safety, cumulative and substitution effects and the reinforcement of various food hazards.

This helps identify gaps in the regulatory systems and strengthens the development of the priority research agenda.

- To understand constraints, it is necessary to understand the demand for food safety: research is particularly required on the incentives needed to create demand, and elucidation of policies and the role of institutions in ensuring the delivery of safe food provided by the poor.
- An additional role for the CGIAR might be in adding to the considerations of other international food safety bodies on science-based but pro-poor options in the development of standards.

The SC confirms that there is an important research agenda on food safety that concerns poor producers that is currently not being addressed elsewhere, and therefore provides a role and entry point for the CGIAR in food safety research. It will require effective partnerships to bring in the scientific expertise from various sectors of related research in order for the CGIAR to develop its comparative advantage.

One of the driving forces behind the study was to evaluate a research agenda on food safety when food safety is viewed as a constraint in realizing income opportunities. The SC agreed with the sentiment of the Roundtable that, in addition to concerns about food safety as an impediment to market access for poor producers, the public health impact of the consumption of “unsafe” food on producers and consumers needs to be considered. This requires that a balance is struck between the dual objective of public health outcomes of food safety research with income generation for small-scale farmers. One such area for a combined research approach, as previously encouraged by the SC, might be a comprehensive program for research on mycotoxins. This wider presentation of the importance of food safety for the poor, including income and public health outcomes, may stimulate demand from donors for pro-poor food safety research. This will have to be ascertained to ensure that there is not funding competition between the food security research aspects of the CGIAR agenda and work on food safety and health.

The SC intends to publish *Food Safety Research in the CGIAR: Report and Recommendations arising from a joint IFPRI-Science Council-sponsored Roundtable on possible approaches to Food Safety Research in the CGIAR* jointly with IFPRI. The SC hopes it will provide immediate guidance for the development of Framework Plans for SPs to which food safety research is relevant, and for the targeted development of food safety research in the CGIAR in the future.

## Summary

The Science Council (SC) of the CGIAR recently initiated a process to solicit insight from a number of multi-disciplinary stakeholders involved in food safety so as to identify priority areas for food safety research on which the CGIAR Centers might focus. Since the research areas related to food safety are quite broad, a roundtable workshop of experts was held on 8<sup>th</sup> and 9<sup>th</sup> May 2007 in Washington DC (hosted by IFPRI) with the aim of identifying (1) gaps in food safety research which relate to the poor, and, (2) those pro-poor food safety research priorities on which the CGIAR system might focus.

The roundtable meeting began with three presentations. First, the goals and objectives of the round table were reviewed and where food safety research responded to the research priorities identified for the CGIAR. The second presentation considered some of the important food safety research areas involving the poor. The third identified areas of interest and different institutions currently involved in food safety research. (Some of this material is contained in the papers which accompany this Report.) This was followed by a number of short presentations by expert participants as initiators for discussion of seven key topics spanning major food safety concerns. These focused on 1) the demand for food safety, 2) contamination pathways of concern for the poor to ensure the production of safe fruits and vegetables, 3) socio-economic impacts of meeting (or not meeting) the demand for improved food safety requirements, 4) concerns associated with zoonoses in food produced by the poor, 5) concerns associated with microbial pathogens in food produced by smallholders, 6) mycotoxins in food produced by the poor, and, 7) the trade implications of the demand for safe food.

Break out discussion groups used this background to consider different components of the production to consumption chain, and to facilitate the identification of food safety research priorities that the CGIAR Centers should focus on. These were reported back to the larger forum and the results are provided in this report. The meeting concluded with an open forum and discussion around the following six salient approaches in considering the prioritization of food safety research in the CGIAR:

1. Food safety has to be treated as a cross-cutting issue. It relates to both domestic and international markets, requires collaboration across different lines of research and involves participation of both the private and public sectors.
2. Research needs to encompass the entire supply chain rather than focus on producers or consumers in isolation, and thus the research needs to be multi-disciplinary. The CGIAR Centers do not necessarily have a strong comparative advantage in food safety research *per se*, but could have a comparative advantage in combining the outcomes from different types of research and applying best practice in case studies to potential markets/niches where products from less-developed enterprises have an opportunity for entry. It is therefore vital to work in collaboration with different public and private sector institutions. The CGIAR Centers' focus should be on filling pro-poor research gaps so as to provide International Public Goods (IPGs) which are relevant for poverty alleviation.



3. There is a need to carry out a risk ranking exercise so as to prioritize a few food safety risks that should be addressed in relation to poor producers and consumers. Once priority risks have been identified research efforts should be targeted towards pro-poor research and the application of the risk analysis process (risk assessment, risk management, and risk communication) should be undertaken to aid decision makers in selecting cost-effective solutions for reducing risk for the types of products the poor produce or consume.
4. Substantial insights are expected from:
  - a. Focusing on improving food safety for domestic and regional markets in the first instance. This is likely to ensure pro-poor solutions and to inform future work on ensuring the access of the poor to international markets;
  - b. Critical analyses of successes and failures in maintaining market access for the poor in light of changing food safety standards, which will help identify the institutions/policies needed;
  - c. Understanding the demand for food safety (which is likely to differ substantially between countries and regions and between different sorts of producer groups and elements of the marketing chain).
  - d. Research on the incentives needed to create demand and to turn a public good into a private good (this may include work on different forms of collective action, third party certification schemes etc).
  - e. Research to identify food safety infrastructure and other policies needed, including the role various institutions play in ensuring the delivery of safe food produced by the poor.
5. There is a need to identify specific processes utilized by the poor to ensure the delivery of safe food that is considered equivalent to established private and international standards e.g. recent CGIAR contributions to small-holder milk production schemes. The advantage of such research is that it could aid in bringing up the poor's ability to meet international standards on their own terms, raising awareness in international standard setting bodies and resulting in a movement away from systems-based prescriptive standards towards performance-based standards.
6. The CGIAR should find its stance amongst other global bodies and actors in food safety research at national and regional levels and construct its agenda appropriately. One role should be in adding to the considerations of other international food safety bodies on science-based but pro-poor options in the development of standards.

In the summary discussions, it was noted that there will be a need to reflect on the way research can have an effect on innovation. Whilst the participants discussed possible research priorities by production to consumption chain and by commodity, (listed in Annex 1 of the Report) this tends to focus research questions on producers. Working from consumer behavior to production allows the capture of the demand side of food safety, cumulative effects, substitution effects and the reinforcement of various food hazards, which would also help identify gaps in the regulatory systems and strengthen the development of the priority research agenda.

The Roundtable generally reinforced the stance that the public health outcomes of food safety research are important and are complementary to the objective of raising incomes for small-scale farmers. It would be up to the CGIAR to balance its intentions between these two clear targets for food safety research.

### **Context for the Study**

The Science Council of the CGIAR recently initiated a process of system-level priority setting in line with its aim to develop a more cohesive and better-focused research program to alleviate poverty, hunger, and malnutrition through agricultural research. One of the overarching goals of the research carried out by the CGIAR and its partners is to improve the livelihood of low-income people in developing countries. In the CGIAR system, five broad priority areas have been identified, each with four sub-priorities.

Several of the System Priorities deal with Food Safety either directly or indirectly. The priorities which are most directly linked with food safety are listed below:

- Priority 2A – Enhancing the yield of staple products
- Priority 2C - Enhancing nutrition quality and food safety (through genetic improvement)
- Priority Area 3 (Reducing rural poverty through agricultural diversification and emerging opportunities for high-value commodities and products) includes the following sub-priorities: 3A, Increasing Income from Fruits and Vegetables; 3B, Increasing income from Livestock and 3C, Enhancing Income through increased productivity from fisheries and aquaculture
- Priority 5B: Making international and domestic markets work for the poor.

At the invitation of the Science Council (SC), the International Food Policy Research Institute (IFPRI) developed a concept note for outlining the research priorities for the CGIAR system. The concept note drew upon the existing knowledge base that IFPRI has generated from its own works as well as insights from other sources including several small group consultations that were convened. The concept note discussed the importance of food safety for the poor in developing countries in part reflecting the changing diet worldwide towards more perishables. The concept note suggested that the poor were losing market access and had to find ways to overcome four distinct problems: 1) how to produce safe food; 2) how to be recognized as producing safe food; 3) how to identify cost-effective technologies for reducing risk; and 4) how to be competitive with larger producers.

The concept note emphasized that, compared to the types of research currently being undertaken, there existed critical research gaps relating to food safety research that involved the poor as producers or as consumers. The concept note identified three key food safety research areas that were pro-poor that the CGIAR centers could focus their research effort on:

1. Enabling poor households to compete and profit from the emerging but demanding markets for high-end foods.

2. Finding ways to ensure safer food to the poor households identifying it as a crucial element of food security.
3. Identifying cost-effective policies to improve food safety and to inform decision makers about them.

The concept note suggested that by focusing on research gaps that neither the private sector nor the national institutions were addressing, and by conducting applied research where possible, the CGIAR Centers could channel their resources in food safety research to bring about solutions to pro-poor food safety issues.

The roundtable workshop convened by IFPRI and the SC was aimed at narrowing down the focus of food safety research and determining the priority areas of food safety research for the CGIAR system. Experts from different areas were participants in this workshop (Please see annex for the list of participants). IFPRI and the SC secretariat have jointly prepared this document that summarizes the outcomes of the workshop. This document will form the basis of a report to the SC for its Meeting in August 2007, and for the information of other stakeholders.

## **1 INTRODUCTION TO THE ROUNDTABLE**

Dr Joachim von Braun, Director General of IFPRI, opened the Roundtable<sup>1</sup> and welcomed participants. He noted that food safety was a topic which was central to many of the goals that the CGIAR seeks to address. Although the topic had been around for some time, it had never been addressed in a sufficiently robust or comprehensive fashion, and it was appropriate that the CGIAR adopt a research focus on this topic of increasing importance. IFPRI was pleased to offer its facilities and to assist the SC in examining the issues so as to move the agenda forward in a direction most appropriate for the CGIAR.

He noted that IFPRI, as with the other CGIAR Centers, does not have a long tradition in conducting food safety research targeted at helping the poor, though it had carried out several but disperse initiatives looking into specific food safety problems. A 2020 series publication identified that there is more knowledge regarding food safety in the Centers than was previously thought. Noting that a single program on all food safety issues would be too broad, von Braun recommended a more focused approach which he hoped would come out of this workshop.

The roundtable began with two general background papers that introduced the topic from the SC's viewpoint and updated IFPRI's work in this area. This was followed by a more detailed look into specific topics of food safety that might be of significance to the work of the CGIAR. A number of selected experts were asked to briefly introduce the topics, providing a setting for consideration on the core and emerging issues in the respective areas. They were discussed further in an open discussion, whose summary can be found in Section 2, below. The participants then broke into several discussion groups (based on different points in the supply chain) to deliberate on the research gaps where CGIAR could make a contribution for the benefit of the poor in developing countries. The salient points that emerged from the roundtable discussions are summarized in Section 3, below.

## **2 OUTCOMES OF OPEN DISCUSSION AT THE ROUNDTABLE**

### **2.1 Food safety as a cross cutting issue**

In the opening discussions, it was widely recognized that food safety concerns are cross-cutting in nature and these areas have several intersections with the work of the CGIAR. The CGIAR System Priorities can be regarded, in part, as the areas that the CGIAR needs to be competent in to address its objectives. Food safety issues are also addressed by many international platforms and agencies with different expertise such as WHO and FAO. Research gaps in areas which affect the poor should be the priority of the CGIAR Centers. In general, the question of context is the challenge, as food safety cannot be examined in the abstract, but within a framework (of regional trends, food chains, institutes, mechanisms) which is also important to ensure the production of International Public Goods (IPG).

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<sup>1</sup> What follows is not a summary of the various sessions following the Agenda (for which see Annex 2), but an extract of the major issues and research questions raised during the two day Roundtable. As some of the outputs are generalized from discussion groups, the text is in large part not attributed to individual participants.

### ***Trade concerns***

Food safety research has to look at both domestic as well as export markets and producers' concerns in food and water safety. The CGIAR focus should not be on wealthy countries but middle- and lower-income consumers, where management of a food safety system is a key challenge. The availability of carefully articulated information surrounding food safety and how the poor can improve the safety of their products and meet international standards without having a major impact on their livelihoods is also important. The CGIAR Centers have a comparative advantage in implementing research on potential markets/niches in which products from less developed enterprises have opportunity to enter.

### ***Different types of research can be combined to amplify results***

The CGIAR can capitalize on new technologies for food production/food safety. This includes identifying innovations which make foods of the poor safe along the food chain; and conducting research on both pro-poor technical and policy issues on food production/marketing at global and national levels. There is also a need to determine how different types of research can be brought together - for example the integration of approaches to address the issue of mycotoxins and food safety in ways that address the needs of the poor.

### ***Examining the role of private and public sectors***

In food safety, public sector bodies have traditionally established and implemented a minimum set of food safety and animal health standards. Increasingly the private sector has responded to the growing awareness and concerns of consumers and non-governmental organizations in relation to food safety. This has risen from both food scares and the increased levels of communication and societal knowledge of nutrition, health, food safety and hygiene. Therefore research on food safety and uptake must encompass the participation of both public and private actors.

### ***Meeting international standards***

Increasing concern over trans-boundary food safety risks has resulted in the development of stricter international legislation to ensure safety of internationally traded food, and the developed nations have become very active in trying to ensure high levels of domestic food safety and systems to control standards in internationally traded food. Developing countries which fail to manage food safety hazards face serious economic consequences in terms of disruption of access to international and regional markets.

The Roundtable recognized the importance of the Codex Alimentarius Commission in Food safety standard-setting. Such international standards often form the basis for standards established by national government bodies.

It is increasingly recognized that to be credible, food safety standards must be scrutinized by an independent third party who certifies the degree of compliance. Abuses of third party certification by private enterprises can occur. A current reality is that practical, large-scale, food safety issues are often advertised and driven by policymakers and the media, rather than integrated food control systems.

## **2.2 Need for a supply chain based approach**

An integrated farm to table approach is important for food safety research. As well as a more integrated value chain analysis, there are often economies of scale in meeting food safety

requirements, and this leads to increased importance of farmer associations to promote the successful participation of small farmers in supply chains. Research has to take this important institution into account.

While a focus on the smallholders/small processors is necessary for CGIAR research, the impact on poor consumers should always be considered. It was suggested that the implications of food safety on the health of the poor is extremely important. Research should, therefore, include this perspective along with issues relating to market demands for food safety and technologies that are cost effective for the poor farmers.

In supply chains that include smallholders, one of the central issues is creation of awareness regarding the merits of food safety and the need for meeting regulatory requirements. The lack of awareness about the benefits of food safety could exist among consumers as well. A case from China provided an example where smallholders producing tomatoes according to European import standards encountered problems with the lack of recognition for their higher standards in the domestic markets. Similarly, green food and organic produce present opportunities for poor farmers but are beset with risks of failure owing to several factors (for example the challenge to maintain integrity of supply chains with a need to avoid contamination for example by non-green products). Compared to conventional agriculture, different food safety issues arise when dealing with organic supply chain both in pre- and post-production areas. In fast growing developing countries like China, this situation is complicated by the need to manage widely contrasting traditional and modern supply chains for agricultural products which can exist side-by-side in the same localities.

### 2.3 Approaches to food safety risks

#### *Types of risk*

Major risks associated with animal husbandry are the transmission of zoonotic disease and contamination of animal products with human pathogens. Many of these zoonotic diseases have implications for human health and strong repercussions on trade. In developing countries, the smaller scale of agricultural production, minimal health standards in slaughterhouses (as older and sick animals get eaten more commonly), and the close association of domestic animals with humans in some (social) systems raises different kinds of hazards. Threats to children are also significant as they often are daytime caretakers of animals in many poor countries. Most developing countries do not have the resources to detect many zoonotic diseases and other emerging hazards and thus are especially vulnerable to several trans-boundary food safety emergencies.

Pathogens of concern in developing and developed countries could largely be the same (*Salmonella*, pathogenic *E.coli* for example), but their types and prevalence differ by geographical locations and farming practices. In some countries, guidelines for the hygienic production of animal products (such as cheese production in Latin America) have been adapted to smallholder producers. Contrary to expectation, small holder production can be less prone to contamination (owing to small number of animals and small quantity of product preventing mixing of contaminated products in large amounts). However, implementing risk mitigation methods in developing countries is likely to be more challenging. Some processes like irradiation are well known but underused in practice even in developed countries. The knowledge and facilities for such methods are likely to be extremely scarce in developing countries. Epidemiological characterization of hazards and risks in developing countries is important, and comprehensive

information is required for tackling epidemics. The heightened sensitivity of export markets will also require knowledge of hazards and risks in animal and aquaculture feed, microbial pathogens in seafood, and antibiotic drug residues in meat.

Toxins in crop products are a major constraint to health and marketing. Recently, CGIAR research has demonstrated that mycotoxins affect children's growth.<sup>2</sup> Their presence in products moreover can act as significant barriers to trade. The mitigation measures for mycotoxins are currently quite expensive.<sup>3</sup> Genetic modification per se cannot be the solution given the number of affected crops many of which do not show high resistance. A consolidated approach would include research, diagnostic tools, improved management capacity, awareness building, etc. Similar considerations apply to the problem of residual pesticides.

Water safety (and high prevalence of diarrheal diseases in children) is basically a sanitation problem. However, these may become trade-related food safety issue because of hygiene-related problems (during harvesting and post-harvest handling) especially for exports of fruit and vegetables from developing countries.

#### ***Risk analysis to identify and rank priority commodities, types of risk and systems***

To identify a few targeted commodities for technical and policy research, the participants suggested that there is a need to prepare risk ranking across commodities so that the CGIAR Centers can target their research efforts to reduce risk on commodities of most importance to the poor. It would be particularly important to develop and implement appropriate risk analysis tools to guide policy and research to focus on those commodities and value chains that would have maximum impact on the poor. Risk analysis (risk assessment, risk management and risk communication) then can be implemented to help in identifying cost effective solutions for reducing risk for the types of products the poor produce or consume. Major advantages might be derived from utilizing/adapting existing risk analysis tools - where available - to look at a variety of products grown and consumed by the poor so as to identify cost effective technologies that help the poor.

It was accepted that the capacity for undertaking such research is currently limited in most developing countries. Thus, a component of food safety research should include capacity building in risk analysis and implementation.

#### ***Success and failure in relating food safety to the poor in developing countries***

The Roundtable was unanimous in confirming the value of studies that bring the success stories in combating the identified food safety hazards to public knowledge. This best practice research could relate to several interrelated contexts, in organization of production, post harvest processes and in market creation. It was recognized that there are challenges in how to document this research - especially in the light of the several less-tangible factors (e.g., issues such as transparency and accountability which are often responsible for successes). Similarly, studies should be undertaken to highlight failed systems and lessons learned (like raspberries in Guatemala where a fledgling industry initially collapsed from a cyclospora scare, but was able to withstand later food contamination problems because effective traceability systems were installed in the sector that allowed unsafe raspberries to be traced back to the responsible farmers). Such information should be used to create a central knowledge base e.g. at FAO, about

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<sup>2</sup> See <http://www.ifpri.org/themes/aghealth/iita.asp>.

<sup>3</sup> See [http://www.fao.org/ag/agn/agns/foodproducts\\_coffee\\_en.asp](http://www.fao.org/ag/agn/agns/foodproducts_coffee_en.asp)

the threats to success and the institutional arrangements required to organize high standards in food systems.

Lack of capacity in national systems to manage a food safety system is likely to be the binding constraint in developing countries. Often, problems of institutional and human capacity in developing countries outweigh technical issues. The situation is exacerbated by a general lack of private sector investment in national food control systems. In developing countries this could lead to both under- as well as over- regulation depending upon the knowledge base of the institutions and the role of special interests. Thus important research areas emerge with regard to the means to facilitate policy reform, building the regulatory structure and enabling environment (like infrastructure) in the national food control systems that are oriented towards the poor. Research should also be directed towards strengthening systems of surveillance and monitoring. There is a need to promote a better partnership between food producers and governments in improving infrastructure for food production and sanitation; consequently, research on methods in public-private partnerships in management, risk analysis, public participation and awareness would be useful.

***Research on identifying equivalent processes for risk reduction that are pro-poor***

The Roundtable recognized that research should focus on identifying flexible and practical approaches that ensure safety of the products coming for small producers vis-à-vis international standards. Research output in this area could aid the poor to meet international standards on their own terms. An example is the new guidelines developed by FAO and WHO on HACCP for the application of food business in less developed countries. Such guidelines would be instrumental in fostering a movement away from systems-based prescriptive standards towards performance-based approaches.

The meeting unanimously agreed that the CGIAR can contribute towards helping the poor in meeting international standards or equivalent standards which are science-based (e.g., the previous provision of basic information by ILRI for certain scientific standards in livestock). Such mechanisms could be replicated in other areas. Avoiding contamination of fresh produce is a high priority in international agenda and FAO/WHO are conducting research on current practices in different countries with a view to possibly support Codex work on developing specific codes on safe production. Similarly, agencies are currently developing guidelines on how best to deal with irrigation practices. A possible entry point for the CGIAR Centers in these areas is to ensure that options for a pro poor food safety system are adequately taken into account.

## **2.4 Priorities, incentives and disincentives**

The majority of the participants acknowledged the clear need for the application of various food safety standards but that health concerns of local people were at least as important as meeting market demands. The Roundtable also identified consumer behavior and the effect of food safety on malnutrition as important to smallholders in developing countries. However, questions were raised as to whether the CGIAR had a role to address these issues in the framework of food safety.

It is difficult to encourage LDC producers to adopt better practices if there are no immediate observable benefits to them from adoption of such practices. The various technologies/systems currently available to ensure safe foods tend to be relatively costly, and the challenge was therefore on how to propose such technologies be taken up by poor farmers, and to distinguish



those technologies available today from those that could be implemented in the future. Currently there do not seem to be incentives that encourage trade in safer foods, and food safety alone is a difficult “product” to market. On the other hand, once market confidence is damaged through issues of unsafe produce, it takes a long time, if at all, to be restored.

Although the meeting clearly differentiated food quality and food safety, it was recognized that they are more difficult to unravel in the market place and in political contexts. Higher prices are paid for fair trade foods and food quality. Thus, for each kind of product, it is necessary to determine which public good can lead to an increase in income or reduction of costs and what management tools need to be employed for this purpose. Research is required on what incentives are needed to make a public good into a private good following the examples of the green label effort in China, third party certification systems, NGO-driven efforts, lessons from animal health control systems, compensation incentives etc. It is likely that collective action might be necessary in generating incentives.

In summary, the dynamics of food exports are influenced by the marketplace, and smallholder farmers are affected and constrained by the changing demand in the developed countries. For example, many UK retailers only buy from large producers because they have the resources to invest in the safety systems demanded by the marketplace. Thus, potentially, market forces, without intervention might not naturally lead to an optimum situation for smallholders as there could be market failures at several points in the supply chain.

Food safety might be a public good from the consumers’ point of view, but for the producers, who must bear the costs, food safety is also a factor that can drive smallholder producers out of the market. It is crucial for them that costs are spread over all the stakeholders along the production chain and support can be secured for the “farm-to-table” institutional system. Increasing the effective size of producer organization units, the ability to charge price premiums, and demonstrated willingness on the part of consumers to recognize the food safety issue and pay the price premiums would overcome some of these challenges.

The intention would be to work within existing frameworks and with international sources of expertise. For example, if the CGIAR Centers were to act as focal points for comparative risk assessment they could draw on the Codex and its international committees involved in policy dialogue and in providing guiding documents on standards of risk assessment in contaminants, microbial safety, etc. Of particular interest to the Roundtable participants was prioritizing research on market demand for food safety and the incentives that this leads to.

### **3 OUTCOMES OF THE DISCUSSION GROUP MEETINGS**

Noting these different components in food safety research, the participants broke into three group’s viz. primary production, post-harvest handling and markets. The groups were then invited to recommend a few priority areas for research relating to their particular focus based on within group discussions. The recommendations arising from those group discussions are briefly summarized below (see Annex 1 for details).

#### ***Group 1: Primary production***

- The establishment of comparative risk assessments to define priorities for food safety research.

- Product specificity is critical in food safety research (this relates broadly to the risk ranking priority identified in the open discussions) – the group highlighted this with examples as given below:
- Staple food crops – mycotoxins are the most important research issue
- Fruit and vegetables – quality of irrigation water and pesticides are the most important research issue as well as possible microbiological contamination
- Livestock – assessment and management of risk in formal and informal markets are the most important research issue
- Fish – assessment and management of food-borne trematodes and antibiotic contamination are the most important research issues

**Group 2: Post-harvest handling**

- The establishment of an inclusive risk assessment approach to the farm to market chain (this relates to the supply chain focus in the open discussions).
- Research priorities are likely to be differentiated by the commodities to be considered (this relates broadly to the risk ranking priority identified in the open discussions) for example:
  - Durable commodities (grains, tubers, oil seeds and nuts) – e.g. emphasis on grain moisture content and good storage practices
  - Perishable commodities (fruit and vegetables) with an emphasis on adaptation of known technologies to domestic markets (e.g. applying antibiotic or pesticide contamination prevention approaches developed in relation to export markets)
  - High risk commodities (farmed fish and livestock) with an emphasis on the implementation of risk analyses frameworks and research on *feed* safety.

**Group 3: Markets**

- Focus research on opportunities in the domestic and regional markets for low income producers and its implications. (This would initially reallocate research focus from high income export markets. This was considered to be more pro-poor but was accepted as a stepping stone for facilitating poor farmer's access towards higher end markets). This was also accepted by the group as a highly under-researched segment of food safety research.
- Research on the existing demand for food safety in developing countries and on ways to stimulate this demand in developing countries
- Research on food safety infrastructure to cater to the needs of the poor farmers in response to the existing and potential demand for food safety.

#### **4 FINAL REMARKS**

In considering the outcomes of the Workshop and the important messages that they contain for food safety research in general, the IFPRI Director General noted that it might be necessary to consider the "Food safety versus quantity tradeoffs". This reflected his concern that without substantial new funding, a focus on food safety might dilute the CGIAR agenda of ensuring food sufficiency. While presently this issue may not be considered as an "either/or" question, this debate has been raised among the CGIAR Centers in the past. It was suggested that focusing the food safety debate in the public health sphere might help to rationalize the debate. If a new and more focused approach to food safety is to be adopted, the Director General suggested that the SC needs to convince the donors and other stakeholders that the investment of CGIAR budget in this area would lead to major benefits in terms of poverty alleviation.

In the formulation of research, it might be useful to take alternative approaches in identifying key areas along the supply chain. Considering issues commodity by commodity tends to focus research questions on producers. Rather, it might be useful to begin with the consumer behavior and work backwards up to primary production. This would still frame the issues along the supply chain including the issue of demand for food safety. A supply chain approach working this way would be helpful in capturing cumulative effects, substitution effects, and reinforcement of various food hazards – areas which seem to be the gaps in the research and regulatory system.

There is still a need to reflect more on the way in which research is adding to innovation, and the role of the CGIAR vis-à-vis the private sector. Innovation in storage/processing technology may really be a domain for the private sector; in which case further public-private partnerships are needed.

When considering market demand, the great difference between countries in their “psychology of demand for food safety” should be taken into account. A broad-brush typology for national differences in food safety demand would be useful in shaping the appropriate focus and avoiding investment in areas where the payoff might be low due to the lack of market demand.

On behalf of the SC, Dr Rey Martorell noted that the expectation had been that food safety discussion would focus mainly on income generation, with food safety treated as an obstacle to small farmers’ access to high value markets. He noted that in the Roundtable’s strong emphasis was on public health, where food safety is seen primarily as a public good. It would be important to distinguish these two areas in pursuing food safety research priorities within the CGIAR. Thus, the issue would remain as how to balance between economic effects of food safety on poor as producers and health-specific effects of food safety on poor as consumers. This, in turn would determine commodity choices (such as high-value crops versus staples, nutritional value versus economic increases, local versus international markets). The recommendation to focus on regional and domestic markets was the general agreement among the workshop participants, but food safety research must also consider the potential for small producers to join the international export market, as this still seems to provide opportunities.

The active and constructive participation of invited participants was gratefully acknowledged and the Roundtable organizers and the hosts were thanked for their contribution to a successful meeting.

## Annex 1

### Outcomes and Recommendations from the Discussion Groups

#### Group 1. Priorities for Food Safety Research on Primary Production Systems

The key issue that this group emphasized was - A need **to do comparative risk assessments in order to define priorities for food safety research.**

This should involve:

- Improved statistics showing which commodities/food safety problems have the greatest negative impact on the poor.
- Identify major problems (mortality, child morbidity for example) and relative importance of different hazards (e.g. there are large regional differences, but diarrheal diseases are usually among the top 5 causes of death)
- Catalyze a process of increase in data gathering for developing countries where data is scarce

Criteria for selection of priorities in research for this group were:

- Impact on health of the poor consumers
- IPG nature of outputs
- Research areas within Centers' expertise
- Income generation or enhanced cost/benefit ratio
- Focus on poor producers/ consumers

In general, Centers may act as catalyst and focal point in developing countries to facilitate and enable comparative assessments across countries (to provide IPGs), linking ARIs and NARS and institutional players in food safety. Recommendations for approaches to research may best be developed in relation to farm to market systems, but analyzed in terms of specific commodities, inputs, production systems and farm level management and hazards [see below].

#### Staple food crops

Presently, because of developing countries' widespread existence in staple commodities, their direct health effects - including nutritional effects on children - and as a constraint to the marketing of affected produce, research on Mycotoxins is given priority for development of a comprehensive program approach.

Key Food safety issues: 1) Mycotoxins (most important researchable issue), 2. Arsenic / heavy metal contamination, 3. Naturally occurring toxins.

	Assessment, Characterization	Mitigation	Partners
<b>Input level</b>	e.g. Susceptible varieties	Resistant varieties	
<b>Production System</b>			
<b>Output management at farm</b>		Relates to post harvest management	

**Fruit and vegetables:** Key Food safety issues - 1) Wastewater, 2) Pesticides

	<b>Assessment, Characterization</b>	<b>Mitigation</b>	<b>Partners</b>
Input level	No longer a researchable issue: negative side of wastewater (use) (pathogens, heavy metal)  Role of manure in food safety issues in F/V well enough researched?	Develop and adapt cost-effective technologies for safer irrigation.  Incentives for behavior change e.g. through market mechanism, land (tenure) based incentives  How could proper use of manure be made cost-effective with the production system	WHO, FAO UNEP ARIs(Universities in Europe, etc) NARS including local universities, Ministries of Health and Agriculture
Production systems	Assessments of pests, and application of pesticides	Issues: Food safety of local consumers, Trade access  Breeding for resistance (AVRDC) Development of GAP and IPM.  Socioeconomic studies to foster demand, adoption; and institutional partnerships	AVRDC, FAO ICIPE NARS MoA ARI (eg., IPM CRSP)
Output management at farm	Pathogen contamination in harvesting and immediate handling	What kind of incentives or disincentives can encourage proper handling?	Private sector ARIs

\* Focus on products that are eaten raw

**Livestock:** Key research issue - Assessment and management of risk in (in)formal markets

	<b>Assessment, Characterization</b>	<b>Mitigation</b>	<b>Partners</b>
Input level	Hazards transmitted through feed/water Toxins (Mycotoxins) Pathogens	Changes in feed manufacturing and management  Supported by rapid diagnostics for field use	FAO Codex WHO, OIE, ARI Private sector NARS
Production systems	Pathogens Emerging diseases Husbandry systems. Vet drugs (residues, antibiotic resistance) Occupational hazards (zoonoses)	Good production practices for prevention and control of risks  Institutions/ policies/technologies to support adoption of good practices  Policy research on animal health/ delivery systems, including integrating community animal health workers.	WHO FAO OIE NARS International networks for poultry, pork
Output management at farm	Manure? Household consumption		

**Fish:** Key research gap - Food-borne trematodes

	<b>Assessment, Characterization</b>	<b>Mitigation</b>	<b>Partners</b>
Input level	Extent of trematodes in which fish species?	How to produce clean fry	
Production systems	Using human waste in Asia	Control of brood stock Minimize presence of snails Management of ponds	WHO FAO ARIs Ministries of Health and Agriculture/Fisheries
Output management at farm			

**Group 2: Priorities for Food Safety Research in the Post Harvest segment**

Post harvest refers to the storage, processing (for preservation or value addition) and packaging of agricultural products for human consumption or as animal feed. Several cross-cutting issues were recognized by this group:

**Data gaps:** Although there exists a lot of prior knowledge of different aspects of post harvest research, the knowledge is uneven and there is inadequate knowledge of small holder production systems with a view to measurement of food safety risks for:

- Water
- Chemicals
- Processes
- Microbial agents

Hence, there is a requirement for:

- Research to fill data gaps on hazards in post harvest specific for the poor
  - Determination of their prevalence
  - Monitoring/Adjusting existing processes
  - Testing through -
    - Outsourcing
    - Improving local capacity
    - Improving specific tests for local application
    - Establishing Quarantine for pests
  - Differentiating risks affecting the supply chains, target markets and by size of producers
- Research relating to the impacts of international regulations on local systems
  - Identification of institutional stakeholders
  - Designing incentives to improve national systems dealing with food safety
  - Establishing demand for food safety among stakeholders and policy makers by:
    - Creating Awareness
    - Establishing the impact of imports on local economies
    - Establishing the impact of international and national food safety standards on smallholders

The key areas for research on food safety in the post harvest segment of the “farm to market chain” are:

- Identification of food-borne hazards for consumers and those affecting market access
  - Ranking the risk of hazards (methods)
  - Determining their economic and health impacts
  - Identifying the demand for reducing hazard (noting differences in export vs. domestic markets)
  - Establishing baseline measure (for future comparison)
- Compilation of best practices to mitigate food-borne hazards by post harvest treatment through
  - Identification, design and implementation of technologies to reduce risk to acceptable levels
  - Determining the effectiveness of technologies
  - Determining their cost and the cost/benefit ratios of different approaches to mitigation of risk
  - Identification of means to encourage technology adoption through institutional research and optimization of partnerships
- Determination of the impact of technologies on different scales of producers (including the poor)
- Communication of Risk
- Emphasis is placed on the institutional context at the post harvest level for:
  - Monitoring
  - Public/private partnerships
  - Best practices (incentives)
  - Dealing with problems in implementation and facilitating sustainability
- Determining food safety/nutrition/health interactions

The criteria, which rationalize CGIAR involvement in this area, are:

- That there exists an objective, scientific approach to food safety which can be used to drive national actions (systems, research and policy),
- Methods should be generally applicable and lead to IPGs,
- The approach can be modulated in its application across CGIAR target commodities [see boxes below],
- Focuses on the CGIAR goal of inclusivity of, and benefits to, the poor,
- Current CGIAR partnership with international organizations such as FAO; WHO/PAHO; OIE; etc. could be enhanced.

Research has direct impacts on the improvement of human health and improving market access for the poor – relevant to CGIAR goals and priority research.

The emphasis for research will vary by commodity and types of hazards [see boxes below] and based on existing research results (some implicitly included in the development of international standards set by specialist bodies).

Box 1: Durable commodities (grains, tubers, oil seeds, some nuts)

- Research to establish hazards caused by on-farm post harvest practices
- Research on the significant biological hazards in post harvest (wheat, sorghum, pistachio, maize)
  - Insects
  - Mycotoxins
  - Pesticide residues
- Examination of the effects of biopesticides for storage

- Introduction of rapid testing methods
- Institutional research on means to enhance smallholder benefits
- Establishing mechanisms for producer cooperation for risk reduction and improved marketability
- Knowledge transfer/up-scaling (mechanisms for sustainability, inputs into NARS post harvest programs)
- Scale specific post harvest technologies (storage, processing, alternative use, value addition)

Partners: FAO, CFC, producer organizations, national governments

#### Box 2: Perishable (fruit and vegetables)

There is already a lot of government-supported research in this area (for export markets) however, there are a lot of lessons still to be learned for:

- Application of approaches to domestic markets
- Finding means to assist smallholders
- Analysis by commodity – identifying what processes and contaminants increase risk between harvest and sale?
  - Drying/preservation processes and consequences
  - Value adding processing (perishables, puree etc.)
  - Packaging/cold storage/transport
  - Cost/benefit analysis methods
  - Institutional mechanisms
- Developing management in relation to biological cycles (insects/moulds etc.) and economic/food safety risk.

Partners: IFAP, the Regoverning Markets Project, AVRDC.

#### Box 3: High risk commodities (fish – particularly farmed), livestock products (meat, milk)

Much of the approach is generically similar to perishables, but for high risk products local markets remain important. Research is required on:

- Process evaluation
- Implementation of risk analysis framework e.g. for milk (the CGIAR has a role in risk and cost benefit analysis of practices for milk to add to biological research of others)
- Quantification of impact of food safety regulation on smallholders (and spillover of export/import markets on domestic systems)
- Establishment/enhancing of testing facilities
- Research on the relative benefits of changes in practices, alternative processes
- Research on Feed safety
- Establishment of appropriate varieties
- Institutional arrangements and public/private partnership concepts

Partners: FAO, OIE, PAHO, national meat processing and dairy boards.

### Group 3: Priorities for Food Safety Research on Markets

The group identified the following three research priorities for the CGIAR system:

1. Research with focus on the issue of food safety in domestic and regional markets and its implications
2. Research on the existing demand for food safety in developing countries and on ways to stimulate the demand for food safety in developing countries.
3. Research on food safety infrastructure to cater to the needs of the poor farmers in response to the existing and potential demand for food safety.



Below are discussed the basis for selection of such priorities for research and the types of collaborations and institutional support such research activities entail.

**1. Research with focus on the issue of food safety in domestic and regional markets and its implications**

- (i) Criteria for selection – The following are the reasons because of which the group decided in favor of reallocation of weights in research towards domestic and regional markets
  - Highest payoffs – Since the focus is on small farmers, export markets in general could be a difficult market to access. Greater opportunity would most likely be there in domestic and regional markets. These markets should be treated as a stepping stone towards higher end markets for the poor farmers.
  - The outcomes in terms of public health could be most favorable (more impact) in this case and hence have strong impact on the poor
  - There are critical research gaps related to food safety and its implications in these markets.
- (ii) Outcome – Research could at first focus on compilation of cases and creation of a knowledge base on the successes and failures
- (iii) Institutions/policies needed – Review of the cases will shed light on the roles of the institutions and the policies needed on development of food safety in these markets and the support systems for linking small farmers. Given the small farmer focus here, the group emphasized research on the role of cooperatives of different forms (producer groups and marketing groups for example) in markets with food safety standards.
- (iv) Partners – The group agreed that this has to be a multi-disciplinary and multi-sectoral effort depending upon which aspect of food safety in the domestic and regional markets are considered. Some suggestions were made also for specific partners like FAO that will have expertise and interest in working in this area.
- (v) Impact - Knowledge base on the best practices and the information from case studies will help design policies that will relate to the food safety system catered to the small producers and consumers.

**2. Research on demand for food safety in developing countries –**

The second priority was identified to be research on the existing demand for food safety in developing countries and on ways to stimulate this demand.

The focus of research here can be summarized to be on the drivers of demand for food safety and implications of having such drivers on the economy in general and the food system in particular.

The questions to be addressed here are

- (a) What is the extent of demand for food safety
- (b) Why is it low in several cases (are factors such as lack of information, low levels of regulatory infrastructure for example the reasons)
- (c) What are the actionable policy responses that can alter the demand for food safety in developing countries?
- (i) Criteria for selection – The group unanimously believed that there are critical knowledge gaps here. The group felt that understanding this is critical to choice of solutions (a policy change that can facilitate a demand driven solution or would require

dictating mandatory standards). By widening the scope of the drivers of food safety and hence also the ones that get affected by food safety standards (tourism for example), the group felt that it will lead to agricultural markets characterized by good food safety standards be looked upon as a real wealth creator. This will help food safety be prioritized in the policy agenda.

- (ii) Outcomes – Research output that fills in a critical gap in the literature. Could draw from a reasonable body of literature on developed countries.
- (iii) Institutions/policies needed – Depending upon the research outcomes, solutions in terms of institutions and policies could be suggested. For example if it were discovered that the main reason for the lack of demand for food safety was low levels of information for the consumers especially in cases where mitigation options were not expensive, information systems could be suggested as a policy prescription.
- (iv) Partners- In this research partnerships with several agencies will be required, in particular the private sector selling food and the consumer groups and some government agencies.
- (v) Impact – Poor consumers could get a better understanding of the food safety hazards. Based on demand patterns, a support system for small farmers could be set up.

**3. Research on food safety infrastructure and related institutions.** After assessing the existing and potential demand, this research priority focuses on infrastructure customized to the needs of the smallholders to link them with high standard markets.

There were several food system infrastructure discussed. Some of the common ones considered (with a cost benefit basis) were:

- Public private partnerships in provision of infrastructure
  - Market information systems (not only related to prices but also related to standards)
  - Random testing
  - Certification
  - Food production/safety infrastructure
- (i) Criteria for selection- This is ultimately the objective to link small farmers in a market that have high standards but offer high value.
  - (ii) Outcome – Scientific and institutional research on the food safety infrastructure for the smallholders that can be used by policymakers with full information on their costs and benefits.
  - (iii) Institutions/policies needed – Would be the ones that are suited for the smallholders. Overall a gamut of different policies will be needed. Apart from the common ones discussed in policy literature two important ones were chosen by the group. These are viz. (a) Policies relating to capital flows (move towards patient capital) and (b) Policies relating to agricultural marketing.
  - (iv) Partners – Farmer groups and government agencies are important partners along with standard setting agencies. Significant partnership is needed with scientific community.
  - (v) Impact – Sustainable increases in farm incomes and increased resistance of small farmers to changes in food safety requirements will help them move up the value chain.

Annex 2

Workshop Agenda

IFPRI-CGIAR Science Council Expert Roundtable on Food Safety  
4<sup>th</sup> Floor, Conference Room 4AB, IFPRI, Washington, DC, USA May 8-9, 2007

AGENDA

Day 1 : Tuesday, 8 May 2007

<u>Time</u>	<u>Agenda Item</u>	<u>Presented by</u>
08:00-09:00	<i>Registration / Light Breakfast (Conf. Room 4AB)</i>	
	<b>1. Opening of the roundtable</b>	
09:00-09:45	1.1 Welcome note & quick introduction of all participants	IFPRI: Joachim von Braun
09:45-10:15	1.2 Setting the context & outlining objectives – The goals and activities of the CGIAR	CGIAR Science Council Secretariat: Peter Gardiner
	<b>2. Background issues</b>	CGIAR Science Council:
10:15-10:45	2.1 Presentation on the SC general background paper	Ray Martorell
10:45-11:15	<i>Coffee break</i>	
11:15-11:45	2.2 Presentation on the IFPRI Concept note	IFPRI: Clare Narrod
11:45-12:30	2.3 Questions and discussion	
12:30-14:00	<i>Lunch break (Venue: Library)</i>	
14:00-15:00	<b>3. Selected topics</b>	
	3.1 Short statements on selected topics (5-10min. each)	
	a. Demand for food safety (domestic and international)	
	b. Trade implications on Food Produced by the Poor	
	c. Concerns associated with zoonoses in food produced by the poor	
	d. Concerns associated with microbial pathogens in food produced by smallholders	
15:00-15:30	<i>Coffee Break</i>	
15:30-16:00	Short statements on selected topics (5-10min. each) (Cont.)	
	e. Mycotoxins in food produced by the poor	
	f. Food safety on fruits and vegetables (1): Contamination pathways of concern for the poor	
	g. Fruits and vegetables (2): Socio - economic impact of meeting the demand for improved food safety requirements in fruits and vegetables	

16:00-17:30	3.2	General discussion on the selected topics and other areas of possible CGIAR Research
17:30-18:00		Summary of Day 1
18:00-20:00		<i>COCKTAIL RECEPTION (Venue: Library)</i>

**Day 2 : Wednesday, 9 May 2007**

<u>Time</u>	<u>Agenda Item</u>	<u>Presented by</u>
08:30-9:00	<i>Light Breakfast (Conf. Room 4AB)</i>	
09:00-09:15	Introduction of Day 2	
09:15-09:30	<b>4. Breakout session</b>	CGIAR Science Council
	4.1 Description of the breakout session topic(s)	Secretariat: Peter Gardiner
09:30-10:30	4.2 Discussion within breakout groups	Facilitators
10:30-11:00	<i>Coffee break</i>	
11:00-12:30	4.3 Presentations by the breakout groups and discussion	
12:30-14:00	<i>Lunch break (Venue: Library)</i>	
14:00-15:30	<b>5. Recommendations on CGIAR research</b>	
15:30-16:00	<i>Coffee break</i>	
16:00-16:30	<b>6. Other matters of concern &amp; assessment</b>	
16:30-17:00	<b>7. Closing</b>	

Annex 3

List of Participants

Invited experts

Name	Affiliation	Email Address
1. Gerard Barry	International Rice Research Institute (IRRI)	g.barry@cgiar.org
2. Albino Belotto	Health Surveillance and Disease Management Unit, Pan American Health Organization (PAHO)	belottoa@paho.org
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4. Linda Calvin	Economic Research Service, USDA	lcalvin@ers.usda.gov
5. Dean Cliver	School of Veterinary Medicine, University of California, Davis	docliver@ucdavis.edu
6. Maria de Lourdes Costarrica	Food Quality and Standards Service, Food and Agriculture Organization (FAO)	lourdes.costarrica@fao.org
7. Pay Drechsel	International Water Management Institute (IWMI)	p.drechsel@cgiar.org
8. Delia Grace	International Livestock Research Institute (ILRI)	d.grace@cgiar.org
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11. Hector Lupin	Fisheries Department, Food and Agriculture Organization (FAO)	Hector.Lupin@fao.org hmlupin@libero.it
12. Christine L. Moe	Department of Global Health, Emory University	clmoe@sph.emory.edu
13. John Orchard	4.1 <i>Natural Resources Institute, University of Greenwich</i>	4.2 <i>j.e.orchard@gre.ac.uk</i>
14. Rodomiro Ortiz	International Center for Maize and Wheat Research (CIMMYT)	r.ortiz@cgiar.org
15. Tanya Roberts	Economic Research Service, USDA	tanyar@ers.usda.gov
16. Alejandro Schudel	Scientific and Technical Department, Office International Des Epizooties (OIE)	alejandro.schudel@gmail.com
17. Laurian Unnevehr	Department of Agricultural and Consumer Economics, University of Illinois at Urbana-Champaign	laurian@uiuc.edu

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|------------------------|--|-----------------------------|
| 18. Farid Waliyar      | International Crops Research<br>Institute for the Semi-Arid<br>Tropics (ICRISAT) | f.waliyar@cgiar.org         |
| 19. Kevin D. Walker    | The National Food Safety &<br>Toxicology Center, Michigan<br>State University    | walke357@msu.edu            |
| 20. Katinka Weinberger | AVRDC – the World<br>Vegetable Center  | weinberg@netra.avrdc.org.tw |
| 21. James Withee       | Food Safety and Inspection<br>Service, USDA                                      | james.withee@fsis.usda.gov  |

### **Observers**

- |                |  |                                |
|----------------|--|--------------------------------|
| 22. Wolf Maier | European Commission, DG<br>Health and Consumer<br>Protection | wolf-martin.maier@ec.europa.eu |
| 23. Jim Yazman | USAID  | jyazman@usaid.gov              |

### **Workshop Organizing Institutes**

- |                       |   |  |
|-----------------------|---|--|
| 24. Joachim von Braun | International Food Policy<br>Research Institute (IFPRI) | j.vonbraun@cgiar.org                                   |
| 25. Peter Gardiner    | Science Council Secretariat<br>CGIAR Science Council    | peter.gardiner@fao.org                                 |
| 26. Rey Martorell     | (Emory University)                                      | rmart77@sph.emory.edu                                  |
| 27. Clare Narrod      | International Food Policy<br>Research Institute (IFPRI) | c.narrodd@cgiar.org                                    |
| 28. Haruko Okusu      | Science Council Secretariat                             | haruko.okusu@fao.org                                   |
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## Annex 4

### Food Safety and CGIAR Research – a Backgrounder for the Roundtable<sup>4</sup> Washington, DC 8-9 May 2007

#### 1. Introduction and general statement of the overall problem

The production and consumption of food forms the foundation of all societies. Ensuring the health of its members by providing safe food is therefore vital – millions of people fall ill and many die as a result of eating unsafe food. The concern is particularly serious for developing countries: Food- and waterborne diarrheal diseases are leading causes of illness and death in less developed countries.<sup>5</sup> Increasing media coverage of food alerts such as those on bovine spongiform encephalopathy (BSE), dioxin, listeria, salmonella and *E.coli* contamination also demonstrates the high public interest in food-related health risks.

At the same time, food is becoming a highly political matter, with strong links to areas such as international trade, environment, and consumer preference. Food safety can no longer be considered by science on its own, as the pressures from these other areas regulate and justify how to use which science to mitigate food-related risks. In turn, new scientific research findings continue to advise and update the international policies and standards.

In this context food produced by smallholders in developing countries tends to be regarded as unsafe, affecting the health of many consumers (including the producers themselves). This negatively affects the income streams of smallholders as they lose out on market competition. These problems form the basis of the discussion on food safety as it applies to the mandates of the CGIAR, whose primary goal is to enable developing country producers to achieve food security and reduce poverty.

The issue of food safety cannot be tackled without inputs from a wide range of experts in the sciences, economics, and policy-making. The aim of the Expert Roundtable, for which this background paper has been prepared, is to bring together such experts in order to identify current food safety-related scientific research, its limitations, gaps, and ways in which the CGIAR can contribute towards improvement. It is with this in mind that this paper attempts to summarize the general background information on food safety issues with potential relevance for CGIAR research as a starting point for further discussion.<sup>6</sup>

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<sup>4</sup> Written and compiled by Haruko Okusu on behalf of the Standing Panel on Priorities and Strategies of the Science Council. This paper is based in part on material supplied by Harry A. Kuiper, Gijs A. Kleter, Marcia Samasuwo, Tafadzwa Mandimika, Esther J. Kok and Kelebohile M. Lekoape.

<sup>5</sup> The World Health Organisation (WHO) reports that it kills an estimated 2.2 million people annually, and leaving other serious consequences such as kidney and liver failure, brain and neural disorders, reactive arthritis and paralysis (WHO, 2002)

<sup>6</sup> This paper does not aim to cover all aspects of food safety in general; issues that are outside of the purview of CGIAR have not been included.

## 2. Food safety and CGIAR System Priorities

The issue of food safety is intimately bound to the overall goal of the CGIAR, as it seeks to improve incomes through agricultural products for human consumption. It is consequently featured in several of the CGIAR System Priorities.

- Enhancing nutrition quality and food safety (through genetic improvements) (SC, 2005; Priority 2C)
- Reducing rural poverty through agricultural diversification and emerging opportunities for high-value commodities and products, including: Increasing Income from Fruits and Vegetables (*ibid.* Priority 3A); Increasing income from Livestock (*ibid.* Priority 3B); and Enhancing Income through increased productivity from fisheries and aquaculture (*ibid.* Priority 3C);
- Making international and domestic markets work for the poor (*ibid.* Priority 5B).

Food safety is a broad topic that touches on many areas such as the use of marginal water, farming practices, nutrition, and market access, most of which also cut across other research areas in addition to those listed above. The areas for consideration and research are potentially broad but, in line with the goal of the CGIAR, the scope must be focused on the components of food safety, which may affect the participation of small holders in higher value markets for agricultural products. In particular key researchable issues should lead to the development of clear international public goods, rather than more local products or outputs.

## 3. Definition

Food safety generally refers to the degree to which the risks - potential of foods to cause adverse effects in humans upon consumption - can be minimized. Although health protection is the utmost concern, food safety is also closely linked to economic, social, legal, and environmental issues. There is no widely agreed legal definition for “food safety” – perhaps because it is an obvious term to many, but it could also be because of its ambiguity.<sup>7</sup> In the context of this paper, “food safety” has been defined as:

“Protecting the food supply from microbial, chemical, and physical hazards or contamination that may occur during all stages of food production and handling-growing, harvesting, processing, and marketing to the consumer.”<sup>8</sup>

Food safety is closely linked to, and is often discussed together with, food quality. It must be stressed, however, that they are not necessarily synonymous. Food *quality* refers to the characteristics of food that can be judged by the consumers, such as appearance, texture, and flavor. It might also include factors that might otherwise be called “consumer traits” or “perceived quality” – characteristics that cannot be judged but might affect desirability, such as nutrition and production methods (e.g. organic, free-range, fair trade etc.). Not all food quality matters are necessarily related to food safety, and the two should not be confused with each other. In the context of this document, in particular, the

<sup>7</sup> Humans have been known to willingly consume many foods that might be considered “unsafe” by other cultures. These include (a) foods that are known to be poisonous unless a certain preparation is followed, or known to have poisonous relatives (e.g., potatoes, legumes, mushrooms); and (b) foods that are only consumed by a particular population and are otherwise considered poisonous (e.g., *Gyromitra esculenta* in Finland; the *Takifugu* genus in Japan).

<sup>8</sup> Adapted from the University of Rhode Island Food Education Website. <http://www.uri.edu/ce/ceec/food/factsheets/glossary.html>



distinction between the two must be made clear in order to ensure that each aspect of the discussion is framed appropriately.<sup>9</sup>

#### **4. Framing approaches to food safety**

Food safety can be grouped and considered in a number of ways. Different approaches to dealing with food safety might be helpful in defining the scope of discussion for research needs in the CGIAR, also paying attention to what is not covered in this paper.

One way to frame food safety is to look at the source of threat to safe food, which might generally be grouped into:

- Natural and integral components of the whole food, such as allergens and toxins, which could pose a threat depending on dosage, preparation methods, or the susceptibility of the consumer. The levels of these components might also depend on the environment in which the food was produced.
- Biological hazards, including natural toxins (mycotoxins), microbes (bacteria, fungi), pathogenic viruses, and zoonotic agents (bacteria, protozoa, mycoplasma and parasites);
- Chemical hazards, including pesticide residues, toxic metal trace elements, mineral oils, some food coloring agents, and impurities; and
- Physical hazards, including pieces of glass, metal, wood, other foreign bodies.

The sources of these hazards may vary and can occur at any production stage during cropping, harvesting, storage, and sorting, grading, packing, transport/shipping. While all types of food hazards could be considered through CGIAR research, indirect risks from these hazards (such as impact of pesticides on the health of agricultural workers, effects on immuno-suppressed populations, non-point source pollution) are not considered.

Another way to frame food safety is by looking at the food production/processing stage and to consider at which precise step the problem occurs (see Fig. 1). It shows the importance of developing and implementing systems that minimize the risks from different food hazards that might affect each step of the production chain. This might involve such specific activities as: Selection of production site, methods of irrigation, fertilizer application, pesticide application, personnel hygiene, and machinery/equipment maintenance. It is important to note in Fig. 1 that this paper addresses only the food safety issues from the “primary production” up to “retail”. Previously the CGIAR has generally dealt less directly with domestic consumption. However, where precisely the line should be drawn in terms of framing research needs for the CGIAR Centers will need further consideration.

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<sup>9</sup> For example, improving the appearance of whole foods is generally a means for enhancing food quality but not food safety. However, if a new chemical treatment step was required to improve the appearance it might pose a health risk – thereby becoming a food safety issue.







HAZARDS IN THE FOOD PRODUCING CHAIN						
STAGE	PRIMARY PRODUCTION	HARVEST, SLAUGHTER, AND STORAGE	PROCESSING	STORAGE AND TRANSPORT	RETAIL	CATERING AND DOMESTIC CONSUMPTION
HAZARD	ENVIRONMENTAL CONTAMINANTS; VETERINARY DRUGS; PESTICIDES; MYCOTOXINS; PHYCOTOXINS; OTHER NATURAL TOXINS; PATHOGENS	MYCOTOXINS; PATHOGENS; WEED SEEDS; STORAGE PESTS; RODENT/BIRD FECES	PROCESSING CONTAMINANTS; PATHOGENS; ADDITIVES; COLORANTS; FOOD PACKAGING CONTAMINANTS	PATHOGENS; SPOILAGE; DETERIORATION; STORAGE PESTS; RODENT FECS	PATHOGENS; SPOILAGE; DETERIORATION	PATHOGENS; SPOILAGE; DETERIORATION; HEAT PROCESSING CONTAMINANTS
 <b>FOOD CROPS, SPICES, HERBS</b>				<b>FRUITS, VEGETABLES, GRAINS, SPICES, HERBS</b>		
 <b>FOOD-PRODUCING LAND ANIMALS</b>				<b>DAIRY, MEAT, EGGS</b>		
 <b>FOOD-PRODUCING WATER ORGANISMS</b>				<b>SEAFOOD, SEAWEED</b>		

Figure 1. Identification of Hazards in Segments of Food Production Chains (Designed by G.A. Kleter and provided by H.Kuiper, RIKILT - Institute of Food Safety, Wageningen University & Research Centre)

## 5. International policy instruments as trigger for food safety research

In order to warrant fair trans-boundary trade in food and a high level of human and animal health, international organizations have established rules on food safety that are recognized by most member states. In addition, standards and requirements set by international private and public-private initiatives may complement these rules. Policy adoption has become a starting point of food safety - countries might establish their administrative and procedural systems in order to ensure that their products could be officially recognized as “safe” in the international arena. It is thus vital to take into account international policy instruments, as they provide a legal framework for justification and support for CGIAR activities in food safety research.

International instruments deal with food safety directly or indirectly. They may take the form of regulations, agreements, standards, guidelines, certification systems, etc. and could either be binding or non-binding. Many international instruments include food safety as a secondary/indirect objective (or perhaps better described as an indicator) for pursuing other goals. For example, regulations and standards dealing with plant/animal health would include those plant/animal diseases that might affect the health of consumers who eat them. Trade agreements and product quality standards might use food safety as the basis for their minimum requirements for trade to be allowed. Regulations that aim to protect the environment from certain types of pollution concern the use of agricultural chemicals (pesticides), or deal with the environment in which the food might be grown and harvested – including the sea. Such international instruments might include those listed in Table 1.

While WTO (SPS), Codex, OIE, and HACCP are perhaps considered to be the major instruments that govern food safety at the international level, it is necessary to emphasize that there are many others that might have impact on food safety, particularly when considering research needs. It depends on the country’s agricultural methods, environmental conditions, as well as a country’s membership in

various intergovernmental agreements. Table 1 is thus intended to be a more expanded list than the usual “food safety regulations list” to consider how the various legal and policy platforms might form the basis of an approach to food safety in a given developing country.

**Table 1 Examples of international legal/policy instruments that deal with food safety**

Description	Examples
Agreements/standards directly dealing with food safety	<ul style="list-style-type: none"> <li>• Codex Alimentarius</li> </ul>
Sanitary and phytosanitary agreements/standards with implication on food safety	<ul style="list-style-type: none"> <li>• World Organisation for Animal Health (OIE) Health Standards</li> <li>• International Plant Protection Commission (IPPC)</li> <li>• Sanitary and Phytosanitary (SPS) Agreement of the WTO</li> </ul>
Trade-related agreements/standards that deal with food safety	
Environmental agreements dealing with hazards that might affect food safety	<ul style="list-style-type: none"> <li>• Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade (PIC)</li> <li>• Stockholm Convention on Persistent Organic Pollutants (POPs)</li> <li>• Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal</li> <li>• Regional Seas Conventions and Action Plans<sup>10</sup></li> </ul>
Certification systems and standards dealing with food safety as part of market product quality	<ul style="list-style-type: none"> <li>• ISO 22000:2005</li> <li>• Hazard Analysis and Critical Control Points (HACCP) Systems</li> <li>• Good Agricultural Practices (GAP)</li> <li>• CIES Global Food Safety Initiative (GFSI)</li> <li>• Ethical Trading Initiative (ETI)</li> </ul>

Countries normally set up their national regulations in accordance with international regulations for which they might be a signatory, or in order to implement certain voluntary standards in order to qualify for a better recognition of their food production systems. Some national instruments might also be intended to protect local consumers. The CGIAR Centers aim to conduct IPG research. Research processes and products must be in line with the regulations set forth by the producing country as well as in all countries at which the food product is targeted to ensure market access.

## **6. The developing country situation**

The basic concept behind food safety standards in any country is the same, namely that food (and food product) must be safe for human consumption. However, the situation surrounding food production depends much on the variability of crops/livestock/fish, farm sites, procedures, equipment, worker condition, and so on.<sup>11</sup> Thus there is a need to analyze the different food production systems/environments in a particular developing country in order to address the different food safety problems encountered by its small-scale farmers.

<sup>10</sup> These are: Barcelona Convention, Abidjan, East Asian Seas Action Plan, Cartagena Convention, Nairobi Convention, North-West Pacific Action Plan, Guatemala Convention, Helsinki Convention, OSPAR Convention, Arctic Council for the Protection of the Arctic Marine Environment, Global Programme of Action for the Protection of the Marine Environment from Land-based Activities.

<sup>11</sup> While most of the issues discussed in this section apply to agriculture involving plant crops as well as for fruit, vegetables, livestock, and fish, some of the specific examples might be specific to crops.

Food production systems in developing countries have their own characteristics and dynamics, some of which might be fundamentally different from those in developed countries. A particular example is that a country might have two levels of food production, consisting of foods produced for local consumption, and those treated simply as commodities destined for export. The establishment of such layers might be a product of a complex historical background (such as colonialism), or a reflection of the current political/economic situation of a particular country; it could be closely linked to other issues as governance, land/resource allocation, and essential agricultural services such as research, training, marketing and extension. However, the fact remains that these food production systems currently co-exist within the same national boundary, serve different economic purposes, cater to different consumers, and are likely to have different food safety concerns that need to be addressed (see also box 1).

The typical characteristics of the local versus export markets are summarized in Table 2 below. Food safety concerns for local consumption often differ from those targeted for the international markets and in developing countries production infrastructure/systems might be less well established, or are inadequate in handling the requirements of food safety for both local and export-driven markets. Concerns may focus less on meeting international requirements/standards but more about dealing with substantive hygienic concerns, including water hygiene. In some regions, food safety might need to take into consideration consumers with lowered immune systems or those suffering from chronic malnutrition.

**Table 2 Characteristics and food safety concerns of the different types of markets found in developing countries (adapted from a case study in Zimbabwe provided by Kuiper et al.)**

	<b>Local (national) market</b>	<b>International market</b>
Market range	Neighboring families, passers-by of the nearby shop, larger national retail shops in the cities	Within regional free trade / common market zones (e.g. SADC, COMESA, NAFTA) Other, mostly developed countries (USA, EU?)
Labor force	Family labor and small labor force during busy seasons	Larger labor force with seasonal workers
Primary production	Potential for contamination through: Inappropriate pesticide selection / application / storage (lack of knowledgeable people) Inadequate grading labor Inadequate farm hygiene (workers, other animals) Poor water sanitation due to shared water supply with cattle and other purposes, inappropriate sewage treatment	Similar concerns to those for the local market Lack of knowledge of international standards and requirements Lack of monitoring capacity
Harvest, slaughter, and storage	Inadequate farm hygiene (workers, other animals) Inadequate storage facility and conditions (lack of temperature and hygiene control)	Similar concerns to those for the local market Larger labor force may be difficult to monitor for hygiene/health of workers
Processing	Mainly manual or through use of communal facility/equipment Lack of knowledge on, and funds for,	Use of individual or communal handling/packaging facilities Food safety standards of external pack

	cold chain maintenance, food safety systems (HACCP), personnel	houses affect produce Negligence in handling “lower grade” products from small-scale farmers Poor infrastructure for cooperative packing facilities
Storage and transport	Relatively shorter distance from farm to market Dependence on others’ transport Lack of control over temperature, wait time, handling (e.g. workers might sit on the consignment)	Longer distance from farm to market Distance to market destinations, unreliable transport
Monitoring	Local authority is not legally empowered to enforce safety standards; may be subject to changes in local needs	Must follow regional/international requirements May suffer from inadequate financial capacity to employ food safety personnel
Other	No communication channel to relay consumer needs to producers Low literacy rate might prevent proper reading of labels, cautions, etc. on chemicals and fertilizers Food safety training sessions are too costly and logistically impractical for rural small-scale farmers	New and changing national requirements for product certification including food safety standards (e.g. PVOC, COTEC NA, TISCAN) Different languages and interpretations of foreign standard documents Phytosanitary certificates required by other countries

### *Hygiene and Water*

General hygiene is of particular importance in ensuring consumer health in developing countries. Inadequate conditions may affect the hygienic quality of fresh produce such as fruit and vegetables at the time of harvesting, packaging, storage and transport, with serious adverse effects on human health. Loss of market access due to reduced quality and non-compliance with hygiene requirements or standards also have economic consequences. Major factors which must be taken into consideration with respect to hygiene include the state of premises, sanitation, installations and equipment, personnel hygiene and water quality.

In particular, water quality is a crucial factor, affecting many aspects of general hygiene. Water might be one of the simplest means of improving hygiene by washing the equipment, animals, as well as the workers on the premises. However, unhygienic water could become the primary threat to food safety, transmitting many waterborne pathogens. Some contaminants present in the environment (such as dioxins, mercury and other heavy metals) could also make their way into the food supply via water uptake in plants that are consumed by fish and animals (or direct uptake in fish from the surrounding water), and could end up in food products.

In case of plant crops, water often comes in direct contact with edible plant parts and thus introduces a potential source as well as vehicle for microbial contamination. This risk is heightened when the crops are irrigated just before harvest. Since washing fresh fruit and vegetables is the easiest way in which to remove microbial contamination hazard from the surface, water quality becomes an essential concern. Several factors such as the type of harvest, the extent of exposure to contaminated water before harvest, the methods of handling harvested produce can influence the growth of microorganisms. The extent of contamination by dirty water on produce being handled depends on the water source, how and when it was used and the characteristics of the crop e.g. leafy vegetables, rough texture (that could promote micro-organism capture and/or attachment). In this regard, use of

wastewater in urban and peri-urban agriculture (as also described in the subsequent section) also poses a serious concern in developing countries.

A water quality control analysis program that evaluates the potential contamination hazards on the basis of the season and the environment of the water supply source would be a starting point in improving the water hygiene. This could involve periodic microbiological analyses, including faecal contamination detection tests (e.g. *E. coli* detection assays). A safer irrigation technique such as drip irrigation or low volume spraying might also be considered to reduce the risk of contamination through water.

#### *Urban and peri-urban agriculture*

A particular problem for developing regions of the world is the continuing increase in population, and migration to urban and peri-urban areas. Small scale production of foods in urban and peri-urban environments contributes on the one hand to urban food security and generates income for families, but this type of agriculture has negative environmental effects such as depletion of water sources, contamination of drinking water, soil erosion, loss of vegetation etc. Urban and peri-urban agriculture make a significant contribution to the supply of fresh foods in urban areas in Africa (Egal et al., 2003). Adverse effects can also be expected on the consumers often due to operation under sub-optimal conditions of food production, which include presence of agrochemicals, microbial contamination, zoonotic diseases, use of industrial processing effluent, product processing, and preservation. Further research is needed to identify critical points of potential health threatening risks associated with this type of agriculture, and more effort should be exerted on public education, training and communication.

#### *Detection and Tracing in an Environment of Small Farmers and Dispersed Markets*

Detection and Tracing processes are tools that monitor food products from production to consumption. This allows the identification of food hazards and their sources in the production chain, thereby eliminating or reducing significantly the threat of foodborne bacteria, other pathogens and toxins from reaching the consumers. Regulatory agencies and the food industry need fast, automated, cost-effective analytical methods that are sensitive, specific, reliable, and safe and that also minimize waste.

Detection methods vary widely depending on the type of food hazard, for which rapid in-field detection methods are needed. The increasing knowledge on the effects of compounds on signal transduction pathways in cells, including the transcription of specific genes, will lead to the development of new bioassays. New high throughput techniques may eventually allow rapid screening of many samples for many different types of activity in a relatively short period of time. Development of rapid and specific clean-up procedures, which is, at present, a rate-limiting step, is a prerequisite. Collaboration between laboratories in developed and developing countries in this area is of great importance in order to develop systems, which may also be used on-site by food producers. Various interesting applications of bioassays for other types of food contaminants have also been developed. These include the development of a bioassay for dioxins, estrogen assays, and those for acetylcholine esterase inhibitors (Hoogenboom, 2001).

Traceability refers to the capability for tracing goods along the distribution chain on a batch or series number basis, and is an effective supplement to other preventive measures implemented in the field or processing station. Information obtained by tracing will help to isolate and get rid of produce batches that could become a health hazard. The purpose of traceability is to provide evidence that a food producer complies with specifications and requirements, or that all the necessary measures have been

taken to comply with customer demands (customer approach) or to be able to trace the historical record of a product in case of a problem (food safety approach) or to comply with regulations (regulatory approach). Another purpose is to be able to store the history of the supplier processes so that it can be reviewed later in order to improve overall operations. The limitation of a traceability system is that it only enables one to find that which has been defined beforehand.

## 7. Modern biotechnology and food safety

### *Positive Impacts*

Modern molecular biological approaches such as assisted marker breeding and genetic modification using recombinant-DNA technology, may offer important possibilities to improve the quantity, quality and safety of agricultural produce. Potential applications through genetic modification include improvement of crops to suit specific environmental conditions such as drought, high salt/aluminium soil content or resist specific pests, and also crops are under development with the purpose of improving their nutritional value or safety properties.

**Table 3 GM crops with improved food safety quality currently under development. Animals. (adapted from information provided by Kuiper et al. using data collected by G.A. Kleter, RIKILT)**

Plant/Species	Altered characteristic	Transgene
Cassava	Cyanogenic glycosides ↓	Hydroxynitril lyase
Cassava	Cyanogenic glycoside ↓ (linamarin)	Silencing of P450 enzymes CYP79D1 and CYP79D2
Maize	Fumonisin ↓	De-esterase and de-aminase
Potato	Solanine ↓	Antisense sterol glycotransferase
Rice	Allergenic protein ↓	Antisense 16kDa allergen
Soybean	Immunodominant allergen ↓	Gene silencing of cysteine protease P34 (34kDa)

The total area of genetically modified (GM) crops grown in industrial and developing countries has been on the increase since 1996.<sup>12</sup> Currently the GM crops which are under cultivation have been modified through the introduction of one or a few genes coding for products conferring herbicide tolerance, insect resistance or a combination of these traits (James, 2005). These are still limited to agronomic traits; there are currently no crops in the market that directly addresses food safety. Although, considering that damage to maize plants inflicted by stem borers often predisposes to fungal infestation with mycotoxin contamination, it may be argued that the insect resistance trait indirectly contributes to food safety. A number of GM crops with traits that are aimed to improve food safety are currently under development (Table 4), mainly in lowering the levels of allergens, and toxins.<sup>13</sup> Currently no commercial GM animals, including fish, have been approved for the purpose of

<sup>12</sup> In 2005, more than one third of the global biotech crop area, equivalent to 33.9 million hectares, was grown in developing countries, with a continued growth reported by China, India, the Philippines, Argentina, Brazil, Mexico, Uruguay, Paraguay and South Africa.

<sup>13</sup> So-called 'quality' or 'output' traits with the purpose to improve human or animal nutrition and/or health. Substantial changes are made in the metabolism and composition of the GM plants and derived foods/feed. While they do not address food safety per se and are therefore not part of the thrust of this paper, it should be noted that this type of GM food/feed may be of particular interest for countries with problems regarding food security and nutrient deficiencies.

food<sup>14</sup> but ongoing research is being conducted on GM animals in the areas of reducing allergens in shrimp and preventing transmissible spongiform encephalopathies in cattle and sheep.

### *Potential Negative Impacts*

The application of modern recombinant-DNA biotechnology in agricultural production has also evoked serious criticisms from environmental and consumer organizations across the world. Concerns over the potential risk that this technology might bring to human health are among the main contentions in the layers of controversies surrounding GM crops.<sup>15</sup> Modern biotechnology can, therefore, be considered both as a tool for improving food safety as well as a technology for use on specific applications, which should be evaluated in relation to risks to food safety.

While most of the concerns might be considered exaggerated, theoretical and overly precautionary – particularly since many of the potential effects are identified and eliminated at the product development stage –,<sup>16</sup> some issues remain for closer examination. First is the potential unintended effect of growing abiotic-stress resistant crops. Specific alterations of the plant's metabolism leading to improved responses to environmental stress conditions such as salt or metal tolerance, or drought resistance, might induce fundamental changes in the stress-response mechanism of the plant, which might be triggered in certain conditions in the form of increased anti-metabolites and/or toxins. Another area is in the unintended/inadequate consumption of plants and animals that were intended for non-food purposes, such as “biopharming”<sup>17</sup> or “bioplastics”.<sup>18</sup> Also, rendering plants and animals tolerant to the presence of certain agents might simply make them become “silent carriers” of the disease, allowing the agents to get carried over to the consumers.

There are continuing discussions about whether genetic modification would require a new way in which safety is considered or whether it remains within the traditional approaches to food safety. Indeed, the source of food safety threat would be neither natural nor the result of contamination; it is a new composition of the whole food as a result of changes (both intentional and unintentional) in the genetic makeup. The change is also made at the pre-production stage. There are also doubts as to whether genetic modification as a technique could itself constitute a food risk – particularly when the same technique can be used to remove food risk (such as in removing allergens from whole foods). It is nonetheless important to pay special attention to the food safety discussion surrounding genetically modified foods for a number of reasons. Considering that many CGIAR Centers engage in transgenic research of various form, acknowledgement must be made that various public concerns have been taken into account. Attention must also be paid in order for it to not overwhelm the other, more conventional food safety issues that are the main concern of this paper.

## **8. Other issues**

### *Changes in Mycotoxin Infestation patterns*

Profound global environmental changes are observed in atmospheric decomposition, deterioration of land (erosion and degradation), depletion of ocean fish resources, decrease in ecological diversity,

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<sup>14</sup> A fluoroluminescent, ornamental zebra fish is the only transgenic animal commercially available so far.

<sup>15</sup> Issues that have been raised as a potential food safety concern in GM crops include the potential for integration, expression and stability of the transgene in the host, and pleiotropic effects due to expression of the transgene (morphological, metabolic abnormalities, altered susceptibility towards viruses).

<sup>16</sup> Food safety assessment is also a main step in the GM risk assessment process for regulatory approval, followed by environmental risk assessment and (the sometimes optional) socio-economic consideration.

<sup>17</sup> Production of pharmaceutical compounds in plants and animals.

<sup>18</sup> Production of plastics from plants.



spread of “invasive” species, and long-range deposition of persistent environmental pollutants. This may lead to further pressure on the safety and quality of agricultural produce.

Global climate changes may give rise to disruption of complex ecological systems that determine, for instance, the geography of vector-borne infections such as malaria, and the incidence of food-borne and water-borne diseases, ranges of plant and livestock pests and pathogens. Increased temperature and altered precipitation patterns may result in increased losses of soil minerals, potentially affecting interrelationships among soil microbial populations, and uptake by plants of trace metals and fertilizers, thus affecting plant growth and yield.

Changes in environmental conditions and the climate may thus have a range of different effects on agriculture (Battilani et al., 2007). Weather conditions may influence infection cycles of fungi, leading to different infection patterns; for instance *Fusarium graminearum*, producer of deoxynivalenol (DON) is favored by warmer climatic conditions. Aflatoxins produced by *Aspergillus flavus* are expected to become more prevalent with prolonged hot and dry weather. *F. verticillioide*, producer of fumonisins, is the most common species infesting maize in Southern Europe; the occurrence of fumonisins has been associated with dry weather during grain fill and late season rains, conditions foreseen with the predicted climate changes, and thus favorable for production of these toxins. However infestation levels will vary due to variations in climate that influence and determine local conditions.

#### *Harmful Algal Blooms*

An issue of increasing concern is that particularly aquatic “filter-feeding” animals such as mussels and other shellfish may serve as vectors for toxic substances contained by the plankton that they feed on. Various species of plant plankton (“phytoplankton”) can at times form large monocultures in seas and oceans, which are referred to as “harmful algal blooms” or “red tides”. In a similar fashion, blue-green algae may form in freshwater reserves. This phytoplankton growth is the result of a complex interplay of, *inter alia*, temperature, wind, current, water-dissolved nutrients (also from discharge of human activities), and sunlight. Therefore, changes in human activities and climate change may impact on the occurrences of these outgrowths

While these outgrowths can deprive other water life forms of oxygen, light, and nutrients, some phytoplankton species also produce substances that can be toxic (toxins). In addition, the toxins may be transmitted to humans consuming seafood contaminated with the phytoplankton and derived toxins. Various food intoxication symptoms are known, for example diarrhetic shellfish poisoning (DSP), and also a number of causative organisms have been classified, such as *Dinophysis*, which causes DSP. Identification of some of these phytoplankton species and their toxins is difficult, and therefore in some cases, a bioassay involving feeding rodents is still the official method for their detection.

In order to prevent contamination of shellfish and other marine foods with these kinds of toxins, national governments have monitoring programs for harmful algal blooms in place. If such blooms are anticipated, shellfish shall not be harvested and a “wash-out” period be considered before harvest.<sup>19</sup>

## **9. Summary of research recommendations for the CGIAR**

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<sup>19</sup> The issue of harmful algal blooms has caught the attention of UNESCO’s Intergovernmental Oceanographic Commission, which, among others, has established the Harmful Algal Blooms program. Within this program, students from developing countries are trained, for example, in the analysis and identification of harmful phytoplankton species. See <http://ioc.unesco.org/hab/intro.htm>

A sample of CGIAR Centers (Kassam and Barat, 2003) found that some Centers are conducting research related to food safety. The main focus of research seems to be with aflatoxin contamination by *Aspergillus* fungi in various crops. This may involve breeding for non-toxigenic strains of *Aspergillus* and the development of rapid screening assays to detect aflatoxins and metabolites (See Box 1, below). Other research involves plant breeding for agronomic traits that reduce the use of pesticides such as insect- and virus-resistance (including the development of *Bt* crops),<sup>20</sup> and dairy safety research on the issues surrounding milk-borne diseases. A more exhaustive investigation may reveal a wider variety of food safety research as part of greater research activities, such as integrated pest management and crop improvement.

Box 1. Detection of aflatoxins and its metabolites (source: F.Waliyar, ICRISAT)

Aflatoxin contamination is widespread in staple crops like groundnut, maize, cassava, etc. and compromises the safety of food and feed supplies. It is important to be able to detect and quantify aflatoxins in commodities to protect human and animal health. Many different methods, including antibody-based ones, are available for quantitative estimation of aflatoxins. However, most of these methods are expensive and/or difficult to use in developed countries.

Using the state-of-the-art facilities, scientists at ICRISAT developed polyclonal and monoclonal antibodies for the detection of total aflatoxins, aflatoxin B1 and M1 (secreted in milk). These were used to develop a simple and inexpensive competitive enzyme-linked immunosorbent assay (cELISA). The cELISA has lower detection limit of 2.5mg/kg and each sample analysis cost US\$1, cheapest in the world, and >100 samples can be analyzed in a day. In addition, M13 phase-displayed aflatoxin epitope (mimotope) was identified, that can replace the aflatoxin standard in the ELISA test, further reducing the cost and increasing the safety. Polyclonal antibodies were also produced against aflatoxin-albumin adduct in humans to identify the aflatoxin-exposed populations by cELISA. The detection limit of this test is 5pg/mg albumin and costs US\$2 per sample analysis.

These tests have provided a unique opportunity for ICRISAT and its partners to conduct field studies to identify high risk populations and determine the dietary sources to stimulate appropriate interventions to enhance the food and human health safety, and trade thereby farmers' income. The diagnostic reagents are widely distributed to partners in Asia and SSA. ICRISAT helped in setting up of 16 aflatoxin monitoring laboratories in India, Mozambique, Kenya, Malawi and Mali that uses our cELISA technology. These laboratories are contributing to the quality certification of the farmers produce and enhancing the competitiveness of the produce in domestic and international markets. For instance, the aflatoxin laboratory at Malawi contributed to the revival of groundnut exports to Europe and South Africa. Current efforts are focused on developing simple and inexpensive on-site screening test for aflatoxin estimation.

Arising from the discussion earlier in this document as well as in other related documents (Narro et al. 2005; Kassam and Barat, 2003; TAC 2001), the following list of potential research areas on food safety in the CGIAR can be gathered. This is neither a definitive list nor a recommendation that the CGIAR Centers must pursue. Rather, this is a starting point for discussion in order to determine whether food safety is indeed a high priority for CGIAR *research*, and if so, how the subject area should be framed in order to identify research/capacity needs and niche areas for CGIAR intervention.

*Improving food safety down the production chain*

<sup>20</sup> This research is also related to the aflatoxin research, as damaged crops are more prone to *Aspergillus* infestation.

- Integrated pest management methods to reduce agrochemical use and frequency
- Post harvest technology research and dissemination for improving grading and quality standards
- Research on allowing small-scale farmers to meet food safety standards; aligning food safety controls along required food quality certification – particularly in the area of risk assessment and traceability
- Development of detection methods associated with food production by smallholders; partnerships or co-operatives to develop simple and rapid detection methods for various types of chemical and biological agents threatening food production chains
- Strengthening the analytical capability of laboratories in the area of food contamination monitoring and food safety quality assurance

#### *Policy matters*

- Identifying what policies and institutions are required to fulfill the standards demanded in food production processing and distribution
- Innovative approaches to risk management: Different institutional options, involving certification systems, overcoming transaction costs, distribution of benefits and risks between smallholders and market agents, and evaluation of effectiveness.

#### *Modern biotechnology (transgenic research)*

- Development of GM food/feed crops of importance for developing countries with improved safety characteristics
- Research on food safety surrounding the development of GM food/feed crops with improved characteristics to resist ecological and environmental stress conditions prevailing in developing countries, particularly regarding unintended effects in the composition

#### *Water hygiene*

- Evaluation of methods for the potential contamination hazards at different seasons and water supply source, and development of a set of microbiological analyses of water
- Development of safer irrigation techniques that would reduce the risk of water-borne diseases.

#### *Nutrition*

- Elucidation of the interaction of nutrition and food safety (genomic and metabolic profiling methods; nutritional status of susceptibility to naturally occurring toxins, pesticides and food borne diseases from microorganisms)
- Development of foods/crops with reduced toxins and improved nutrient quality by either conventional or genetic methods

#### *Detection and traceability*

- Experimental approaches for early detection of the occurrence of food contaminants, using methods which are of low costs and may be applied during the production phase at farm level or during storage and processing
- Development of rapid screening assays that can be used for extensive monitoring programs.
- Design of new screening methods for chemical contaminants in foods, based on biological principles, which may be applied in field situations.



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## Annex 5

### Food Safety Research Priorities for the CGIAR - A concept note from IFPRI for the Science Council

prepared by  
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#### 1. Introduction

Today almost half the world's population living on less than two dollars a day mainly consumes subsistence foods (staples) (WDI 2006). As incomes rise, households devote a smaller share of the food budget to grains and other starchy staples and a larger share to meat, milk, fish, fruits, vegetables, processed foods, and prepared foods. For example, a study of Chinese food demand revealed that income elasticities for fish, poultry, and pork are in the range of 0.7 to 3.4, while those for grains were 0.1 to 0.2. The income elasticities for fruits and vegetables were in between these two ranges (Hsu et al., 2002). Thus, with growth in incomes, the share of perishable commodities in the consumption basket increases. This implies that alongside consumption diversification, the demand for food safety starts to grow with rise in incomes. Delgado (2005) points out that not until consumers' income increases to above ten dollars a day that they begin to be able to afford to pay for certain food safety and quality attributes.

The importance of food safety for development outcomes increases with changing diets towards more perishables. Unsafe food is a risk factor for malnutrition owing to its effect on food borne diseases; diarrhea caused by consuming unsafe food is particularly associated with malnutrition (WHO). Food safety standards, such as those imposed to meet enhanced food safety requirements however can affect farm incomes negatively through reduced market access in products that comprise the most dynamic segment of food markets. This, in turn can affect household welfare and food consumption. This is extremely relevant in a world where 75% of the poor depend on agriculture for livelihood.

Thus, as the CGIAR Centers begin to address food safety issues they will have to identify the extent to which the Centers focus their efforts on food safety and its impact on market access and the extent to which they will look at food safety as a good in itself to provide to poor people. With large scale dependence on agriculture for the poor, poverty cannot be reduced without investing research efforts into understanding the implications of changes in food safety requirements for the poor producers along with the poor consumers. If small scale producers/processors are not able to meet the new food safety requirements, it is likely that they will be further marginalized. This will be particularly important if the domestic food safety regulations are also designed to cater to the needs of rich country export markets and a minority of wealthy consumers in their countries. Especially at risk with such changes are the small producers who face four distinct problems: 1) how to produce safe food; 2) how to be recognized as producing safe food; 3) how to identify cost-effective technologies for reducing risk; and 4) how to be competitive with larger producers.

Smallholders are a development priority of the CGIAR system. Overall, smallholders currently constitute 85% of the world's 460 million farms (von Braun, 2005). In most developing countries there has been a continuous process of fragmentation of land holdings. In Africa, for example, the average size of landholdings has been declining over the last few decades – in Democratic Republic of Congo, it shrunk from 1.5 to 0.5 hectares between 1970 and 1990, while in Ethiopia, it decreased from 1.4 to 0.8

hectares between 1977 and 1990. India's average farm size has decreased from 2.2 hectares in 1950 to 1.4 hectares in 1995/96 (FAO Statistics Division). Similar trends hold for Asia. In China, the average farm size has decreased from 0.56 hectares in 1980 to 0.4 hectares in 1999 (Fan and Chan-Kang, 2003). In developing countries, the share of smallholders in operated area is also sizeable. In India, farms smaller than 2 hectares constitute 40% of the area. The corresponding numbers for Nepal, Bangladesh, Indonesia, Egypt and Ethiopia are 68%, 83%, 54%, 47% and 67% respectively. Smallholders also account for a sizable share of agricultural production and in many instances their contribution is growing. In India, smallholders contribute over 40% of food grain production (in comparison with 33% in 1980); they own the majority of livestock and dominate the dairy sector (Narayanan and Gulati, 2002). In Kenya, their share in agricultural production had increased from 4% in 1965 to 49% in 1985 (Lele and Agarwal, 1989) while their share in Malawi is 85% (Malawi Department of Information). In Ethiopia, smallholders contribute 97% of total milk production and 75% of commercial milk production (Ahmed, Ehui, and Assefa, 2004).

Despite the large share in holdings and the volume of production, smallholders remain among the most disadvantaged and vulnerable, next to the landless and urban poor. 50% of all undernourished people in the world, three-quarters of Africa's malnourished children, and the majority of absolute poor can be found on small farms (Millennium Project Task Force on Hunger, 2005). Recent research in India shows incidence of hunger at 32% among farmers with less than 0.5 hectares. The incidence of poverty is 38% for the same group; the likelihood of being affected by hunger or poverty drops to 12 and 13% respectively for farmers with more than 4 hectares (Singh, Agricultural Policy 2004). In Africa, the average per capita income of smallholders in most countries falls below the poverty line. In Mozambique, the poverty line is nearly four times the per capita income of the smallholders.

This concept note addresses areas where the Consultative Group on International Agricultural Research (CGIAR) could take an active role in filling food safety research gaps tailored to the needs of the poor producers/processors and consumers. There is increasing evidence on tightening of both public and private food safety standards in developing countries. Recent food scares (avian flu and salmonella) and associated illnesses and deaths in Asia combined with increased urban concerns have resulted in a growing political awareness regarding the need to reduce the incidence of food hazards in commodities through the establishment of food safety standards and regulations for products regardless of whether they are destined for the informal, formal, or export markets. In light of this change, the research output generated could be extremely useful in supporting analysis that inform decision makers of the cost and effectiveness of policies to improve food safety *vis a vis* the alternatives, in particular those alternatives that might be more cost-effective for the poor to implement.

## **2. Changes in the food system with respect to food safety requirements and its implications**

Food safety is receiving heightened attention in both developed countries (DCs) and LDCs (see Unnevehr, 2003). There are several reasons for this change. First, as discussed above, the demand for safe food rises as income increases; consumers willing to pay more for food with lower risk of microbial contamination, pesticides, and other disease-causing substances. Second, as technology improves, it is easier to measure contaminants in food and document their impact on human health. Third, trade liberalization has increased opportunities for agricultural exports, and food safety regulations have become the binding constraint on food trade in many cases. Fourth, international food scares, including those related to BSE and avian flu, have made consumers, producers, and legislators more aware of the risks associated with food safety problems.

Though all countries share similar concerns about food safety, the relative importance of different risks vary with climate, diets, income, and public infrastructures (Unnevehr, 2003). Yet LDCs, with their cheap labor and comparative advantage in production of many types of food products, are

increasingly becoming the suppliers to DCs. Recognizing the benefits of being at the source, multinationals have set up shop in many LDCs so as to source their supplies to meet domestic and international demand. These companies have high standards and provide technical assistance to their suppliers to ensure the delivery of products with certain safety attributes to high-end markets. Though these companies may be the suppliers of products going to specific markets, the majority of the agricultural production in LDCs still remains in the hands of poor households who are not necessarily aligned to multinational supply chains.

Implementing food safety standards requires having processes in place to control food hazards along the whole supply chain. Many food safety hazards stem from problems associated with inputs into production, growth and transport of microbial pathogens, and are magnified as products move along the supply chain. The supply chain in many LDCs is now often based on transactions in spot markets, implying limited communication and coordination between farmers, traders, and consumers. This lack of coordination coupled with poor infrastructure and insufficient cold storage systems create an environment in which market participants have little incentive to reduce microbial pathogens and pesticide residues. Historically, the LDC markets were characterized by inter-personal transactions, in the new food system especially with food safety standards, the supply chain has become longer, wider, and anonymous. However, the institutions have not been developed to replace what a handshake could once achieve. Thus it is common to observe obsolete public food safety laws in several developing countries while the effective private regulation has changed drastically.

In countries where water quality is poor, irrigation on farm or use of inadequately composted animal manures can be a source of contamination. Further, poor water quality can lead to contamination or cross contamination of agricultural products after the product is harvested through the use of contaminated water in food preparation or processing regardless of control measures put in place along the supply chain. Of major concern are waterborne pathogens such as bacteria (i.e., salmonella and campylobacter), viruses (i.e., hepatitis A and rotavirus), and parasites (i.e. giardia and cryptosporidium). These pathogens are of concern also for many developed countries; currently in the US contaminated groundwater is responsible for approximately 68% of the waterborne disease outbreaks reported each year despite the existence of public sector monitoring programs (Brodsky, 2005). The World Health Organization (WHO, 2002) estimates 1.7 million deaths and 54.2 million disability adjusted life years (DALYs) lost worldwide per year due to unsafe water, hygiene and sanitation (Jalan et al 2003).

Peri urban production of fruits and vegetables using wastewater is quite common in developing countries and could be an important source of contamination. Wastewater contains high concentrations of pathogens (like helminthes eggs and bacteria) that have the potential to cause disease. Untreated wastewater irrigation leads to relatively high prevalence of hookworm (Feenstra et al 2000) and Ascariasis infections among children (Cifuentes et al 2000 and Habbari et al 2000). Though most of the ailments following consumption of food products treated with wastewater need not necessarily be life threatening but the impacts of diseases could have important implications relating to development. Worm infections for example affect the school attendance of children strongly as shown by Miguel and Kremer (2004). Yet some other diseases could even be life threatening. Dalsgaard et al (2001) quoting World Bank study states that cholera and also typhoid can be effectively transmitted by irrigation of vegetable crops with contaminated water. To minimize the potential for the health hazard from the use of wastewater, the World Health Organization (WHO) has clearly laid out guidelines for the safe use of wastewater for agriculture and aquaculture (Husain et al 2002). Yet, the use of untreated wastewater continues unabated in most developing countries. This is surprising especially in light of the availability of some low cost treatment options that can substantially lower the risk from wastewater usage.



Part of the reason that in spite of the risks associated with the use of peri urban waste water, the demand for fruits and vegetables treated with such water exists is the lack of information among consumers. The lack of information leading to markets not providing standards (that could be achieved at low costs) is quite prevalent in developing countries. Hence research on the assessment of demand for food and water safety and the factors behind the observed demand patterns have strong policy implications. There exists a scant literature on this topic. Jalan et al (2003) establish that in the presence of low cost options to purify water, providing information to households led to significant adoption of such techniques. Thus, if lack of awareness constrains the demand for food safety, then interventions like public education become very important. With low cost treatment options available, a market driven solution could then be attempted and the public sector need not necessarily provide such services.

In contrast with the DCs where a variety of sanitation and food safety management practices (implemented through initiatives such as HACCP and Eurepgap) are in place, many of these practices do not exist in LDCs. In many cases, consumers in LDCs have adapted to the problems by implementing certain cultural practices (boiling/fermenting/cooking food for long periods prior to eating) to reduce the likelihood of the presence of food-borne pathogens. These practices however are effective in a limited way and cannot control the effect of several pathogens. Poor lack access to expensive mitigation technologies and are more vulnerable to risks because of unsafe food and water. Similarly, poor are less likely to afford safer food that command a price premium. Thus, higher standards may lead to reduced consumption of certain foods implying that the net nutritional effect on the poor may be negative. Proposed standards requiring pasteurization of milk in Kenya is one example. This highlights the trade-off between food safety and low-cost food supply for the poor that needs to be fully understood when policy decision regarding standards are being implemented.

Unfortunately, governments in many developing countries and the private sector are implementing food safety standards to meet international requirements without exploring all the ramifications and the possibility of alternative solutions that could offer a better cost benefit ratio. Limited understanding of ways to mitigate these problems that are relevant and cost-effective for the poor can result in prescriptive rather than performance-based standards. Prescriptive standards are often less flexible and have higher fixed costs, which may result in the displacement of poor producers from the market. Gaining a comprehensive understanding of the problem, and potential solutions involves multidisciplinary research studies and a framework in which to analyze the effectiveness of policy choices tailored not only to the large producers, but also the situation of poor producers/processors and consumers.

The research priorities of the CGIAR Centers currently are: 1) sustaining biodiversity for current and future generations; 2) producing more and better food at lower costs through genetic improvement; 3) reducing rural poverty through agricultural diversification and emerging opportunities for high-value commodities and products; 4) poverty alleviation and sustainable management of water, land, and forest resources; and 5) improving policies and facilitating institutional innovation to support sustainable reduction of poverty and hunger. Within the scope of these priorities many food safety knowledge gaps affecting the poor can be addressed. The CGIAR Centers could play a pivotal role in identifying cost-effective risk mitigation technologies, risk-risk trade-offs, and effective institutions for delivery and monitoring food safety so as to alter policy decisions that are inadvertently affecting the poor producers. This proposed food safety research agenda seeks to promote the participation of poor households and low-income countries in the production of safe products for both local consumption and export and to develop decision tools relevant for developing countries, such as risk analysis, in a manner that decision makers can utilize effectively.

### 3. Issues on focus in this concept note

This paper discusses the following sets of issues that relate to the food safety research priorities of the CGIAR:

- Focus of institutions currently involved in food safety research
- Key food safety issues affecting the poor producers/processors
- Role the CGIAR Centers could play in food safety research
- Researchable questions targeted at aiding poor producers/processors that the CGIAR could focus on
- Institutions that could be mobilized to fill food safety research gaps involving the poor

The discussion below summarizes findings from two round-table discussion groups held in 2005 in conjunction with the American Agricultural Economics Association meeting and the International Association for Food Protection meeting. It provides insights of experts from different backgrounds in identifying food safety research priorities for the CGIAR Centers. Participants were experts involved in research, policy work, or in implementing practices directed at improving food safety, animal health, or plant health, or had knowledge of the CGIAR Centers and came from universities, governments, international institutions and the private sector.

#### 3.1. Research focus of institutions currently involved in food safety research

Historically, in food safety research, the private and public sectors have complemented each other. The public sector has largely focused on areas where private sector incentives have traditionally been weak or have become weaker as incentives changed. Though most food safety research historically has been directed at supply side questions (such as technologies to ensure proper detection of pathogens), increased efforts are being directed at understanding areas where there is the most demand for food safety (such as estimating the willingness to pay for food safety attributes of food and water).

The main objectives of food safety research fall into the following seven categories:

1. To measure the incidence of foodborne hazards and factors associated with growth of microbial organisms and other harmful contaminants along the supply chain,
2. To develop technologies to measure and mitigate foodborne hazards along the supply chain and identify crucial infrastructure needs,
3. To inform the design of food production and processing procedures and standards,
4. To monitor the incidence of foodborne disease and identify the causes,
5. To provide insights into demand for food safety by different types of consumers.
6. To provide education and technical assistance in order to understand socio-economic factors affecting delivery of research, technology transfer and adoption,
7. To inform the design of policies and institutions to maintain food safety

The public sector has been the source of most basic research (original research that advances scientific knowledge but with no immediate commercial application), while the private sector has focused on applied market-oriented research. The relative importance of the public and private sectors in these research areas based on a qualitative assessment of the kinds of activities carried out by each sector is depicted in Table A (see Narrod *et al*, 2000). In the area of foodborne hazards, both sectors have made large research investments. Private research has focused on developing products in which intellectual property rights can be protected such as new machinery and diagnostic kits. Public research has emphasized basic studies on antibiotic drugs, microbial pathogens, pesticides, mycotoxins, parasitic disease, and heavy metals. The public sector has also conducted research on pathogenicity, epidemiology and ecology of microbial pathogens. The public sector increasingly conducts research in

the area of risk assessment and aids the private sector in the development of new control methods in agricultural production and processing.

**Table A: Roles of the public and private sectors in food safety research and education**

Area	Private Sector <sup>a</sup>	Public Sector <sup>a</sup>
Research on foodborne hazards along the supply chain	** Applied research to ensure products have acceptable levels for shelf-life and handling. Applied research on hazards leading to development of new tests to detect hazards.	*** Basic research on antibiotic drugs, microbial pathogens, pesticides, mycotoxins, parasitic disease, and environmental contaminants; Research on pathogenicity, epidemiology and ecology of hazards; Development of risk assessment models for hazards.
Research on technologies to measure and mitigate foodborne hazards along the supply chain and identification of crucial infrastructure needs	*** New equipment or methods to prevent them where market or regulatory incentives exist (eg antimicrobial rinses).	*** Development of new control methods in agricultural production and processing.
Food Production and Processing Procedures and Standards	*** Applied research leading to the establishment of standard operating procedures, good manufacturing practices, and HACCP systems.	*** Research to develop new methods of monitoring or to determine appropriate standards for regulation.
Foodborne Disease Surveillance	* Little involvement unless customers are affected.	*** Monitoring and investigation of disease incidence and outbreaks; research to understand public health consequences.
Education, technical assistance, technology transfer, and adoption	** Provision of technical service independently or along with sales of a food safety product or vaccine; Industry organizations may provide education to members.	*** Education of consumers, food service workers, industry managers or small firm owners through publicly supported programs; Applied research to understand factors and prioritize research efforts and identify ways to improve adoption.
Analysis to support decision making, policy design, and standard setting	* Little involvement unless regulatory actions effect profit; then conduct research to submit to public effort in an effort to alter regulatory agenda	*** Applied research in the development of risk assessment, cost-benefit analysis, and cost-effective analysis in support of regulatory analysis and standard setting; research on risk ranking for priority setting, and identify risk-risk trade offs, research to identify effective ways to communicate risks to public
Analysis of demand side concerns for food safety	** Research to understand demand for food safety so as to implement technologies or management process at critical points along the supply chain to ensure competitiveness	** Research to understand demand for food safety so as to prioritize food safety regulatory efforts; research to understand the cost of foodborne illness

<sup>a</sup> stars indicate relative emphasis on research by sector: \*\*\* major focus of research; \*\* important but secondary focus of research; \* little research conducted.

Source: Narrod, Unnevehr, and Pray, 2000

In the area of procedures and standards, the private sector has played an active role in developing its own guidelines for processes, which may be used as internal standards or specified as part of contracts between firms. In case of product standards the private sector (markets) provides some product standards efficiently. This is the case where there is no market failure because of benefits not being internalized by the provider. The most common examples are the standards known as the ISO series; the International Standards Organization certifies these standards. The reason these standards are provided efficiently by the market is that the benefits of such standards are internal to each consumer. When there is asymmetric information, then the privately provided standards mediated

through third party certification could depict quality. Else publicly provided process and product standards based on research could be employed to signal quality.

The public sector has also conducted some research to develop new means of monitoring the hazards and to assess the feasibility, benefits, and appropriateness of kinds of standards for regulation. There is a clear connection between this type of research and risk assessment, cost-benefit analysis, cost-effectiveness analysis, and risk communication. For the most part, the public sector has been the primary actor involved in this type of research to inform the regulatory process. Foodborne disease surveillance and the associated public health research are a unique public sector responsibility, and are carried out at the national, state, and local levels.

Education is undertaken in a limited fashion within industry, but more broadly by the public sector to serve different parts of the food chain. In one sense, both the public and the private sector have conducted some research on demand. The public sector research on understanding the cost of foodborne disease has been a derived demand to help prioritize their regulatory efforts. The private sector has focused its efforts on trying to understand the demand for food safety to implement technologies or management processes at critical points along the supply chain to ensure their competitiveness.

Though significant contribution has been made by both pure and applied research towards improving food safety, most of this research has focused on developed countries. Little research has been targeted towards the developing country needs and in particular the poor there. Critical research gaps thus exist in the scientific understanding of ways to improve the situation of the poor because of food safety regulations (both as producers and consumers). Applying existing knowledge to improve food safety in developing countries without adapting it to the client needs in developing countries may restrict the net benefits to be small. The characteristics of the households that are pertinent for the design of a food safety system in the poor countries are the small farm sizes, low levels of human capital of the farmers and the consuming households, lack of liquidity and low purchasing power, modest use of agricultural inputs in production, low opportunity cost of labor and limited access to markets. The lack of food safety research tailored to the needs of the poor producers/processors and consumers within LDCs provide an ideal opportunity for the CGIAR Centers to target their efforts at filling these research gaps. The CGIAR Centers with their extensive coverage and foothold in developing countries imply a strong platform to initiate and develop food safety research that fits the realities of developing countries some of which have been mentioned above.

### **3.2 Key food safety issues related to the poor in developing countries**

Treating the fragmented nature of landholdings as generic to most developing countries, there still are several key food safety issues affecting the smallholders on which the development community would benefit significantly from an improved understanding. The lack of understanding can result in inefficient prescriptive actions and the introduction of technologies and process that are not necessarily cost/effective for the poor and ignore risk/risk trade-offs. Below, we present an outline of issues affecting the poor that were suggested during the roundtable discussions and was understood that that we lack complete understanding of:

- A. Foodborne hazards along the supply chain associated with production by the poor producers/processors
  - Nature of hazard - microbial pathogens, pesticides, aflotoxins involving the poor
  - Contributions of water supply to foodborne disease amongst products produced by poor
  - Food safety situation associated with street vendor or in general the informal food services sector

- The agent(s) associated with emerging zoonotic diseases relevant to poor; how is disease transferred; what is its cause?
  - Costs to the poor of foodborne disease
  - Identification risk/risk trade-offs
- B. Controlling source of problems (pest, disease, food safety) and eradicating or controlling for the problem and establishing appropriate infrastructure
- Costs and benefits and effectiveness of small-scale intervention strategies to reduce risk
  - Identification of market practices/infrastructure necessary to ensure the delivery of safe agriculture products by poor producers
  - Identification of important risk and cost associated with poor infrastructure (i.e. reliable electricity for cold storage)
- C. Food production and processing procedures and standards (establishment, monitoring, and impact)
- Implications of such standards in informal marketing channels serving to link smallholders to poor consumers; market vs. national/international regulatory requirements; Different slaughter/processing lines within countries;
  - Current practices for measuring standards; Optimal standards for different size producers/markets; Prescriptive vs. performance based standards and impact on the poor
  - Methods to monitor compliance and accountability; Third party certification
- D. Foodborne Disease Surveillance
- Baseline surveillance of foodborne health problems amongst the poor producers/processors
  - Potential for the establishment of foodborne disease outbreak reporting networks targeted at poor producers/processors
  - Existence of sensitive robust tests for foodborne hazards that the poor can use
  - Possibility for establishing equivalency in different monitoring approaches for disease that may be suitable to areas where the poor are producing agricultural products that differ from internationally prescribed methods.
- E. Education and technical assistance and the effectiveness of technology transfer and adoption of control mechanisms in food production/processing
- Adoption of safe cooking practices and sanitation programs
  - Teaching hygiene and risk reduction methods for preventing cross-contamination in pre-harvest and post harvest
  - Effectiveness/feasibility/acceptance of implementing small-scale inspection regimes
  - Developing/adapting technologies that are inexpensive, and reasonably accurate testing methods for residues and microbial pathogens and that are rapid and easy to use
  - Policies/institutional practices preventing producers from adopting cost-effective food safety control measures
- F. Policy design and standard setting for the poor producers/processors
- Analysis of market failures associated with food safety of the type that lead to exclusion of small farmers and small processors
  - Externalities adversely affecting food safety associated with other problems in the production system
  - Relationships of poor producers/processors to larger integrated producers
  - Analysis of the indirect costs of control measures and implications of measure that may require restructuring of the industry to control diseases

- Knowledge and analysis of factors other than food safety standards of the international market that determine the poor's access to markets (eg. disease/pest reason)
- Successful cases of private and public sector collaboration in meeting food safety objectives for the poor
- Free rider problem- Owing to reputation effects, how are free rider problems avoided in successful cases involving poor producers in exports? What factors determine success? What factors accounted for failure?

G. Demand for food safety

- Extend of existing institutional support directed at the poor/ identification of how they could be strengthened to meet the food safety needs of the poor
- Degree of confidence in the government; What is the level of faith in official institutions?
- Unmet public demand for food safety
- Understand what the market incentives for meeting food safety standards are

### **3.3. Potential role of the CGIAR Centers in foods safety research**

The CGIAR system was formed to mobilize science to conduct research to benefit the poor and generate global public goods. The research agenda has evolved over time from the original focus on increasing productivity in individual food crops to a broader focus recognizing that biodiversity and environmental research constitute the key components in enhancing sustainable increases in agricultural productivity. With growing attention being placed on improving food safety by both developed and developing countries, the sustainability of the system with small producers/processors depends critically on enhancement of food safety attributes of production and other processes in the food chains involving small farmers and processors. The CGIAR Centers could play a pivotal role in facilitating their efforts to improve food safety of their products by identifying mechanisms to produce safe food, establishing reliable institutions that can monitor and certify that products are equivalent to certified products from more formal institutions. At the communication level, the Centers could demonstrate to decision makers where a deeper understanding of the issue may result in actions that do not marginalize the poor. This is especially relevant in a situation where grading, standards and certification by private agencies turn out to be uneconomical for the small players in the markets. A system with cheaper costs of certification but accepted equivalence will be particularly helpful to the small producers and processors.

Risk analysis of products is the tool currently being used internationally for assessing the risks associated with the sanitary and phytosanitary concerns. Risk analysis aims to aid decision makers in evaluating policy alternatives, taking into account science, science based risk assessments, and economics (cost/effectiveness and cost/benefit). The risk analysis models are meant to be dynamic; evolving as data and science improves. Alternatives are designed to focus on the multiple objectives that decision makers have when deciding a course of action. If real data exist then epidemiological models could be used to analyze outcomes from food safety interventions.

The CGIAR system, encompassing many types of scientific expertise, offers a unique opportunity to promote multi-disciplinary research and deliver public goods that will lead towards improved food safety for the poor. Across the many Centers there are epidemiologists, plant pathologists, veterinarians, economists, and statisticians; together they have the potential to build the capacity within developing countries to conduct risk analysis and draw on international experts when needed. Furthermore, they have the opportunity to develop decision tools that will simplify decision making in a way that policy makers can comprehend and thus can help them in policy choices. The Science Council needs to take the lead in asking the CGIAR Centers to develop a cohesive food safety agenda that spans the various International Agricultural Centers. It should recommend mobilization of

expertise from both the national agricultural research centers, universities, and private sector to focus research efforts on filling the research gaps that then can be translated into policy action through the use of tools such as risk analysis. Research on food safety in developing countries tallies closely with different research priorities of the CGIAR Centers and their relationship is discussed below. The research priority where food safety would fit most closely is priority 3.

**Priority 3 of the CGIAR Centers focuses at reducing rural poverty through agricultural diversification and emerging opportunities for high-value commodities and products** – There is a need for research relating to food safety that cuts across priorities, priority one – producing more and better food at lower costs through genetic improvement - and priority four -Poverty alleviation and sustainable management of water, land, and forest resources so as to fill in the gaps. Types of research that might be conducted under several of the CGIAR’s research priorities are briefly described below:

Priority 1 - Producing more and better food at lower costs through genetic improvement

- Traditional varietal selection and genetic modification – reducing levels of naturally occurring toxins; considering susceptibility to molds and mycotoxins contamination

Priority 3 - Reducing rural poverty through agricultural diversification and emerging opportunities for high-value commodities and products. These opportunities could be in the areas of:

- Post harvest technology – building capacity for the poor to avoid food contamination post-harvest
- Enhancing traditional food safety linkages - Establishing product and process parameters as elements of food quality and safety assurance programs; Investigating natural systems of pest control – reducing problems with residues control
- Adoption and technology transfer studies
- Harnessing scientific expertise worldwide to tailor existing technologies to small-scale producers
- Conduct research so as to fill data gaps that could be used as inputs into risk analysis to support/alter decision making

Priority 4 - Poverty alleviation and sustainable management of water, land, and forest resources;

- Development of low cost testing of hazards in water used for agricultural production and processing

### **3.4. Research questions in food safety that the CGIAR Centers could address**

Though there exist many areas where there is a lack of understanding regarding the food safety system for the poor, the CGIAR system should focus its efforts on research gaps in areas where they have research strengths. Their research strength will certainly need to be supplemented by collaborating with other scientists in the national agricultural system, the private sector, and non-government organizations already involved in specific food safety work. Results from collaborative efforts could lead to implementation of a risk analysis framework to provide stakeholders with an understanding of the cost-effectiveness of potential decisions *vis a vis* the alternatives and the risk-risk tradeoffs to poor of actions associated with potential decisions. These research efforts should not only identify how regulations and standards affect the poor adversely, but also provide alternatives supported by analyses that decision makers could consider and possibly alter their approaches to food safety. Below is a summary of the research questions that came out of the round table discussion on the areas that the CGIAR system may focus on

A. Research to measure the incidence of foodborne hazards and factors associated with the growth of microbial organisms and other harmful contaminants in the supply chain (Production, biotech, plant and animal health, distribution and storage, integration). The specific questions are:

- What are the microbial pathogen problems associated with using manures as fertilizers?

- What is the process of the transport of pathogens in manures, pesticides, and unprocessed chemicals through a watershed?
- What are the implications of using bio technological produced crops on food safety?

B. Research to develop technologies to measure and mitigate foodborne hazards along the supply chain and identification of crucial infrastructure needs. The specific questions here are:

- What are effective pathogen/pesticide reduction technologies/strategies that can be developed/adapted for poor producers/processors with regards to specific commodity/pathogen combinations?
- Can cost effective risk mitigation measures for poor producers/processors be identified with regards to specific commodity/pathogen combinations?
- What are effective integrated pest management strategies that reduce the risk of pests and hence overcome barriers to trade?
- Are there low cost alternatives to cold chains? (i.e., canning processes, package improvements that will also improve the shelf life of perishable commodities that can easily be used by the poor)?

C. Research to inform food production and processing procedures and standards

- Can cheap and effective inspection and supply chain control mechanisms be developed that work for the poor which are recognized as being equivalent in the international and national communities?
- What is the role played by private sector in delivering food safety and can the private sector solutions be applied with modification (for example scaled down) to include different size producers?
- What is the impact of food safety requirements on domestic supermarkets? What role do the poor play in supplying to supermarkets or buying from them?
- What can be learned from the export success stories involving small farmers?

D. Research to monitor the incidence of foodborne diseases and its causes

- What are the domestic public health food safety issues?
- What are the causes of foodborne diseases amongst the poor?

E. Research to provide education and technical assistance in order to understand socio-economic factors affecting delivery of research, technology transfer, and adoption

- Can smallholder-based cooperatives ensure delivery of a safe product in a competitive manner?
- What is the success of development education and training programs on HACCP and EUREPGAP for the poor?
- What transformations were required in production and marketing systems for LDCs to export to Europe? What circumstances result in products being self selected to go to local markets instead?
- Can there be effective field test strategies for street vendors?
- What is the impact of liability determination on the structure of industry and contract farming? How are the poor affected? How does it impact poor producers' incentives to adopt improved food safety practices?
- What are the spillover effects of improved food safety in export markets on the domestic market?
- How can optimal food distribution/procurement networks in LDCs be designed to involve the poor?
- What types of institutional mechanisms are needed to speed up the adoption of cold storage and maintenance of cold chains?



F. Research to inform design of policies and institutions to maintain food safety

- How can risk assessment methodologies/templates for wet markets, poor producers/processors, and specific products be developed?
- How can risk analysis methods be developed to effectively convey policy alternatives and their implications to decision makers?
- What are the risk-risk tradeoffs -what are the production cost impacts? How large are the income effects?
- What is the role of 3rd party certification?
- What is the benefit and cost of investing in public infrastructure and disease control in terms of alleviating poverty by targeting export markets? Where should the resource allocation be to gain greatest benefit be by the public sector?
- How does meeting the SPS requirements affect income generation? How does it affect household welfare?
- What are the driving forces for changing food safety requirements? Is it the perception of risk associated with certain products or is it a science based perception?

G. Research on demand-side factors

- What is the cost of foodborne disease on the poor?
- How strong is the demand for food safety amongst the poor? How has it evolved over time? What are the factors determining the changes in demand for food safety?

**3.5. Institutions that could be mobilized to fill food safety research gaps involving the poor**

As discussed above, filling in the research gaps for the food safety systems for the poor will require multidisciplinary research in the fields of economics, epidemiology, food and nutritional sciences, risk analysis, microbial sciences, sociology, and political economy. Applied research will require identification of commodities that the poor are involved in such as livestock, fisheries, fruits and vegetables, root crops, grains, and include research on inputs in production such as water. Applied research tailored to the needs and practices of poor producers/processors will need to be done. This has to be followed by policy research to understand the impact of regulations on poor producers/processors mainly through the use of risk analysis.

Depending on the current agendas of the specific Centers, there is the potential for all the CGIAR Centers to contribute to the research efforts on food safety. It is, imperative that those centers that are involved in research on high-value perishable commodities (IFPRI, ILRI, World Fish, and AVRDC) direct more of their research efforts towards food safety to benefit the poor producers and consumers. As the Centers do not have expertise in many food safety areas, they will need to work with various international organizations such as FAO, World Bank and other regional banks, WHO, and CODEX/OIE/IPPC (various SPS standard setting bodies). They will also need to tap into the research efforts currently underway at various National Institutes and at various universities in both DCs and LDCs. Table B below is a preliminary list of potential institutions that could be mobilized to contribute towards food safety research. With the aid of the Science Council, CGIAR Centers, and other institutes, this will be refined further.

**Table B: Potential institutions could be mobilized to provide food safety research support**

<b>Area</b>	<b>CGIAR Centers +</b>	<b>Other scientific experts that could be mobilized</b>
Research on foodborne hazards along the supply chain	World Fish, ILRI, IFPRI, AVRDC, CIMMYT	Various universities and National Agricultural Research Labs
Research on technologies to measure and mitigate foodborne hazards along the supply chain and identification of crucial infrastructure needs	ILRI, IFPRI, CIMMYT	Various universities and National Agricultural Research Labs
Food Production and Processing Procedures and Standards	IFPRI CODEX/IPPC/OIE	Various universities and National Agricultural Research Labs
Foodborne Disease Surveillance	World Fish, ILRI, International Water Management Institute, International Centre for Diarrhea Disease Research, AVRDC, FAO, WHO	US Armed Forces Research Institute of Medicine US Center for Disease Control and equivalent in other countries
Education and technical assistance	World Fish, ILRI, International Water Management Institute, International Centre for Diarrhea Disease Research, AVRDC, FAO, WHO, World Bank	Various National Agric Aid programs US Center for Disease Control and equivalent in other countries
Policy design and standard setting	FAO, IPPC, OIE, Codex, WHO	Various universities and national public institutes conducting such analysis
Socio-economic factors affecting delivery of research, technology transfer and adoption	IFPRI, ISNAR, World Fish, ILRI	Various universities and economic research centers
Political economy surrounding food safety regulations and requirements	IFPRI	Various universities
Decision making tools to inform policymaking	IFPRI, ILRI, CODEX, IPPC, OIE	Various national agriculture and food agencies
Demand side research	IFPRI, ILRI	Various universities and private sector

## Annex 6

### Acronyms

ARI	Advanced research institute
AVRDC	AVRDC-The World Vegetable Center
BSE	Bovine Spongiform Encephalopathy
Bt	Bacillus thuringiensis
cELISA	competitive enzyme-linked immunosorbent assay
CFC	Common Fund for Commodities
CGIAR	Consultative Group on International Agricultural Research
CIES	CIES - The Food Business Forum
CIMMYT	International Maize and Wheat Improvement Center
COMESA	<a href="#"><u>Common Market for Eastern and Southern Africa</u></a>
CRSP	Collaborative Research Support Program
Codex	Codex Alimentarius (Commission)
DALY	disability adjusted life years
DC	Developing country
DNA	Deoxyribonucleic acid
DON	Deoxynivalenol
DSP	Diarrheic shellfish poisoning
EMBRAPA	Brazilian Agricultural Research Corporation
ETI	Ethical Trading Initiative
EUREP	Euro-Retailer Produce Working Group
FAO	Food and Agricultural Organization of the United Nations
GAP	Good Agricultural Practices
GFSI	Global Food Safety Initiative
GM	Genetically Modified (Genetic Modification)
HACCP	Hazard Analysis and Critical Control Point
ICIPE	ICIPE – African Insect Science for Food and Health
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IFAP	International Federation of Agricultural Producers
IFPRI	International Food Policy Research Institute
IITA	International Institute of Tropical Agriculture
IPG	International Public Goods
IPM	Integrated Pest Management
IPPC	International Plant Protection Convention
IRRI	International Rice Research Institute
IWMI	International Water Management Institute
LDC	Least Developed Country
MoA	Ministry of Agriculture
NAFTA	North American Free Trade Agreement
NARS	National Advanced Research System
NGO	Non-Governmental Organizaion
OIE	International Office on Zoonotics
PAHO	Pan-American Health Organization
SADC	South African Development Community
PIC	Prior Informed Consent of the Rotterdam Convention
POPs	( Stockholm Convention on) Persistent Organic Pollutants
PVOC	US Private Voluntary Organization Consortium
RIKILT	Institute of Food Safety, Wageningen University

SC	Science Council of the CGIAR
SPS	Sanitary and Phytosanitary Agreement of the World Trade Organizaion
SSA	Sub-Saharan Africa
UNEP	United Nations Environment Programme
UK	United Kingdom
USDA	United States Department of Agriculture
WDI	World Development Indicators
WHO	World Health Organization
WTO	World Trade Organizaion



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