

CONSULTATIONS AND WORKSHOPS

Risk assessment of microbiological hazards in foods

**Report of a Joint FAO/WHO Expert Consultation
Geneva, Switzerland
15–19 March 1999**



Issued by the World Health Organization in collaboration with the
Food and Agriculture Organization of the United Nations

**FOOD SAFETY PROGRAMME
DEPARTMENT OF PROTECTION OF THE HUMAN ENVIRONMENT
WORLD HEALTH ORGANIZATION**



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CONTENTS

1	INTRODUCTION	1
2	BACKGROUND	2
3	OBJECTIVES OF THE CONSULTATION	4
4	SUMMARY OF THE PRESENTATIONS AND DISCUSSIONS	4
5	RISK ASSESSMENT OF MICROBIOLOGICAL HAZARDS AT NATIONAL AND INTERNATIONAL LEVELS	5
	5.1 Expert Advice	5
	5.2 Scope	5
	5.3 Relationship Between the Meetings of Experts and Risk Managers	6
	5.4 Outputs	7
6	MECHANISMS TO SUPPORT OF MICROBIOLOGICAL RISK ASSESSMENT	8
	6.1 Data and Information Needs	8
	6.2 Development of Technical Capabilities for Microbiological Risk Assessment	9
	6.3 Integration of Microbiological Risk Assessment into Existing Food Safety Systems	10
	6.4 Resource Needs	10
7	ISSUES RELATING TO DEVELOPING COUNTRIES	11
8	SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS OF THE CONSULTATION	12
9	REFERENCES	16
	ANNEX 1 - LIST OF PARTICIPANTS	17
	ANNEX 2 - BIBLIOGRAPHY	20
	ANNEX 3 - LIST OF WORKING PAPERS	22

1. INTRODUCTION

The Food and Agriculture Organization of the United Nations (FAO) and the World Health Organization (WHO) convened an Expert Consultation on Risk Assessment of Microbiological Hazards in Food, in Geneva, Switzerland, from 15 to 19 March 1999. The list of participants is presented in *Annex 1*.

Mrs Poonam Khetrapal Singh, Executive Director of the Sustainable Development and Healthy Environments Cluster in WHO, opened the Consultation on behalf of the Director-General of WHO. In welcoming the participants, Mrs Khetrapal Singh stated that present-day international trade in food plays an increasingly important role in the provision of safe and nutritious diets for the world's populations. She noted that international trade has a twofold benefit. Trade in food introduces a greater variety of foods into the diet, providing consumers with a wider choice of products. Food trade also provides food exporting countries with foreign exchange. International food trade is indispensable for the economic development of many countries, and thus for an improvement in the standard of living for many peoples.

The growth in international trade in food has increased the risk of cross-border transmission of infectious agents and underscores the need for an international approach to estimate the risk that microbial pathogens pose to human health and to identify appropriate interventions to reduce or eliminate these risks. More than three million people die annually from diarrhoeal diseases, while hundreds of millions suffer from frequent episodes of diarrhoea and its debilitating consequences. Of particular concern are the extent and life-threatening nature of such diseases in the young in developing countries. The world has experienced a continuing increase in the reported incidence of foodborne diseases and developing countries are likely to bear the brunt of foodborne disease.

Mrs Khetrapal Singh thanked the participants, on behalf of the Director-General, for accepting the invitation to attend and for placing their valuable time and expertise at the disposal of the two organizations. She reminded them that their participation in the Consultation was in their personal capacities as international experts in the subject area and not as representatives of their governments, institutes or other organizations. Mrs Khetrapal Singh acknowledged that the participants had already done a great deal of preparation prior to the Consultation and would be asked to work many additional hours during the coming week.

Mr Gregory Orriss, Chief, Food Quality and Standards Service, Food and Nutrition Division of the FAO, welcomed the participants on behalf of the Director-General of FAO. He noted that this was the fourth in a series of consultations held in the area of risk analysis. The first of these meetings was held in Geneva in 1995 and like this one it focused on the risk assessment component of risk analysis. The other two consultations, held in Rome in 1997 and 1998, addressed risk management and risk communication respectively.

Mr Orriss stressed that the issues to be discussed at this Consultation are of great importance both for the protection of the health of consumers and for the international trade in food. He noted that Article 5 of the Agreement on the Application of Sanitary and

Phytosanitary Measures (SPS Agreement) requires that World Trade Organization (WTO) Members ensure that their sanitary and phytosanitary measures are based on an assessment of the risks to human, animal or plant life or health, and in so doing take into account risk assessment techniques developed by the relevant international organizations. The development of risk assessment techniques as a means of evaluating the risks associated with microbiological hazards is viewed by the Codex Alimentarius Commission (CAC) and by FAO and WHO as a priority.

Mr Orriss stressed the need for the Consultation to develop recommendations for an approach to microbiological risk assessment at the international level. He also reminded participants to consider the inputs and needs of developing countries in the elaboration of their recommendations.

Dr Allan Hogue, WHO Secretary, emphasized the need for the Consultation to address risk assessment of microbiological hazards in foods from an international perspective. International risk managers need a scientific basis for measures to reduce the risk of illness from foodborne pathogens. The CAC has requested risk assessment to support the activities of the Codex Committee on Food Hygiene (CCFH). Dr Hogue also stated that the need for scientifically justified food safety measures must be balanced by the ability of the scientific community to generate the necessary data and refine the scientific tools for risk assessment.

The Consultation elected Dr Roger Skinner as Chairperson and Dr Steven Hathaway as Vice-Chairperson. Dr Anna Lammerding agreed to serve as Rapporteur. The deliberations of the Consultation were based on a number of background papers (listed in *Annex 2*).

2. BACKGROUND

The globalization of food trade and increasing problems worldwide with emerging and re-emerging foodborne diseases have increased the risk of cross-border transmission of infectious agents. Because of the global nature of food production, manufacturing, and marketing, infectious agents can be disseminated from the original point of processing and packaging to locations thousands of miles away. It is important to understand how infectious agents enter and spread through the food chain in order to prevent or minimize exposure of the consumer to such agents. This underscores the need to estimate the risk that foodborne pathogens pose to human health in an international context and to identify possible interventions to reduce or eliminate these risks.

Food safety in the late 20th century and beyond requires enhanced levels of international cooperation in setting standards and regulations. Food safety measures are not uniform around the world and such differences can lead to trade disagreements among countries. This is particularly true if microbiological requirements are not justified scientifically.

The standards, guidelines and recommendations adopted by the CAC and international trade agreements, such as those administered by the WTO, are playing an increasingly important role in protecting the health of consumers and ensuring fair practices in trade. In 1962, the Joint FAO/WHO Food Standards Programme was created with the CAC as its executive organ. The Codex Alimentarius, or the food code, is a collection of international food standards that have been adopted by the CAC. Codex standards cover all the main foods, whether processed, semi-processed, or raw. The principal objectives of CAC are to protect the health of consumers and ensure fair practices in the food trade.

In the case of microbiological hazards, Codex has elaborated standards, guidelines and recommendations that describe processes and procedures for the safe preparation of food. The application of these standards, guidelines and recommendations is intended to prevent or eliminate hazards in foods or reduce them to acceptable levels.

The WTO SPS Agreement entered into force in 1995 and applies to all sanitary and phytosanitary measures, which may, directly or indirectly, affect international trade. It provides basic rights and obligations for WTO Members and directs them to harmonize sanitary and phytosanitary measures on as wide a basis as possible based on international standards, guidelines and recommendations. For food safety, the standards, guidelines and recommendations established by the CAC relating to food additives, veterinary drug and pesticide residues, contaminants, sampling and methods of analysis, and codes and guidelines of hygienic practice are recognized as the basis for harmonization of sanitary measures.

WTO Members may introduce or maintain measures that result in a higher level of sanitary or phytosanitary protection than would be achieved by measures based on international standards, guidelines and recommendations. In this regard, WTO Members are required to ensure that their sanitary and phytosanitary measures are based on an assessment, as appropriate to the circumstances, of the risks to human, animal or plant life or health, taking into account the risk assessment techniques developed by the relevant international organizations. Article 5 of the SPS Agreement provides an impetus for the development of microbiological risk assessment to support the elaboration of standards, guidelines and recommendations related to food safety.

The current Consultation is the latest in a series of consultations held by FAO and WHO on the subject of risk analysis. The Joint FAO/WHO Expert Consultation on the Application of Risk Analysis to Food Standards Issues held in 1995 was the first in this series (1). It delineated the basic terminology and principles of risk assessment and concluded that the analysis of risks associated with microbiological hazards presents unique challenges. The report of the Joint FAO/WHO Expert Consultation on Risk Management and Food Safety held in 1997 identified a risk management framework and the elements of risk management for food safety (2). The Joint FAO/WHO Expert Consultation on the Application of Risk Communication to Food Standards and Safety Matters held in 1998 identified elements and guiding principles of risk communication and strategies for effective risk communication (3). In addition to the foundation provided by the series of Joint FAO/WHO Expert Consultations, the CCFH has elaborated principles and guidelines for microbiological risk assessment. The "Draft Principles and Guidelines for the Conduct of Microbiological Risk Assessment" were adopted by the 23rd Session of the Codex Commission in June 1999 (4).

Upon the recommendation of the 22nd Session of the CAC* (5) and the 45th Codex Executive Committee (6), FAO and WHO convened this Consultation to take the next step in the development of an international strategy and supporting mechanisms for risk assessment of microbiological hazards in foods. The objectives of the Consultation were specifically considered in this context.

3. OBJECTIVES OF THE CONSULTATION

- To examine current scientific knowledge concerning microbiological risk assessment for food and related issues.
- To recommend an overall strategy and framework for risk assessment of microbiological hazards to FAO, WHO and their Member Countries.
- To recommend methodologies for risk assessment suitable for use at an international level to estimate the risk that microbiological hazards pose to human health.
- To recommend how risk management options may be developed and used by FAO, WHO and their Member Countries.
- To suggest priority issues in risk assessment.

4. SUMMARY OF THE PRESENTATIONS AND DISCUSSIONS

The Consultation noted that the scientific basis for microbiological risk assessment is still being developed. In recent years, risk assessment techniques have been increasingly used by both national governments and international bodies to provide a framework for considering the scientific evidence and issues related to food safety. Risk assessment provides a structured and transparent approach for organizing and evaluating data and information and a means of measuring the uncertainty associated with the findings. In the past, food safety risk assessments have been primarily limited to the determination of the levels of specific chemicals that can be present in the food supply without having an adverse impact on public health. Historically, microbiological food safety issues have been considered too complex to establish quantitative safety limits based on a risk assessment.

However, recent advances in predictive microbiology and modeling have provided methods to assist in quantitative microbiological risk assessment.

* In the report of the 22nd Session of the CAC, the Commission requested FAO and WHO to convene an international expert advisory body similar to the Joint Expert Committee on Food Additives (JECFA) and the Joint Meetings on Pesticide Residues (JMPR) on the microbiological aspects of food safety to address particularly microbiological risk assessments.

The Consultation recognized that there are a variety of potential methods that can be employed for conducting microbiological risk assessments, but in general these are likely to fall into two broad categories: qualitative and quantitative. Two examples of quantitative risk assessments were presented during this Consultation: *Salmonella enteritidis* in shell eggs and egg products in the USA (7) and *Campylobacter jejuni* in chicken in Canada (8). These presentations highlighted the usefulness of risk assessment in providing a scientific basis for the development and evaluation of risk management options to mitigate risk from foodborne pathogens.

The Consultation considered methodologies for risk assessment of microbiological hazards in foods and recognized that the "Draft Principles and Guidelines for the Conduct of Microbiological Risk Assessment" (4) provides a basic framework for microbiological risk assessment at the international level. This can be used within the risk management framework described in the Joint FAO/WHO Expert Consultation on Risk Management and Food Safety (2).

5. RISK ASSESSMENT OF MICROBIOLOGICAL HAZARDS AT NATIONAL AND INTERNATIONAL LEVELS

There is a critical need for technical advice on risk assessment of microbiological hazards in foods to meet the needs of national governments, the food industry, the scientific community, trade organizations and international consumer groups. FAO, WHO, and CAC have a direct role to play in assisting these groups in matters related to food safety and should strengthen efforts to facilitate access to specific advice on microbiological risk assessment.

5.1 Expert Advice

The Consultation recommended that :

- ☛ *A vehicle for the provision of expert advice on microbiological food safety risk assessment should be established by FAO and WHO. Initially this vehicle should take the form of a series of meetings of experts to provide advice in response to requests from Member Countries through FAO, WHO, and CAC. Subsequent to these initial meetings FAO and WHO, taking into account the recommendations of the CAC, should consider whether to establish these meetings of experts on a more formal basis.*

5.2 Scope

Microbiological risk assessment has been principally carried out by government agencies, food industries and academia at the national level. However, there are numerous aspects of microbiological risk assessment that may require consolidation, adaptation and integration of additional data and information to be useful in an international context. For example, exposure assessment will vary according to food availability and preferences in different geographical areas.

The Consultation recommended that the scope of the meetings of experts should include:

- ☞ *Review and interpretation of existing microbiological risk assessments to provide the scientific advice requested by FAO, WHO and the CAC*

The primary activity of the meetings of experts will be to provide authoritative recommendations to FAO, WHO and the CAC on microbiological issues related to food in international trade. These recommendations may include advice on risk management options, including microbiological criteria and microbial limits.

- ☞ *Advice on how risk assessments conducted at the national level can be applied to international issues*

It is anticipated that national governments will continue to be the primary source of risk assessments pertaining to microbiological food safety issues. Such national risk assessments will provide information and data needed for addressing microbiological food safety issues on an international basis, and for the elaboration of international food safety standards by the CAC. Risk assessment work at the international level will take into account various national risk assessments and also evaluate data and information on different food habits, food production systems, and food process and marketing systems that exist in regions of the world. It is expected that the meetings of experts will identify the types of additional data, variables, methods and analysis required to make valid and science-based international recommendations, as well as research needs.

- ☞ *Guidance on microbiological risk assessment practices*

It is anticipated that the meetings of experts will identify data and information needs, approaches and methodologies to conduct effective microbiological risk assessment. The provision of guidance in these areas would both encourage and facilitate the use of microbiological risk assessment as a tool contributing to the international evaluation and national management of microbiological food safety hazards.

5.3 Relationship Between the Meetings of Experts and Risk Managers

The success of the meetings of experts will depend on the establishment of an effective risk management framework including the necessary infrastructure and lines of communication between all interested parties. Critical to this is a clear understanding of the goals and priorities for work to be undertaken and a well defined risk assessment policy. While functional separation of risk assessment and risk management is a general strategy, effective ongoing dialogue between the experts and risk managers is essential to achieving timely and useful advice. To assure optimal use of the expert advice provided, any risk assessment process should be fully and systematically documented and clearly communicated to the risk managers.

FAO, WHO, the CAC and their Member Countries have responsibilities for identifying priority issues and data and information needs in the area of international microbiological food safety. FAO and WHO should regularly convene meetings of experts to address specific priorities. FAO and WHO should ensure that the meetings of experts are conducted in a manner that promotes consistency in the way that risk assessment requests are addressed, with due recognition of the technical capabilities and resources required.

5.4 Outputs

The advice required from the meetings of experts will vary depending on the specific microbiological food safety issue or problem. The Consultation recommended that the primary outputs of the meetings of experts should include the following:

Advice in response to specific requests from FAO, WHO and the CAC:

- ☞ Evaluation of existing risk assessments in relation to the principles for the conduct of microbiological risk assessments;*
- ☞ Evaluation of the international applicability of existing risk assessments, including the need for additional data or related information;*
- ☞ Evaluation of the likely impact of different risk management options (e.g. optimization of food safety systems such as the Hazard Analysis and Critical Control Point (HACCP) System, implementation of farm-to-table control strategies, establishment of microbiological criteria, equivalence of intervention technologies and risk ranking).*

The meeting of experts may also, at the request of FAO and WHO, provide advice and recommendations on:

- ☞ The scientific components of risk assessment included in educational materials and technology transfer documents and programmes developed by FAO and WHO;*
- ☞ Additional information and analyses needed to expand the applicability of national risk assessments to address international issues and concerns.*

The establishment, procedures, funding and support of the meetings of experts must ensure that they are capable of providing the wide range of outputs that are required to meet the needs of FAO, WHO, and the CAC. The outputs of the meetings of experts should take into account the unique needs and concerns of developing countries.

6. MECHANISMS TO SUPPORT OF MICROBIOLOGICAL RISK ASSESSMENT

In order to advance the use of microbiological risk assessments in national and international settings a number of important tasks need to be undertaken by international organizations and national governments . This section of the report addresses the information and technical capabilities needed to support the development of microbiological risk assessment and promote the use of risk assessment as a tool to underpin decisions on risk management internationally.

6.1 Data and Information Needs

The outcome of a risk assessment is dependent on the adequacy and quality of the data and information used. The food industry, scientific community and consumer organizations may have data and information to support microbiological risk assessment and risk management decisions. Data and information sharing and technical cooperation will facilitate the exchange of ideas, techniques and approaches needed to support microbiological risk assessment. It is important that scientists from appropriate disciplines are involved in this process. Further development of ideas, techniques, approaches, and information to support the process of risk assessment and risk management is needed so that appropriate advice can be provided at the international level.

The Consultation recommended the following activities to support risk assessment of microbiological hazards in foods:

☞ *FAO and WHO should request and compile information necessary to support the work of the meetings of experts. This information may include risk assessments conducted at the national level and relevant background information and data.*

☞ *FAO and WHO should maintain an inventory of methods and techniques for the analysis of data and information as generated by the reviews and deliberations of the meetings of experts.*

Archiving this information will provide an “institutional memory” which will ensure transparency and consistency of the work of the meetings of experts and facilitate the transfer of technology and information.

☞ *FAO and WHO Member Countries should identify relevant critical data requirements and prioritize risk assessment-related activities. They should collect and provide data and information on food consumption patterns, food processing, handling and preparation methods, levels of pathogens in foods and other information as identified in the Codex "Draft Principles and Guidelines for the Conduct of Microbiological Risk Assessment" (4). The data should include information concerning the consumers studied and the methods used in order to establish the reliability of the data and to estimate the attendant uncertainties.*

- ☞ *FAO and WHO Member Countries should promote the systematic investigation of outbreaks of foodborne illness and collect information useful in microbiological risk assessment. In particular, epidemiological and microbiological information (e.g. the number of pathogens per gram of food implicated in outbreaks) will improve the basis for dose-response assessments.*
- ☞ *FAO and WHO Member Countries should encourage the formation of multidisciplinary teams to review the available information for hazard characterization and recommend methods for the further development of credible dose-response models.*
- ☞ *The scientific community should consider risk assessment data and information needs when planning experiments or surveys. These aspects should also be considered when reporting results to ensure that the information generated is available for microbiological risk assessments.*
- ☞ *The food industry should make data and information related to microbiological risk assessment available for use by the meetings of experts. The data should be accompanied by information concerning methods of collection and analysis including their reliability, and other relevant information.*
- ☞ *FAO and WHO Member Countries should solicit feedback from consumer organizations on whether the outputs from, and processes of, risk assessment and risk management are communicated in a clear, understandable, and consistent manner.*

6.2 Development of Technical Capabilities for Microbiological Risk Assessment

FAO and WHO Member Countries should have clear strategies to develop research capacities, information systems and national expertise for risk assessment. Because microbiological risk assessment in relation to food safety is a relatively new activity and is multidisciplinary in nature, it is important that national governments have access to the full range of expertise and information available in their country. This will require the identification of the type, extent, quality and availability of data as well as key organizations with responsibilities for, or capacities to support, microbiological risk assessment. As countries develop and use microbiological risk assessment, the information generated may also be useful in an international context.

The Consultation recommended that:

- ☞ *FAO and WHO Member Countries should support the work of the meetings of experts by identifying and compiling a detailed list of microbiological risk assessments conducted in their country, and by providing additional information relevant to microbiological risk assessment.*
- ☞ *FAO and WHO Member Countries should use information developed by Codex and the meetings of experts when developing, conducting and evaluating microbiological risk assessments.*

- ☞ *FAO and WHO Member Countries, the scientific community and the food industry should strengthen technical cooperation in order to enhance risk assessment capabilities at national and international levels.*
- ☞ *Structured decision-support tools (e.g. decision trees) should be developed nationally and internationally to assist risk managers in utilizing risk assessment results in the selection of risk management options and to help improve consistency of risk management decisions.*

6.3 Integration of Microbiological Risk Assessment into Existing Food Safety Systems

The establishment of a HACCP system requires a hazard analysis step to identify all the hazards that may reasonably be expected to occur at each stage from primary production, processing and distribution to the point of consumption. Information from relevant microbiological risk assessments may be useful in hazard analysis as a basis for determining which hazards need to be addressed in the HACCP plan (i.e. their prevention, elimination or reduction to acceptable levels is essential to the production of safe food).

The Consultation recommended that:

- ☞ *The food industry should take into account the findings of relevant microbiological risk assessments in the development of HACCP plans. This will improve the capability of establishing equivalence among HACCP systems and facilitate international food trade.*

6.4 Resource Needs

Resource availability will impact on how comprehensively microbiological risk assessment can be implemented. Although microbiological risk assessment is resource intensive, its importance justifies this investment.

The Consultation recommended that:

- ☞ *FAO and WHO should encourage their Member Countries to support the activities of the meetings of experts through the provision of financial and other resources.*
- ☞ *National governments should provide adequate resources to conduct microbiological risk assessments as appropriate to their circumstances.*
- ☞ *FAO and WHO should provide sufficient resources to support the activities of the experts. This includes adequate administrative support for activities such as data acquisition and archiving, and preparation and dissemination of findings.*

7. ISSUES RELATING TO DEVELOPING COUNTRIES

Microbiological risk assessment has evolved within the food safety regulatory agencies and academia of a few developed countries. Many developing countries currently lack the technical and financial resources to develop the necessary data and information to support or conduct microbiological risk assessment. Substantial assistance is needed in the areas of infrastructure and technology transfer to enable developing countries to conduct microbiological risk assessment.

The Consultation recommended that:

- ☞ *FAO, WHO, and Member Countries with appropriate expertise acting bilaterally, should assist developing countries by providing appropriate technical advice, assistance and training.*
- ☞ *Collaborative case studies should be conducted between developing and developed countries to transfer knowledge and experience in microbiological risk assessment.*

8. SUMMARY OF THE RECOMMENDATIONS OF THE CONSULTATION

The Consultation recommended that:

- *A vehicle for the provision of expert advice on microbiological food safety risk assessment should be established by FAO and WHO. Initially this vehicle should take the form of a series of meetings of experts to provide advice in response to requests from Member Countries through FAO, WHO, and CAC. Subsequent to these initial meetings FAO and WHO, taking into account the recommendations of the CAC, should consider whether to establish these meetings of experts on a more formal basis.*

The scope of the meetings of experts should include:

- *Review and interpretation of existing microbiological risk assessments to provide the scientific advice requested by FAO, WHO, and the CAC;*
- *Advice on how risk assessments conducted at the national level can be applied to international issues;*
- *Guidance on microbiological risk assessment practices.*

The primary outputs of the meetings of experts should include the following:

- *Advice in response to specific requests from FAO, WHO, and the CAC;*
- *Evaluation of existing risk assessments in relation to the principles for the conduct of microbiological risk assessments;*
- *Evaluation of the international applicability of existing risk assessments, including the need for additional data or related information;*
- *Evaluation of the likely impact of different risk management options (e.g. optimization of food safety systems such as the Hazard Analysis and Critical Control Point (HACCP) system, implementation of farm-to-table control strategies, the establishment of microbiological criteria, equivalence of intervention technologies and risk ranking);*

The meeting of experts may also, at the request of FAO and WHO, provide advice and recommendations on:

- *The scientific components of risk assessment included in educational materials and technology transfer documents and programmes developed by FAO and WHO;*
- *Additional information and analyses needed to expand the applicability of national risk assessments to address international issues and concerns.*

The Consultation recommended the following activities to support risk assessment of microbiological hazards in foods:

- *FAO and WHO should request and compile information necessary to support the work of the meetings of experts. This information may include risk assessments conducted at the national level and relevant background information and data.*
- *FAO and WHO should maintain an inventory of methods and techniques for the analysis of data and information as generated by the reviews and deliberations of the meetings of experts. FAO and WHO Member Countries should identify relevant critical data requirements and prioritize risk assessment-related activities. They should collect and provide data and information on food consumption patterns, food processing, handling and preparation methods, levels of pathogens in foods and other information as identified in the Codex "Draft Principles and Guidelines for the Conduct of Microbiological Risk Assessment" (4). The data should include information concerning the consumers studied and the methods used in order to establish the reliability of the data and to estimate the attendant uncertainties.*
- *FAO and WHO Member Countries should promote the systematic investigation of outbreaks of foodborne illness and collect information useful in microbiological risk assessment. In particular, epidemiological and microbiological information (e.g. the number of pathogens per gram of food implicated in outbreaks) will improve the basis for dose-response assessments.*
- *FAO and WHO Member Countries should encourage the formation of multidisciplinary teams to review the available information for hazard characterization and recommend methods for the further development of credible dose-response models.*
- *The scientific community should consider risk assessment data and information needs when planning experiments or surveys. These aspects should also be considered when reporting results to ensure that the information generated is available for microbiological risk assessments.*
- *The food industry should make data and information related to microbiological risk assessment available for use by the meetings of experts. The data should be accompanied by information concerning methods of collection and analysis including their reliability, and other relevant information.*
- *FAO and WHO Member Countries should solicit feedback from consumer organizations on whether the outputs from, and processes of, risk assessment and risk management are communicated in a clear, understandable, and consistent manner.*

To improve the technical capabilities for microbiological risk assessment the Consultation recommended that:

- *FAO and WHO Member Countries should support the work of the meetings of experts by identifying and compiling a detailed list of microbiological risk assessments conducted in their country, and by providing additional information relevant to microbiological risk assessment.*
- *FAO and WHO Member Countries should use information developed by Codex and the meetings of experts when developing, conducting and evaluating microbiological risk assessments.*
- *FAO and WHO Member Countries, the scientific community and the food industry should strengthen technical cooperation in order to enhance risk assessment capabilities at national and international levels.*
- *Structured decision-support tools (e.g. decision trees) should be developed nationally and internationally to assist risk managers in utilizing risk assessment results in the selection of risk management options and to help improve consistency of risk management decisions.*

In regard to the integration of microbiological risk assessment into existing food safety systems the Consultation recommended that:

- *The food industry should take into account the findings of relevant microbiological risk assessments in the development of HACCP plans. This will improve the capability of establishing equivalence among HACCP systems and facilitate international food trade.*

The Consultation recommended the following activities to provide resources for microbiological risk assessment:

- *FAO and WHO should encourage their Member Countries to support the activities of the meetings of experts through the provision of financial and other resources.*
- *National governments should provide adequate resources to conduct microbiological risk assessments as appropriate to their circumstances.*
- *FAO and WHO should provide sufficient resources to support the activities of the experts. This includes adequate administrative support for activities such as data acquisition and archiving, and preparation and dissemination of findings.*

The Consultation recommended the following activities to transfer the technology for microbiological risk assessment to developing countries:

- *FAO, WHO, and Member Countries with appropriate expertise acting bilaterally, should assist developing countries through the provision of appropriate technical advice, assistance and training.*
- *Collaborative case studies should be conducted between developing and developed countries to transfer knowledge and experience in microbiological risk assessment.*

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A number of working papers were presented over the course of the Consultation. These served as the basis for the discussions which led to the development of the report recommendations. The titles of the working papers and author information are listed in this Annex. Some of the working papers may be published in the scientific literature. All inquiries should be directed to the contacts listed below.

Title	Author(s)	Contact
Microbial Risk Assessment: From Concept to Reality	Robert L. Buchanan	U.S. Food and Drug Administration Center for Food Safety and Applied Nutrition 200 C-Street, SW Washington, DC 20204, USA
Priority Issues for Risk Assessment of Microbiological Hazards	Patricia Desmarchelier	Section Leader, Microbiology and Production Hygiene Food Science Australia P.O. Box 3312 Tingalpa DC Queensland 4173, Australia
A Strategy for Applying Microbiological Risk Assessment Internationally	Lester M. Crawford	Georgetown University Center for Food and Nutrition Policy 3240 Prospect Street, NW Washington, DC 20007, USA
An Overall Strategy for Risk Assessment of Microbiological Hazards	Jean-Louis Jouve	Risk Evaluation Unit Principle Administrator - DG XXIV Rue de la Loi 200 B-1049 Brussels
Priority Issues for Risk Assessment of Microbiological Hazards in Foods	Jørgen Schlundt	Danish Veterinary and Food Administration Mørkhøj Bygade 19 DK-2860 Søborg
A Strategy for Risk Assessment of Microbiological Hazards in Developing Countries	Sirilak Suwanrangi	Chief, Fish Inspection Centre (Bangkok) Quality Control Division Department of Fisheries Kaset-Klang Chatuchak Paholyothin Road Bangkok 10900, Thailand
A Risk Assessment of <i>Salmonella</i> <i>enteritidis</i> in Shell Eggs and Egg Products	Presented by Kaye Wachsmuth	Deputy Administrator, USDA-FSIS-OPHS Room 341-E Whitten Bldg. Washington, DC 20250-3700, USA
Approaches to Risk Management of Microbiological Hazards in Foods	Steve Hathaway	Programme Manager (Technical Development and Risk Analysis) MAF Regulatory Authority, P.O. Box 646 Gisborne, New Zealand

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Considerations for the Conduct of Microbial Food Safety Risk Assessments	Anna M. Lammerding	Chief, Microbial Food Safety Risk Assessment Health Protection Branch Health Canada 110 Stone Road West Guelph, Ontario N1G 3W4, Canada
Searching for Possibilities of Establishing an International Framework for Microbiological Risk Assessment	Kazuaki Miyagishima	Department of Public Health Faculty of Medicine Kyoto University 606-8501 Kyoto, Japan