



منظمة الأغذية
والزراعة
للأمم المتحدة

联合国
粮食及
农业组织

Food
and
Agriculture
Organization
of
the
United
Nations

Organisation
des
Nations
Unies
pour
l'alimentation
et
l'agriculture

Продовольственная и
сельскохозяйственная
организация
Объединенных
Наций

Organización
de las
Naciones
Unidas
para la
Agricultura
y la
Alimentación

Item 7.1 of the Provisional Agenda

COMMISSION ON GENETIC RESOURCES FOR FOOD AND AGRICULTURE

Twelfth Regular Session

Rome, 19 – 23 October 2009

SCOPING STUDY ON MICRO-ORGANISMS RELEVANT TO FOOD AND AGRICULTURE

TABLE OF CONTENTS

	<i>Para.</i>
I. Introduction	1 - 5
II. The importance of micro-organisms relevant to food and agriculture	6 - 18
III. Options to strengthen international cooperation	19- 47
IV. Guidance sought	48

I. INTRODUCTION

1. At its Eleventh Regular Session, the Commission on Genetic Resources for Food and Agriculture (the Commission) reviewed the status and needs of biodiversity of micro-organisms and invertebrates for food and agriculture. It noted that this component of biodiversity for food and agriculture had not received adequate attention, especially given the many types of micro-organisms and invertebrates that play critical roles in the provision of essential services within the food chain. It further recognized the important role of micro-organisms and invertebrates in relation to food security and sustainable agriculture, and the need to strengthen capacity and knowledge in order to further understand the many roles and functions of these essential resources in relation to sustainable agriculture.¹

2. The Commission recognized that invertebrates and micro-organisms have different characteristics, and decided to consider them separately in its Multi-Year Programme of Work. It agreed to a timeline for organizing future work, which will see issues on micro-organisms and invertebrates being addressed at the Fourteenth Regular Session of the Commission.²

3. The Commission requested that a brief scoping study on micro-organisms and invertebrates be submitted to its Twelfth Regular Session to facilitate discussions on micro-organisms, and to provide a basis for further analysis and background studies in preparation for its Thirteenth Regular Session.³ The scoping study should analyze the functions and services provided by micro-organisms and invertebrates; current policies and programmes of relevant international organizations; and identify policy gaps and options for strengthening international cooperation.⁴

4. The present document considers the importance of micro-organisms given the functions and services that they provide in food and agriculture, and options for strengthening international cooperation in this field. Advice is sought on possible future work on micro-organisms in the context of the Commission's Multi-Year Programme of Work, and on potential areas for strengthening cooperation among relevant international organisations. The documents, *Main functions and services provided by micro-organisms relevant to food and agriculture*⁵ and *Policies and programmes of relevant international organizations working in the field of micro-organisms for food and agriculture*⁶ supplements the information provided in this document.

5. The study, *Use and exchange of microbial genetic resources relevant to food and agriculture*,⁷ provides additional information on the use and exchange flows of microbial genetic resources. The study will be presented at the Commission's Twelfth Regular Session as an input to the discussion on the cross-sectorial matter: policies and arrangements for access and benefit-sharing for genetic resources for food and agriculture.

¹ CGRFA-11/07/Report, paragraph 65

² CGRFA-11/07/Report, paragraph 66

³ CGRFA-11/07/Report, paragraph 68

⁴ CGRFA-11/07/Report, paragraphs 66 and 67

⁵ CGRFA-12/09/Inf. 16

⁶ CGRFA-12/09/Inf. 17

⁷ Background Study Paper 47

II. THE IMPORTANCE OF MICRO-ORGANISMS RELEVANT TO FOOD AND AGRICULTURE

Micro-organisms relevant to food and agriculture

6. Micro-organisms constitute by far the largest group of living organisms on earth, with only a small fraction of microbial species has been identified up to now. They include bacteria, yeasts, fungi and viruses that are found in almost every environment. Micro-organisms can be highly diverse in their biochemistry, physiology and nutritional modes. Most of them reproduce rapidly and the significant plasticity of their genome⁸ allows them to easily adapt to changing environmental conditions, as well as perform a variety of essential ecosystem functions on which food production depends.

7. Agricultural production depends heavily on this biodiversity, and plants and animals cannot grow optimally without them or perform essential physiological needs. For example, micro-organisms are critical in the degradation and recycling of organic matter in soils, and in facilitation of efficient ruminant digestion. A good illustration of this are root nodulating bacteria, such as *Rhizobium*, and rumen bacteria that respectively establish mutually beneficial symbiosis with the roots of agricultural plants and the guts of ruminant livestock. Micro-organisms can play major roles as biological control agents, and are therefore, an important component of integrated pest management programmes (IPM). They provide a broad range of beneficial services in food processing and their use is emerging in the forestry and fishery sectors.

8. While micro-organisms are essentially beneficial organisms, they can also cause a broad range of human, animal and plant diseases. When micro-organisms perform functions that are beneficial to humans, they are referred as providing beneficial services. Negative impacts on humans are characterized as non-beneficial services. It is not exceptional for micro-organisms to deliver both beneficial and non-beneficial services.

9. The main micro-organisms relevant for agriculture are soil micro-organisms (plant growth promotion and nutrient cycling); biological control agents; plant pathogens; farm animal pathogens; micro-organisms used in agro-industrial processes (bioremediation; production of bioenergy; micro-organisms to enable biotechnology processes (genetic engineering). The main functional groups for food processing are beneficial micro-organisms (fermentation and probiotics); non-beneficial micro-organisms (spoilage agents and health hazardous microbes).

10. Systematic understanding of micro-organism species of relevance to food and agriculture, including their genetic variability is critical, both to determine beneficial characteristics and to find remedies to combat negative impacts. An information document has been prepared to provide an overview of the main functions and services of micro-organisms, including specific examples for illustrative purposes.⁹

Trends in the conservation and use of micro-organisms relevant to food and agriculture

11. The wide scope of the micro-organism sector has meant that it has so far received little systematic attention, but this trend is rapidly changing with the increased recognition of the added value of better understanding and managing this biodiversity. Given the complexity of the sector, a brief analysis of the status and trends in the conservation and sustainable use of microbial genetic resources is presented in the following paragraphs before exploring options to strengthen international cooperation.

⁸ Capability to exchange genes between widely-divergent species, high mutation rate and other means of genetic variation.

⁹ CGRFA-12/09/Inf. 17.

12. Several initiatives are being undertaken to conserve key micro-organisms and to ensure their future availability. Microbial collections have been established throughout the world during the last century by national institutes, as well as by a number of international organizations, and within the private sector (although mostly associated with specific research and development programmes) to conserve microbial genetic resources *ex-situ*.

13. Microbial *ex-situ* collections are valuable both to conserve genetic resources and biodiversity, and to provide the essential underpinning for emerging biotechnologically based projects and industries. There are different types of *ex-situ* collections of microbial genetic resources, in particular: research collections and culture collections. More recently, the broader concept of Biological Resource Centres (BRCs) has been introduced. One of the main purposes of these Centres is to conserve microbial genetic diversity.

14. Individual institutions establish collections of micro-organisms in support of their own research programmes. Such collections hold a large amount of genetic diversity of a particular set of micro-organisms (i.e. soil micro-organisms such as *Rhizobium*, or fermentation micro-organisms such as *Lactobacillus*). Many national or public food and agriculture related research institutions hold working microbial collections.

15. Only collections complying with certain standards can refer to themselves as culture collections. Culture collections provide a number of services, including to the food and agriculture sector, and need to meet a number of standards in relation to the collection, authentication, maintenance and distribution of cultures of micro-organisms, as well as for documentation, cataloguing and information systems.

16. In recent years, culture and other collections have put in place procedures that regulate the conditions to access and use their materials, including through the use of Material Transfer Agreements. Some culture collections also provide a special service for long-term preservation of micro-organisms whose distribution may be restricted at the discretion of the depositor. Such “safe deposits” are a way to ensure long-term preservation without further distribution of the microbial culture deposited. Culture collections are also increasingly playing an essential role as repositories for microbial strains as part of patent deposits.

17. A number of countries, including Italy and Uruguay,¹⁰ are particularly interested in how to manage micro-organisms *in-situ*, and have established national research projects to this end. These projects also tend to focus on how to monitor microbial diversity and how to better understand the role of micro-organisms in providing beneficial services to ecosystems on which food production depends.

18. Finally, micro-organisms provide a variety of beneficial services to agricultural systems and to the food industry, which makes it worthwhile to optimize their utilization. In food production, it is common to manage and use micro-organisms that are already present in the given agricultural ecosystem. However, there are cases where the introduction of a micro-organism that originated elsewhere has provided significant beneficial impacts to the receiving agricultural system. Obstacles to the sustainable use of micro-organisms in developing countries includes, limited management capacity, a lack of a strategy to ensure their production in sufficient quantities and the absence of quality standards. Legal frameworks to register and regulate use of this important component of biodiversity are also often absent, or are not specific enough as they have been developed for other purposes. The lack of appropriate legislation particularly affects the use of native and introduced species by local small- to medium-sized enterprises.

¹⁰ CGRFA-11/07/Circ.1 and CGRFA-11/07/Circ.2.

III. OPTIONS TO STRENGTHEN INTERNATIONAL COOPERATION

19. The Commission requested an analysis of current policies and programmes of relevant international organizations and to identify policy gaps and options for strengthening international cooperation. An information document has been prepared that provides an overview of the policies and programmes of relevant international organizations working in the field of micro-organisms for food and agriculture.¹¹

20. The information document reports on the work being carried out by *inter alia*: CAB International (CABI), the Convention on Biological Diversity (CBD), centers of the Consultative Group on International Agricultural Research (CGIAR), the Food and Agriculture Organization of the United Nations (FAO), the International Plant Protection Convention (IPPC), and the Organisation for Economic Co-operation and Development (OCDE), World Federation of Culture Collections (WFCC).

21. This section explores possible options for strengthening cooperation with regard to microbial genetic diversity in relation to three areas, namely: global biodiversity assessments and information systems; technical guidelines and management tools; and international policy such as action plans, codes of conduct and standards.

Global biodiversity assessments

22. As explained above, the wide-scope of the micro-organism sector and the complexities related to their classification, conservation and use make it difficult to provide a systematic understanding of the status of microbial genetic resources, and to identify trends in their conservation and use. The following paragraphs briefly introduce a number of international initiatives that are contributing to the assessment of the status and trends of micro-organisms, including the development of specific databases and the establishment of international information-sharing networks.

23. There have been inconsistencies regarding the taxonomy and nomenclature of micro-organisms in the past, leading to distorted results and databases. Coherent taxonomic databases are a pre-condition for the proper storage and use of microbial material, and significant capacity building is needed to restore the backlog. Within the International Union of Microbiological Societies (IUMS), which is a scientific union of the International Council of Science (ICSU), a number of research committees deal with the taxonomy of micro-organisms.

24. International information networks such as the StrainInfo bioportal,¹² bring together relevant and available information on biological material kept at multiple culture collections, including the historical traces and geographic distribution of the strains. Mycobank,¹³ an on-line database, administered by the International Mycological Association, documents mycological nomenclatural novelties and associated data.

25. Establishing networks among microbial *ex-situ* collections and linking their databases remains a challenging exercise, especially because of the uniqueness of each collection. The World Federation for Culture Collections (WFCC), founded in 1963, pioneered in setting-up a global information network to promote and support the long-term establishment of culture collections and related services, and to strengthen the relationship between collections and their users. As of August 2009, the Federation's operational database - the World Data Center for Micro-organisms

¹¹ CGRFA-12/09/Inf. 16

¹² www.straininfo.net

¹³ www.mycobank.org

(WDCM)¹⁴ - has records of 556 national and international culture collections containing lists of micro-organism species held in 68 countries. This database is an important source of information for all microbiological activity; it is also a reference point for data activities amongst the institutions belonging to the federation.

26. Although most culture collections are governmental or semi-governmental, or are hosted by universities, some are operated by international agricultural organizations. A number of international institutions that provide technical assistance in food and agriculture manage substantial microbial collections, such as CAB International or centres of the Consultative Group of Agricultural Research (CGIAR). The CGIAR Centres have started a system-wide assessment of microbial collections in their centres to better understand their current status and possible long term utility. The assessment will include evaluation of the uses of those collections, including research partnerships, and the requirements that might be needed at technical, investment, partnering and policy levels to ensure the long-term conservation of microbial genetic resources for the benefit of the agricultural community.

27. The World Data Center for Micro-organisms includes various types of culture collections. There is a growing trend, especially in some developed countries, towards central multi-sectorial culture collections or internationally recognized culture collections specialized in a particular set of micro-organisms (bacteria, fungi, plasmids, etc.). Other culture collections are sector-specific, examples for food and agriculture include collections on: soil micro-organisms, in particular *Rhizobium* bacteria; fungi of interest to biological control; lactic acid and other food fermentation bacteria; crop, farm animal or forestry pathogens; aquaculture bacteria, etc.

18. Many stakeholders in food and agriculture, ranging from researchers to industrial users, regularly use the services provided by culture collections to access microbial strains and related information, or for the long-term storage of well-characterized strains. There are, however, many food and agriculture public institutions holding microbial collections that are of interest to the sector, but that have not been included in the above mentioned database.

28. So far, the status of *ex-situ* collections of microbial genetic resources for food and agriculture and the challenges faced in maintaining their collections have not been mapped. Given the many types of micro-organisms for food and agriculture and the complexity of the sector, this is a challenging endeavour that may be best carried out through a step-by-step approach.

29. To ensure sustainable food production and for the surveillance and control of non-beneficial organisms, the conservation of microbial genetic resources is key, as are their practical applications and their sustainable use.

30. To date, no assessments have been made of the trends in the utilization of microbial genetic resources for food and agriculture. The programme of work on agricultural biodiversity of the Convention on Biological Diversity (CBD), the implementation of which is facilitated by FAO, calls for the development of specific assessments of components of agricultural biodiversity that provide ecological services, including targeted assessments on priority areas such as pest management and nutrient cycling.¹⁵ A number of case studies on the management of soil microbial genetic diversity were submitted to the CBD as an input to the implementation of the International Initiative for the Conservation and Sustainable Use of Soil Biodiversity, an initiative established within the agricultural biodiversity programme.

¹⁴ <http://wdcn.nig.ac.jp/hpcc.html>

¹⁵ <http://www.cbd.int/decision/cop/?id=7147>

31. To map the status and trends in the use of microbial genetic resources for food and agriculture, a first step would be to initially focus on a reduced set of micro-organisms for food and agriculture, such as soil micro-organisms, biological control agents and plant pathogens.

32. The Commission may wish to emphasize the need for a step-by-step approach in assessing the status and trends of microbial genetic diversity of relevance for food and agriculture. It may wish to request that FAO start with the preparation of targeted assessments on the status and trends in the conservation and use of microbial genetic resources of soil micro-organisms, biological control agents and plant pathogens, in cooperation with partner international organizations. When reviewing the progress made, the Commission may wish to look at other types of micro-organisms relevant to food and agriculture, such as food processing micro-organisms, farm animal pathogens or micro-organisms for agro-industrial or biotechnological processes.

33. These targeted assessments would be built upon available information and serve to strengthen existing information sharing mechanisms on micro-organisms or culture collections. Such a publication will allow FAO to initiate steps towards the development of a comprehensive understanding of the status and trends in the conservation and sustainable use of microbial genetic diversity for food and agriculture. It would also contribute to the implementation of the CBD's programme of work on agricultural biodiversity, and in particular, the international initiative on soil biodiversity, for which FAO already provides technical and policy coordination.

34. The first set of targeted assessments could be prepared for the Fourteenth Regular Session of the Commission when key issues for micro-organisms are scheduled for review within the Multi-Year Programme of Work. Progress made in preparation of these targeted assessments would be reported to the Commission's Thirteenth Session, so that the Commission can then decide to request FAO and its partners to initiate work on assessing trends of other microbial genetic resources for food and agriculture.

Technical guidelines and management tools

35. The conservation and sustainable utilization of micro-organisms in food and agricultural systems is assumed to play an ever-important role for food security and sustainable agriculture. Much technical work remains to be done for the conservation and use of microbial diversity, especially in developing countries. These countries require support to explore their biodiversity, establish collections and enhance technical programmes to guarantee the sustainable utilization of microbial genetic resources, which will provide benefits at all levels.

36. There are a number of technical guidelines relevant to the *ex-situ* conservation of microbial genetic resources. The World Federation for Culture Collections has developed *Guidelines for the Establishment and Operation of Collections of Cultures of Microorganisms*. Only collections complying with standards set-out in the guidelines can refer to themselves as culture collections. More recently, the concept of Biological Resource Centres was introduced by the Organization for Economic Cooperation and Development (OECD). These centres are very similar to culture collections in their functioning and objectives. The OECD published in 2007, *OECD Best Practice Guidelines for Biological Resource Centres*, which include guidelines for the micro-organisms domain.

37. Regarding the sustainable utilization of microbial genetic resources, FAO has relevant technical projects to improve soil management, biological control and the surveillance of agricultural pathogens. A number of international institutions that provide technical assistance in food and agriculture manage substantial microbial collections, are actively involved in field projects and programmes in the area of micro-organisms. CABI International develops and scales-up biopesticides to control agricultural and environmental pests on a large scale, using naturally occurring organisms, such as fungi and bacteria in an environmentally benign manner. Some CGIAR centers, such as the International Institute of Tropical Agriculture (IITA), manage

microbial collections, including samples of pathogens, which are being used for diagnosis within national and regional integrated pest management or plant breeding programmes.

38. The Commission may wish to request FAO and partner organizations to maintain and strengthen technical support to developing countries in their conservation and sustainable management of microbial genetic resources, and to provide a report on such programmes and activities by its Fourteenth Session, when key issues for micro-organisms will be discussed.

International policies: plans of action, codes of conduct and standards

39. There is no intergovernmental body specifically dealing with microbial genetic resources at a global scale, and there are few international policies relevant to the conservation and sustainable use of the invertebrate diversity in relation to food and agriculture. Intergovernmental forums dealing with aspects of the conservation and use of microbial genetic diversity are the CBD, the Budapest Treaty, OCDE or now the Commission.

40. As previously noted, the CBD programme of work on agricultural biodiversity includes an international initiative on soil biodiversity that is coordinated and facilitated by FAO. At its last Session, the Commission welcomed FAO's further coordination and implementation of this initiative.¹⁶

41. The IPPC is an international treaty that has been dealing with the introduction and release of biological control agents for many years. It provides mechanisms by which countries can prohibit or restrict the movement of biological control agents and other organisms of phytosanitary concern claimed to be beneficial into their territories. Within the framework of the IPPC, an international standard on the transboundary movement of biological control agents was developed in 1995, and was revised in 2005, to include other beneficial organisms: *Guidelines for the export, shipment, import and release of biological control agents and other beneficial organisms* (International Standard for Phytosanitary Measures - ISPM No. 3).

42. The main feature of the Budapest Treaty on the International Recognition of the Deposit of Micro-organisms for the Purposes of Patent Procedures of the World Intellectual Property Organization is that a Contracting State which allows or requires the deposit of micro-organisms for the purposes of patent procedure must recognize, for such purposes, the deposit of a micro-organism with any "International Depository Authority". Within the context of the Budapest Treaty, several culture collections serve as repositories of biological resources for the purpose of implementing Intellectual Property Rights, and in some cases, support the enablement or description for patentability. These collections are defined as International Depository Authorities.

43. Long-term collaboration is also essential, as sharing of strains of micro-organisms is a critical element of international cooperation to ensure sustainable food production and for the surveillance and control of pathogenic organisms. Access to microbial genetic resources collections and distribution are submitted to many requirements and exchanges are becoming more and more formalized.

44. Background Study Paper 47, *Use and exchange of micro-organisms relevant to food and agriculture*, examines the use and exchange flows of microbial genetic diversity for food and agriculture. The study will be presented at the Commission's Twelfth Regular Session as an input to the discussion on the cross-sectorial matter: policies and arrangements for access and benefit-sharing for genetic resources for food and agriculture.

¹⁶ CGRFA-11/07/Report, paragraph 65

45. The study shows that institutions housing culture collections are responding to the new legal frameworks on access and benefit-sharing, particularly by moving in the direction of using legal instruments: acquisition agreements when acquiring materials and material transfer agreements (MTA) when distributing them. Many collections are in a state of transition in terms of using these mechanisms.

46. A number of international organizations active in the field of microbial genetic resources, such as WFCC, CABI International and the CGIAR, are currently considering the special needs of microbial genetic resources in relation to access and benefit-sharing policy developments.

IV. GUIDANCE SOUGHT

47. The Commission may wish to:

- i. request FAO and relevant international organizations to strengthen technical support to developing countries in relation to their efforts to achieve the conservation and sustainable use of microbial genetic resources for food and agriculture;
- ii. emphasize the need of a step-by-step approach in assessing the status and trends of microbial genetic resources for food and agriculture;
- iii. request FAO to start work on microbial genetic resources by preparing, together with relevant international organizations, targeted assessments on the status and trends in the conservation and use of microbial genetic resources of soil micro-organisms, biological control agents and plant pathogens, for presentation to the Commission at its Fourteenth Regular Session;
- iv. request FAO to report on progress made in preparation of these assessments at its Thirteenth Session, so that the Commission may consider further work needed;
- v. request its Secretary to invite the Executive Secretary of the Convention of Biological Diversity to inform the Conference of the Parties of the plans of the Commission to advance work on microbial genetic resources for food and agriculture, which will be a valuable contribution to the implementation of the programme of work on agricultural biodiversity of the Convention;
- vi. request FAO and relevant international organizations to provide a report on technical programmes and activities relevant to the conservation and sustainable use of microbial genetic resources at its Fourteenth Regular Session, when key issues for micro-organisms will be discussed; and,
- vii. consider the need for further analysis and background studies on micro-organisms relevant to food and agriculture in preparation for its Thirteenth Regular Session.