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PROMOTING AND FACILITATING ACCESS TO, AND TRANSFER AND DEVELOPMENT OF TECHNOLOGY

Note by the Executive Secretar

SUMMARY

The first meeting of the Conference of the Parties (COP), in its decision I/7, requested the first meeting of the Subsidiary Body for Scientific, Technical and Technological Advice (SBSTTA), in accordance with Article 25, paragraph 2(c), to provide advice to the second meeting of the COP on □ays and means to promote and facilitate access to, and transfer and development of technologies as envisaged in Articles 16 and 18 of the Convention". In its decision II/18, the second meeting of the COP also decided that in its mediu -term programme of work it wished to consider □ays to promote and facilitate access to and transfer of technology, as envisaged in Articles 16 and 18 of the Convention" at its third meeting.

The first meeting of the COP, in decision I/2, further decided that □n accordance with Article 16 of the Convention, and to meet the objectives of conservation of biological diversity and sustainable use of its components, projects which promote access to, transfer of and co -operation for joint development of technology" would be one of the programme priorities for acce ss to and utilisation of the financial resources available through the financial mechanism under the Convention. At its first meeting, held in Paris from 4 to 8 September 1995, in recommendation I/4, the SBSTTA recommended, *inter alia*, that it should maintain an overview of the relevant, existing mechanisms and activities related to technology transfer, and identify the unmet needs of Parties.

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The second meeting of the COP, held in Jakarta from 6 to 17 November 1995, took note of recommendation I/4 on ways and means to promote and facilitate the access to, and transfer and development of technology as envisaged in Articles 16 and 18 of the Convention, adopted by the SBSTTA. The second meeting of the COP desired that such a background document should consider the importance of biotechnology to the conservation and sustainable use of biological diversity, especially to developing countries, as well as the enabling roles of capacity building and the provision of adequate financial resources. The meeting requested that the document identify ke priority issues relating to opportunities for and obstacles to the transfer of technology for consideration by the SBSTTA. It further requested the second meeting of the SBSTTA to submit a detailed report to the third meeting of the COP.

This Note takes into account the relevant SBSTTA recommendations, as well as the decisions of the COP, submissions of States Parties, the results of the Open -ended Intergovernmental Meeting of Experts on Biological Diversity held in Mexico in April 1994, the UNEP Expert Panel Reports I to IV, regional and sub -regional inputs, and the views expressed b relevant international and non -governmental organisations and representatives of the private sector. Recommendation II/3 of the SBSTTA, on ways and means to promote and facilitate access to, and transfer and development of technology, including biotechnology, is contained in document UNEP/CBD/COP/3/3.

The Note presents, for consideration by the COP, an overview of the key issues related to the development and transfer of technology, explores the main issues related to biotechnology, and outlines the key priority issues relating to opportunities for and obstacles to the transfer of technology. It notes the importance of increasing technological capacity in developing countries and emphasises the role of government in promoting the participation of the private sector in building technological capacity in developing countries. The Note also stresses the need to relate discussions of technology to specific sectors or problems, and signals the need to link future considerations of technology to programmatic issues already identified by the COP, such as marine and coastal biological diversity and agricultural biological diversity.

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INTRODUCTION

1. The first meeting of the COP, in its decision I/7, requested the first meeting of the Subsidiary Body for Scientific, Technical and Technological Advice (SBSTTA), in accordance with Article 25, paragraph 2(c), to provide advice to the second meeting of the COP on "ways and means to promote and facilitate access to, and transfer and development of technologies as envisaged in Articles 16 and 18 of the Convention".

2. In its decision II/18, the second meeting of the COP also decided that in its medium-term programme of work it wished to discuss "ways to promote and facilitate access to and transfer of technology, as envisaged in Articles 16 and 18 of the Convention" at its third meeting.

3. The first meeting of the COP, in decision I/2, further decided that "in accordance with Article 16 of the Convention, and to meet the objectives of conservation of biological diversity and sustainable use of its components, projects which promote access to, transfer of and co-operation for joint development of technology" would be one of the programme priorities for the access to and utilisation of financial resources available through the financial mechanism under the Convention.

4. At its first meeting, held in Paris from 4 to 8 September 1995, in recommendation I/4, the SBSTTA recommended, *inter alia*, that SBSTTA should maintain an overview of the relevant existing mechanisms and activities related to technology transfer, and identify the unmet needs of Parties.

5. The second meeting of the COP, held in Jakarta from 6 to 17 November 1995, took note of recommendation I/4 on ways and means to promote and facilitate the access to, and transfer and development of, technology as envisaged in Articles 16 and 18 of the Convention, adopted by the SBSTTA. The meeting endorsed paragraph 1(d) of recommendation I/4, requesting the Executive Secretary to prepare, for consideration by the SBSTTA at its second meeting, a substantive and well-focused background document, taking into account the views expressed by States Parties and observers during the first meeting of the SBSTTA, the first and second meetings of the COP, including those decisions related to the Clearing-house Mechanism, the deliberations of the first and second sessions of the Intergovernmental Committee on the Convention on Biological Diversity, and of the open-ended Intergovernmental Meeting of Scientific Experts on Biological Diversity, held in Mexico in April 1994, including its annexed UNEP Expert Panel Reports I to IV.

6. The second meeting of the COP desired that such a background document should consider the importance of biotechnology to the conservation and sustainable use of biological diversity, especially to developing countries, as well as the enabling roles of capacity-building and the provision of adequate financial resources. The meeting requested that the document identify, for consideration by the SBSTTA, key priority issues relating to opportunities for and obstacles to the transfer of technology.

7. It further requested the second meeting of the SBSTTA to submit a detailed report to the third meeting of the COP. Accordingly, the present Note takes into account the relevant SBSTTA recommendations as well as the decisions of the COP, submissions of States Parties, the results of the Open-ended Intergovernmental Meeting of Experts on Biological Diversity, held in Mexico in April 1994, the UNEP Expert Panel Reports I to IV, regional and sub-regional inputs, and the

views expressed by relevant international and non-governmental organisations and representatives of the private sector. Recommendation II/3 of the SBSTTA is contained in the report of its second meeting (document UNEP/CBD/COP/3/3).

8. As requested by the COP, the present Note presents an overview of the key issues related to the development and transfer of technology, explores the main issues related to biotechnology, and outlines the key priority issues relating to opportunities for and obstacles to the transfer of technology. It places particular emphasis on the development of technological capacity in developing countries, and emphasises the role of government in promoting the participation of the private sector in building technological capacity in developing countries. The Note also stresses the need to relate discussions of technology to specific sectors or problems, and signals the need to link future considerations of technology to programmatic issues already identified by the COP, such as marine and coastal biological diversity and agricultural biological diversity.

I. TECHNOLOGY AND THE CONVENTION ON BIOLOGICAL DIVERSITY

1.1 Technology in the Convention on Biological Diversity

9. The Convention explicitly recognises the role that all categories of technology play in the conservation of biological diversity and the use of genetic resources. Issues related to access to technology and access to genetic resources form the foundation on which the Convention is based. Matters pertaining to Article 15 on access to genetic resources are already being considered by the COP under other agenda items. Article 16(1) defines the various obligations of Contracting Parties regarding the access to and transfer of technology: "Each Contracting Party, recognising that technology includes biotechnology, and that both access to and transfer of technology among Contracting Parties are essential elements for the attainment of the objectives of this Convention, undertakes subject to the provisions of this Article to provide and/or facilitate access to and transfer to other Contracting Parties of technologies that are relevant to the conservation and sustainable use of biological diversity or make use of genetic resources and do not cause significant damage to the environment".

10. The wording of this Article requires careful examination. First, it explicitly recognises that the access to and transfer of technology, including biotechnology, are important in meeting the objectives of the Convention. In other words, if the three objectives of the Convention are to be met, the Contracting Parties must have access to the relevant technology. Second, categories of technologies are defined as: technologies relevant to the conservation of biological diversity; technologies relevant to the sustainable use of the components of biological diversity; and those technologies that make use of genetic resources. An important characteristic of such technologies is established: they should not cause significant damage to the environment.

11. The Convention does not contain explicit reference to specific technologies, with the exception of biotechnology, that are relevant to meeting its objectives. Any reference under Article 16(1) to "technologies that are relevant to the conservation and sustainable use of biological diversity or make use of genetic resources" is quite general and open to different interpretations. It may, for example, mean technologies developed specifically to conserve biological diversity, or technologies developed for other purposes, but which may be deployed in conservation activities.

12. There a number of other conditions for the access to and transfer of technology that are required by Article 16. These include: (a) that access to and transfer of technology to developing countries shall be on "air and most favourable terms, including on concessional and preferential terms where mutually agreed" (Article 16(2)); (b) for technology that is subject to patents and other intellectual property rights, "ccess and transfer shall be provided on terms which recognise and are consistent with the adequate and effective protection of intellectual property rights" (Article 16(2)); and (c) the Parties, in particular developing countries, that "rovide genetic resources shall be provided access to and transfer of technology, including technology protected by patents and other intellectual property rights, which makes use of genetic resources. Such access to and transfer of technology shall be on mutually agreed terms" (Article 16(3)). The issue of intellectual propert rights will be considered by the third meeting of the COP under a different agenda item.

13. The conditions outlined in the above provisions have a number of policy implications. First, the reference to "air and most favourable terms, including on concessional and preferential terms where mutually agreed" seems to suggest the access to and transfer of technology on terms other than the established mechanisms and conditions of the international technology market. Second, the Convention does not define the terms for access to and transfer of technology, or indicate such terms. It leaves it to the Parties to define the terms for access to and transfer of technology as the deem appropriate. Its use of the language "here mutually agreed" in Article 16(2) seems to impl that a process of negotiation is established whereby the relevant parties come to agree on the terms before access to and/or transfer of technology is effected.

14. There are a number of other articles of the Conventio n that contain technological provisions. Article 12 focuses on research and training, which is an essential aspect of technological capacit -building. It calls on the Contracting Parties to "stablish and maintain programmes for scientific and technical education and training in measures for the identification, conservation and sustainable use of biological diversity and its components and provide support for such education and training for the specific needs of developing countries". Article 12(c) also cal ls for co-operation "n the use of scientific advances in biological diversity research in developing methods for conservation and sustainable use of biological resources".

15. Article 18 explicitly calls for establishing and strengthening technological capacity for research and conservation through technical and scientific co -operation. It provides that: "each] Contracting Party shall promote technical and scientific co-operation with other Contracting Parties, in particular developing countries ... In pr omoting such co-operation, special attention should be given to the development and strengthening of national capacity, by means of human resource development and institution building". Article 18(3) also establishes the Clearing-house Mechanis for promoting technical and scientific co-operation.

16. One of the main limitations of current discussions on the access to and transfer of technology is that they treat all technologies as having the same characteristics and as being suitable for transfer through one mechanism. The characteristics of a particular technology not onl determine the mechanism or ways for its transfer, but are also likely to influence the kinds of policies that are put in place to promote its development and transfer. Thus, it is important to understand the nature or characteristics of the relevant technologies before determining specific mechanisms and measures to facilitate their development and/or transfer.

1.2 Conservation and sustainable-use technologies

17. Developing countries have acquired various biotechnology techniques or are engaged in the acquisition and development of biotechnology by investing in training their scientists in relevant technology and biotechnology areas, by establishing collaborative arrangements with research and development (R&D) institutions based in industrialised countries (universities and private companies), and by exchanging expertise and acquiring scientific information. The main barriers to the acquisition and development of technology and biotechn ology in most developing countries are the lack of scientific skills in biotechnolog -related disciplines, the absence of appropriate institutional arrangements, the weak private-sector involvement in R&D, and the lack of fiscal and other economic incentives to attract investments in biotechnology development.

18. The problem is really two-fold. First, although relevant skills do exist, they are both in short supply and, more importantly, they are not institutionally cohesive. The organisational context is generally inappropriate to their effective articulation, hence the necessary interactions between the individual components of a viable biotechnology R&D system are simply non-existent. Second, even where there is a partial recognition of the problem, there are neither the necessary policies nor a cadre of policy analysts with the necessary experience and insight to remedy the situation.

19. A large share of the relevant technologies for conserving biological diversity are available in the public domain and can be acquired through training programmes and information searches and exchanges. The challenge, however, is to create institutional structures that are designed to harness the relevant knowledge and apply it to the conservation of biological diversity and to the transformation of genetic resources into new economic products. The extent to which old and new technologies will be deployed to conserve biological diversity and sustainably use its components depends on how well new knowledge and skills are obilised, and particularly on the creation of appropriate institutional arrangements to enable them to be so deployed.

20. echnology" is not a homogeneous concept, but is rather a term connotating a wide range of heterogeneous forms or lements" (knowledge about plant design, process know-how, plant construction, feasibility studies, production management, marketing, distribution, and so on). All of these elements are necessary for starting production, but not all are possessed by any particular institution wishing to establish new production facilities in a given country. Normally, it will possess few of these elements, and it will seldom possess the skills necessary to weld these various elements of knowledge into a viable productive effort.

21. The shortage of these essentially management skills in most countries leads to a situation where the local institution or firm, instead of hopping around" for each technological element, and thereby buying technology at a low eal" price, will tend to rely co pletely upon a foreign firm. This is often done by a large multinational corporation, which itself often subcontracts stages in the technical and production process to provide the complete technology package. Successful technology transfer is achieved when the recipient has acquired not only the technology, but also the capability of applying and modifying it to suit local situations. Technology transfer should lead to the recipient accumulation of the technological capacity for generating technical chang e.

22. There are a wide range of traditional and new technologies that may be applied to conserve biological diversity and sustainably use genetic resources or material. Conservation technologies are interlinked with, and are sometimes the same as sustainable use technologies. However, this note makes a distinction between these two in the typology developed below, as well as outline the

similarities between them. In practice, this typology may be of little practical value and technologies are often recombined to meet certain needs or solve specific problems.

23. Conservation technologies can be categorised as *in sit* or *ex sit* . *In sit* conservation refers to "onditions where genetic resources exist within ecosystems and natural habitats, and, in the case of domesticated or cultivated species, in the surroundings where they have developed their distinctive properties". *Ex sit* conservation means "he conservation of components of biological diversity outside their natural habitats". Thus, *in sit* conservation technologies are those applied to conserving genetic resources within their ecosystems and natural habitats, while *ex sit* conservation technologies are those applied to conserving genetic resources outside their natural habitats. This typology is only useful in the context of technologies already in use in *in sit* and *ex sit* conditions.

24. *In sit* conservation often refers to the establishment and management of protected areas, and also involves the application of "ard technologies" such as aerial s urvey equipment, Geographic Information Systems (GIS), fencing equipment, and "oft technologies" in the form of know-how, management routines, and behavioural patterns and attitudes. Most of these technologies are widely available, even in developing countries, and are being used by various institutions to conserve genetic resources in protected areas. The limiting factor in the application of these technologies is not their availability, but the lack of adequate, reliable taxonomic information on the status of ecosystems, and particularly on the diversity of genetic resources in specific ecosystems or habitats. This problem can be addressed by undertaking taxonomic studies and systematic surveys of plants, animals and micro-organisms in specific ecosystems. To do this, a critical minimum level of well-trained taxonomists and other relevant professionals is required.

25. The categorisation of *in sit* conservation can also be extended to other fields, such as agricultural biological diversity, to cover technologies associated with low external-input agriculture, integrated pest management, revegetation and other on -farm management techniques. These technologies have been discussed by the SBSTTA and will be discussed by the COP under their consideration of the theme of agricultural biological diversity. At its first meeting, the SBSTTA considered other technologies in relation to the conservation and sustainable use of marine and coastal biological diversity. The COP may wish to note the recommendation of the SBSTTA at its second meeting, that a more viable way of addressing issues related to technolog may be to relate them to particular programmatic areas of work, such as agricultural biological diversity and marine and coastal biological diversity, amongst others.

26. The *in sit* conservation of biological diversity involves a series of scientific research-based activities, such as taxonomic studies to identify the diversity within ecosystems, stochastic - population studies to determine the viability of wildlife populations, and genetics among others. In addition, various planning and management techniques are applied to ensure the effective management of ecosystems. Some of the knowledge and skills required by any particular institution for engaging in scientific research, or planning and managing biological diversity under *in sit* systems are generally codified in the form of scientific publications and parks -management manuals, most of which are in the public domain. However, much of the knowledge and skills ar e tacit; that is, they are uncodified and person-embodied. The acquisition of the knowledge and skills comes mainly through acquiring training, research and information. A significant portion of the knowledge is acquired through trial, error and experience; instead of simply derived rules and easil applicable, established practices, there are "ules of thumb" that are acquired and improved on through on-the-job learning and experience.

27. *Ex sit* conservation approaches include the establishment of botani cal gardens, zoos, aquaria, gene and/or seed banks, and arboreta. A wide range of technologies are applied in conserving resources under any of these *ex sit* systems. Botanical gardens and gene and/or seed banks are the main *ex sit* conservation approaches for plants. Gene banks apply technologies such as tissue culture, field-based propagation, protoplast fusion, and cryopreservation. These technologies are science or knowledge -based, that is, they are not established in the form of hardware or machinery as such, but exist in the form of techniques and the scientific knowledge of processes.

28. The *ex sit* conservation of animal genetic resources generally involves either zoos or gene banks. Technologies such as cryopreservation and embryo transfer are applied. DNA fingerprinting and DNA analyses are used to study and analyse the genetic make-up of species. The application of *ex sit* conservation systems, such as gene banks, is becoming more established and technologicall developed. This is mainly as a resu lt of the emergence and application of "igh technologies", mainly biotechnologies such as tissue culture, DNA hybridisation, DNA fingerprinting and allozyme analysis. However, some of these technologies -- DNA hybridisation, for example -- are not widely available to or used by developing countries.

29. Some of the technologies that were originally developed for *ex sit* conservation are now being deployed to promote the efficiency and effectiveness of *in sit* programmes. For example, embryo transfer technology, which was developed and initially applied in the management of domesticated species, is now being used in the conservation of wild species. Similar examples underscore the pervasive nature of biotechnology and the fact that its use cannot be restricted to a particular sector or sub-sector. The applications of the techniques are not unique to a particular method of conservation, and their scope of application is dependent on the "nnovativeness" of those using the technology.

30. The conservation of biological diversity and the sustainable use of its components are technologically linked in various ways. It is generally difficult to make a clear distinction between conservation technologies and sustainable -use ones. A wide range of technologies that were developed to use genetic resources are now being deployed in resource conservation. For example, tissue culture was developed to increase the rate of tissue micropropagation in medical and agricultural areas. This technology is now being applied in gene banks to maintain useful germplasm accessions. It is also used to micropropagate species and in the restoration of degraded ecosystems.

31. Conservation and sustainable-use technologies bring together a wide range of techniques and related knowledge. These technologies are often complex in terms of the intensity of the information and knowledge involved. The development, transfer and application of most conservation technologies -- cryopreservation, for example -- require a wide range of skills that are only developed through training, research and experience in the field.

32. The relevant technologies for the conservation of biological diversity and the sustainable use of its components do not necessarily appear on the international market as equipment or machinery that can easily be purchased. Most of the new technologies for the conservation and sustainable use of biological diversity are science- or knowledge -intensive in nature. These technologies are mainly embodied in human skills, and their acquisition is often associated with the development of human capital. The market value of the technology cannot easily be quantified, and its acquisition and/or transfer involves processes of human -resource development as well as the

exchange of information between and among scientists and institutions. In this regard, the development of the requisite capacity to promote technological development is closely linked to the implementation of Article 12 of the Convention on research and training. Furthermore, traditional programmes involving technical co-operation may play an important role in promoting the implementation of the Convention, especially in relation to technological issues.

1.3 Characteristics of biotechnology

33. The importance of biotechnology in the conservation of biological diversity and the use of its components has received international attention, particularly in the context of the Convention. It has been recognised that the use and conservation of genetic material through *in vitro* methods is the key feature of biotechnology. The set of techniques associated with *in vitro* methods are part of a larger array of techniques and methods that have been developed over a long period. Biotechnology therefore needs to be considered in the context of overall technological development, and not as an isolated set of techniques. Biodiversity provides raw materials for various biotechnology industries in the agricultural, pharmaceutical and chemical sectors. The growth of the biotechnology industry in the past decade or so has been associated with the systematic search for genetic material and the transformation of this into new products. New biotechnological techniques have made it relatively easy to search, screen and store genetic material. Genetic resources have increased in value, with a major resurgence in the screening of genetic resources for their medicinal and biochemical properties.

34. The application of biotechnology in the search for and use and conservation of genetic resources entails scientific knowledge and expertise from a wide range of disciplines, such as botany, ethnobiology, parasitology, genetic engineering, and biochemistry. For example, prospecting for new genetic material with certain biochemical properties requires interdisciplinary expertise and involves a series of procedures including the search for, the collection and scientific identification of plant material, the preparation of extracts and chromatographic analysis, the pharmaceutical screening of crude extracts, the bioassay of each fraction of the extracts, verification of the purity of isolated compounds, and the large-sample isolation of compounds for pharmacological and toxicological tests. All of these technological activities are science-intensive.

35. While the role of biotechnology in the conservation of biological diversity and the sustainable use of genetic resources has been recognised, the nature of the technology has not been well understood. International discussions of the transfer of biotechnology to developing countries have not been based on an understanding of the differences between biotechnology and other technologies. Biotechnology has often been perceived as comprising hardware or machinery. Its knowledge-intensive nature has largely been ignored or misunderstood.

36. In order to effectively apply biotechnology to realise the objectives of the Convention, it is crucial that countries put in place appropriate measures to facilitate its development and transfer. But such measures should be based on a clear understanding of the features of the specific techniques of biotechnology. First, biotechnology comprises a set of techniques that are science- or knowledge-intensive. The development and transfer of the technology require the acquisition and application of scientific knowledge and skills in specific areas such as molecular biology, biochemistry and genetics. Second, biotechnology is a pervasive technology. Biotechnology can be applied in a wide range of economic sectors. It is possible to apply one biotechnological technique

to developing different products using different genetic material. The impacts of biotechnology also spread across various industries (ranging from pharmaceuticals to agriculture) and socio-economic groups. The technology can be applied at local levels as well as in technology intensive industries.

37. Third, biotechnology represents a convergence of a wide range of disciplines. It is multidisciplinary in nature in the sense that one application of the technology draws on various scientific and technical disciplines and involves the use of various techniques in an integrated manner. The development of biotechnology and its application require institutional networking to bring together various expertise and scientific knowledge. Fourth, developments in the area of biotechnology have been characterised by a strong element of uncertainty. There has been, and still is, uncertainty about the potential benefits of the emerging biotechnological developments, as well as about the risks associated with such benefits, as articulated in decision I/5 of the second meeting of the COP. That uncertainty extends to the nature of the benefits arising from biotechnology, and how such benefits are to be shared among a wide range of actors from different economic sectors. The COP will be considering the issue of benefit-sharing at its third meeting.

38. Since biotechnology comprises a knowledge-intensive set of technologies and techniques, its acquisition and/or transfer seldom involves the transfer of massive mechanical equipment. There is considerable evidence showing that even smaller countries with limited industrial capacity are able to move to the frontiers of biotechnology in specific fields by enhancing their human-resource capacity through training and research, particularly under mutually agreed-upon arrangements as envisaged in Articles 12, 15, 16, 18 and 19 of the Convention. This means that the developing countries must invest in training and improve the environment for access to information, especially to specialised scientific databases. They must also seek ways of adding value to their genetic resources through screening and characterisation. This would strengthen their ability to develop new products from genetic resources.

II. TECHNOLOGY TRANSFER AND TECHNOLOGICAL CAPACITY BUILDING

2.1 Mechanisms of technology transfer

39. There are a wide variety of mechanisms or means by which technology is transferred or acquired, of which foreign direct investment (FDI) is the most dominant, accounting for more than 60% of the flow of technology to developing countries. The specific mechanisms through which technology transfer takes place include: turnkey projects, foreign direct investment, joint ventures, wholly owned subsidiaries, licensing, technical-service arrangements, joint R&D arrangements, training, information exchanges, sales contracts, and management contracts. These are not mutually exclusive. The turnkey-projects approach is a dominant mode of transferring certain components and elements of technology under bilateral technical-co-operation arrangements. It involves the construction, demonstrated operation, and commissioning or handover of a facility by technical experts from a technology-supplying firm and/or country to the recipient institution or country. This mechanism has been applied in the development of gene-banking facilities and in the transfer of relevant technology elements in a number of developing countries.

40. Joint ventures are a form of foreign direct investment that requires some subscription of equity capital on the part of host-country nationals who own shares in an enterprise. This form of

technology transfer is not common in the area of the conservation of biological diversity. It is, however, being applied in the pharmaceutical sector, where local nationals are able to buy shares in a subsidiary of a foreign pharmaceutical firm operating in a developing country. Such financial arrangements are also associated with the flow of management skills relevant to the new technological systems. The policy issues related to such activities are often linked to specific corporate strategies and are not a result of national planning. The role of the state in this case is to provide both an enabling policy and an institutional environment that allows firms to operate efficiently.

41. Another mechanism of technology transfer is the licensing arrangement. This is a pure technology contract in the sense that it does not need to be accompanied by the exchange of asset ownership. A licence gives the recipient firm, institution or country the right to use proprietar technology belonging to the supplier in exchange for a fee. Often this fee is calculated on the basis of gross sales of the product less imports, or some comparable "low measure". Occasionally, there is a "ump sum" payment involved. Usually, a licence agreement contains restrictions on use by the recipients, and very often it will cover a range of additional technological "lements" besides the core technology itself (for example, the provision of training, engineering design, specialised equipment, etc.). The main advantage for both parties is that it permits the transfer of technology to take place without the risks associated with financial involvement. This form of technology transfer is applied in new technologies, such as microelectronics, and to some extent in the pharmaceutical industry.

42. The most common mechanisms for transferring conservation technologies include: joint R&D, the training of nationals in foreign universities and other institutions, technology partnerships undertaken under biodiversit -prospecting arrangements, and various forms of information acquisition and exchange. In the domain of biological diversity, partnerships involving joint R&D are now being developed. Under these arrangements, a firm interested in acquiring genetic material from a developing country signs a contract with the relevant institution or authorities in the country. The firm is allowed to prospect for biodiversit -- to explore for commercially important genetic and biochemical material -- in the country under the terms and/or conditions set out and agreed on in the contract.

43. In short, there are a wide range of mechanisms through which technologies are transferred from developed to developing countries, and from one institution and/or firm to another. Which mechanism is adopted depends on the specificity of the technology to be transferred, as well as on the various conditions prevailing in both the supplier and recipient countries. However, conservation and sustainable-use technologies can be transferred through training, joint R&D, specific technology partnerships, and information acquisition and exchange. The challenge for countries is to put in place measures that will facilitate the transfer of the relevant technologies using any of these mechanisms. Even more fundamental is the need for developing countries to build the requisite technological capacity to engage effectively in technolog -transfer arrangements: to search for the relevant techn ologies, select, acquire and develop them, and then apply them to conserving biological diversity and sustainably using genetic resources.

2.2 Research, training and institutional development

44. The Convention deals with issues of training and research in Article 12, which calls on the Contracting Parties to "establish and maintain programmes for scientific and technical education and training in measures for the identification, conservation and sustainable use of biological diversity and its components and provide support for such education and training for the specific needs of developing countries".

45. For a number of reasons, however, most developing countries have been unable either to engage in R&D or to acquire technologies for the conservation and sustainable use of biological diversity. First, many of them have not built up sufficient strength in science and technology, especially in terms of human capital. Second, a lack of financial resources has created major limitations to any further investment in training or in collaborative projects with foreign universities or training institutions.

46. If these countries are to effectively implement the three objectives of the Convention, and particularly those provisions on the access to and transfer of technology, they need to start organising themselves to plan for and invest in training and R&D in new technologies, as well as to upgrade some of the traditional technologies. An emphasis on training and R&D should be given to science-based areas such as taxonomy, botany, genetic engineering and zoology. It is also crucial that the training and R&D priorities be based on specific national needs, which should be outlined in the national strategies, action plans and programmes on biological diversity required under Article 6 of the Convention.

47. The role of institutions in facilitating the development and transfer of conservation and sustainable-use technologies cannot be doubted. Institutions are the main loci of technological development, as well as sites of the accumulation of technological capacity. Institutions are also the organs that undertake conservation and deploy various technologies in using the components of biological diversity. Institutions, in the form of industrial firms, accumulate the capacity to engage in the application of biotechnology and other technologies for transforming genetic resources into drugs and other products.

48. There is a general lack of institutional synergy in national conservation efforts mainl because most of the existing institutions operate in isolation and often compete for limited financial resources. As noted above, the conservation of biological diversity and the sustainable use of its components are systemic activities requiring the convergence of different skills and knowledge, which a single institution cannot possess. For example, institutions that are specifically dedicated to the actual mechanics of conservation, such as gene banks, herbaria and other bodies, are required to classify, preserve and store germplasm. Bodies such as the research departments of universities in areas such as molecular biology, virology, immunology and phytochemistry contribute to national conservation efforts. If the expertise and knowledge of these various institutions are not organised in such a manner as to achieve synergy, it is unlikely that effective conservation can be achieved at the national level.

49. Institutional development is an important factor in facilitating the accumulation of technological capacity in developing countries. Institutions offer countries ways to cope with technological and environmental risks. Recent evidence on the history of technological transformation, especially in newl -industrialising countries, shows clearly the role of institutional change in development. In these countries specific institutional arrangements have been established

for purposes of creating and mobilising financial, human and technological resources and directing these to the solution of specific problems. These countries have formulated policies that explicitl support the formation and strengthening of institutions. There is a need for specific studies to be undertaken in most developing countries in order to determine specific needs for institutional reform.

50. Most developing countries have limited institutional capacities for either negotiating effectively for technology or for acquiring and using public -domain technologies. A number of institutions in developing countries have nevertheless taken important steps by initia ting research in various aspects of biotechnology. However most of these institutions lack a financial and infrastructural endowment to sustain their research and assist in transforming their research findings into production activities of economic benefit to the country. It should also be noted that the limited institutional capacities of many developing countries are related to the inflexibility of the existing institutions to respond to new challenges. In most developing countries, institutions dealing w ith biotechnological R&D are rarely linked to those engaged in biodiversity management. There is, as a result, a lack of institutional synergy in terms of sharing expertise across the institutional terrain. The conventional tenet that prevails in these countries is that conservation is not an R&D or technological enterprise. Conservation institutions are rarely involved in biotechnological R&D, even where that technology offers new opportunities for conserving genetic resources.

51. In order for developing countries to implement as well as fully exploit the benefits arising from the Convention, various institutional reforms are needed. They are required in order to create institutions with the flexibility to mobilise the complementary capacity to undertake both conservation and sustainable-use tasks. Such institutions could also engage in a significant level of research and development as well as training. Existing institutions that show considerable flexibilit for engaging in various aspects of implementing the Convention could be strengthened, or new ones could be created. The strengthening of institutions may include providing the requisite technological infrastructure, mobilising and enhancing skills, building information -acquisition and management systems, as well as guaranteeing a reasonable budget for R&D activities. It is the provision of these items that constitutes institutional development.

52. Institutional development in these countries should be accompanied by various policy and legal reforms aimed at promoting technological development. For example, a tax-incentive scheme could include income tax exemption for foreign engineers, exemption from local taxes on real estate on which to build research institutes, tax exemption for income from technology sales, income tax exemption for technolog -intensive enterprise initiators, and special, accelerated depreciation allowances for projects using new technology. Other measures include tax credits and accelerated depreciation for research and vocational t raining equipment, tax credits for expenditures on research and training, a tax reduction on imports of research equipment, a tariff reduction on imports of high technology industrial equipment, and counting reserve funds for R&D as losses.

2.3 The role of the private sector

53. Another group of institutions that has a major role in the conservation and sustainable use of genetic resources is private firms. The private sector is already a key player in the use of genetic resources and is likely to become even more so in the future. The main form this has taken in recent

years is the involvement of international drug firms in prospecting for new biochemical compounds. However, there is growing evidence of the rise of indigenous firms that are also beginning to play a similar role. Such firms often enter into "strategic alliances or partnerships" with international companies whereby the latter supply technology in return for the local firms' playing a subsidiary role in the overall value-added chain (e.g., by carrying out preliminary screening for specific natural compounds). With suitable incentives and other policy regimes, the private sector should be able to play a leading role in the conservation and sustainable use of biological diversity.

54. In most developing countries, private firms' participation in conservation activities is still limited because of the lack of appropriate incentives. In order to acquire the relevant technologies, these countries need to explicitly bring the private sector into conservation programmes -- both as a source of new technologies and as potential financers of conservation programmes. Private industrial firms possess considerable untapped technological knowledge and skills for the conservation and sustainable use of genetic resources. Because of fragmentary and rigid institutional structures, as well as the lack suitable incentive measures, a large pool of scientific and technical human capital scattered through a wide number of private-sector firms and related institutions is not being efficiently used. This situation continues to deprive developing countries of the opportunity to benefit from existing institutional diversity.

2.4 Technological capacity building

55. Technological capacity includes a range of capacities that allow a country and/or an economic system to understand best-practice technology on a world scale and to use this understanding to promote more rapid economic growth than would otherwise have been possible. Such capacities are determined by indigenous technological efforts to master new technologies, adapt them to local conditions, improve and diffuse them within the economy, and then exploit them by manufactured export growth and diversification, and eventually by the export of the technologies themselves. The indigenous effort required must be undertaken at two levels: the institutional and/or firm level and the national level. Institutions and/or firms, however, are not technologically homogeneous. Rather, they possess their own tacit knowledge, which is restricted to the institution and/or firm itself, and other knowledge that can be traded or transferred.

56. There are three categories of institution/firm level capacity. These are: (a) investment capacity -- which describes the institution's or firm's ability to identify and prepare projects, procure equipment and artifacts, carry out detail design, and to construct, install and operate production facilities; (b) production capacity -- pertaining to the operation, quality control, maintenance, adaptation, equipment stretching, research, design and innovation; and (c) linkage capacity -- relating to skills required for receiving and transmitting information from component or raw material suppliers, sub-contractors, consultants, service firms and technology institutions.

57. In the context of the Convention on Biological Diversity, technological capacity can be viewed as the range of capacities required by a country to understand, develop and effectively apply relevant technologies to conserving biological diversity and sustainably using genetic and biological resources. Such capacities are mobilised and deployed in specific national institutions, as well as in private-sector firms and among indigenous and local communities.

III. SCIENTIFIC, TECHNICAL AND TECHNOLOGICAL CO-OPERATION

58. The role of scientific, technical and technological partnerships in achieving the objectives of the Convention has been recognised in the Convention itself. The Convention suggests technolog partnerships that involve the exchange of information (Article 17) and joint R&D (Articles 15, 16, 18 and 19), and stresses the importance of bilateral and international co-operation to facilitate the sharing of scientific and technological information. Other forms of technology partnership include sub-contractual R&D and those modelled around biodiversit -prospecting arrangements.

59. A number of developing-country institutions are beginning to engage in various forms of technology partnerships with public R&D institutions and private-sector firms from industrialised countries. These partnerships involve: (a) training developing-country scientists in the application of new technologies for the conservation and utilisation of genetic resources; (b) exchanging information on new scientific and technological advances; (c) providing various technolog components to developing-country partner institutions; and (d) engaging in joint R&D. Most of these technology partnerships, however, have not been provided with adequate governmental support on the part of developing countries. They often evolve as a result of the efforts and interests of a few scientists within developing-country institutions who have contacts with developed-country firms and public R&D institutions.

60. It will not be possible for developing countries to effectively engage in the international negotiations on technology transfer, or in the implementation of the Convention in general, unless they have access to some basic information on the various technologies for the conservation and sustainable use of biodiversity. Most of this information can be obtained from scientific publications, workshops, conferences and electronic media from various institutions in industrialised countries. Often, however, developing countries do not treat these as important sources of information on technology. For technologies such as biotechnology, a large portion of technological knowledge can be obtained from scientific journals and workshops. Developing countries need to give adequate attention to these mechanisms of information-acquisition and use them effectively to acquire various elements of new conservation and sustainable-use technologies. They should also create systems for linking themselves to the various forms of global information networks.

61. One of the priority areas in this effort is to establish direct communication links between developing-country institutions and their counterparts in industrialised countries for purposes of exchanging information. Such links will have two fundamental consequences. First, they will make information on biological-diversity conservation and sustainable use available to developing countries that would not otherwise have access to it. Second, they would provide researchers in developing countries with some ideas as to what kinds of information need to be collected in their own countries. These two consequences suggest slightly different institutional arrangements. The first case can be implemented through links with institutions whose aim is to disseminate information *per se*. The second would be related more specifically to research institutions. The problem, however, is that it is not possible to determine in advance the manner in which that information is likely to be used, and it would be unwise at this stage to restrict information to certain kinds of institutions. The priority should be to promote measures that allow for the widest range of access.

62. The linking of developing-country-based institutions to their counterparts in industrialised countries would only facilitate the process of technology procurement. Measures will need to be introduced in developing countries to deal specifically with dissemination, use and management. There are numerous options, ranging from on-line access to publications and other media. All of these need to be explored. The starting-point for information search and acquisition would be to establish direct links with the numerous information facilities that exist in industrialised countries. These facilities serve a wide range of purposes, covering activities such as product information, policy information and public education. These variations need to be taken into account when designing information-search and -acquisition systems.

63. In some developing countries, the macroeconomic and other institutional conditions are not favourable to the development and sustenance of technology partnerships. For example, the instability of local currencies, the lack of an adequate or reliable infrastructure, the lack of incentives for attracting foreign enterprises, and a poor or inadequate legal framework governing inter-institutional or inter-firm transactions and collaborations are major factors hindering the establishment of long-term, strategic technology partnerships.

64. There is a need for developing-country governments to create policy and legal measures that favour the formation of technology partnerships between their institutions and private firms on the one hand, and private sector firms and R&D institutions from some of the industrialised countries on the other. Such partnerships could be extended to cover the exchange of value-added genetic material for new technological knowledge and technological capability building: a developing country could provide value-added genetic material to a developed-country firm or public R&D institution in exchange for new technology in the form of knowledge, information, the training of local scientists, and possibly equipment. This exchange could take place through collaborative R&D. The advantage of this mechanism is that the foreign firm and/or public R&D institutions would bring into the partnership technological know-how in new areas such biotechnology.

65. The clearing-house mechanism (CHM), established as required under Article 18(3) of the Convention, will play a key role in promoting technical and scientific co-operation. The CHM could be developed as: (a) be a source of new information on global scientific and technical R&D activities, including information on new conservation and sustainable-use technologies; (b) a link between developing-country researchers and/or institutions, including private sector firms, and the R&D centres and firms of developed countries; (c) a means of providing developing countries with information on ways of establishing technology partnerships, including assisting them to formulate legal measures (specific technology partnership contracts, for example) and appropriate technolog procurement strategies; and (d) a means of access to new sources of private-sector funding by developing-country institutions.

66. The CHM could facilitate the exchange and dissemination of information by ensuring that new information is put on electronic-communications systems such as the Internet. In fact, the CHM could establish its own system for disseminating information. It can also play an active role in assisting developing countries to develop national information systems or databanks on issues relevant to the Convention. This can be achieved through training developing-country personnel in new information-management systems.

IV. PRIORITY ISSUES FOR THE CONFERENCE OF THE PARTIES

4.1 Technological capacity building

67. The issues addressed in Articles 16 and 18 regarding technological development as well as technical and scientific co-operation are part of the larger agenda of building technological capacit in developing countries in order to facilitate the implementation of the three objectives of the Convention. In this context, priority should be given to the identification of ways to promote technological capacity in developing countries. The evidence provided above shows that technological capacity building is usually a result of efforts made by the developing countries. In this regard, a great measure of responsibility for developing the necessary technology will lie with the countries that are seeking to build up such capacity. The Convention, by emphasising mutual arrangements, provides a strong basis for forging a variety of multilateral and bilateral arrangements that involve technological co-operation.

4.2 Technology, international trade and human capital

68. Discussions of national policy formation need to take into account the role of international trade in technological development. There is ample evidence that foreign investment is the most important vehicle for technology transfer. It is through such investment that the technological landscape of most newly industrialising countries has been transformed so rapidly in recent decades. But the ability of countries to derive greater benefits from foreign direct investment is dependent on the available human capital, a wide range of incentive schemes, and long-term technological-development goals. Investing in human capacity is just starting to feature as a critical policy issue in technology development and will, in the near future, emerge as one of the most important areas of policy concern for most developing countries.

4.3 National and sectoral policies

69. In light of the above assessment, it is evident that issues related to the access to and transfer of technology cannot be addressed in isolation from other priorities in the Convention. Of particular relevance are issues related to specific programme areas already identified by the COP, such as marine and coastal biological diversity, and agricultural biological diversity, as well as other potential items such as forest biological diversity and freshwater biological diversity. Such an approach would be consistent with the provisions of Article 6 on general measures for the conservation and sustainable use of biological diversity, particularly paragraph 2, which calls upon the Contracting Parties to [integrate], as far as possible and as appropriate, the conservation and sustainable use of biological diversity into relevant sectoral or cross-sectoral plans, programmes and policies". In this regard, the COP may wish to integrate issues related to the access to and transfer of technology into the relevant sectoral and cross-sectoral issues, with particular emphasis on marine and coastal biological diversity and agricultural biological diversity, among others.

70. The integration of technological issues into specific sectoral programmes will need to be accompanied by certain policy reforms at the national level that promote technological innovation

and change. Such polic -reform initiatives could be considered in the context of the implementation of Article 6 and be related to Article 10 on the sustainable use of the components of biological diversity. The COP may wish to identify measures for sharing information on and experiences of policy approaches used in promoting technological innovation in general, and biotechnology in particular. Such measures would also include the sharing of experiences in other relevant fields, such as technologies for the restoration of degraded areas and low eternal-input agriculture.

4.4 Technology identification and assessment

71. Such an integrated approach would also make it possible for the Contracting Parties to identify areas of priority in the identification, assessment and selection of technologies for solving specific problems. The COP may wish to start the process of identifying technologies of relevance to the conservation and sustainable use of biological diversity in specific areas. Such identification could be linked to specific problems identified by developing countries through a process that involves key actors such as the private sector and local research institutions. Activities aimed at identifying and assessing technologie s need to be considered in the context of market -based operations, especially in light of the need to link technology assessment to the formulation of national policies that promote local technological innovations.

4.5 Scientific, technical and technological co-operatio

72. The issue of technical and scientific co-operation as outlined in Article 18 has so far been discussed mainly in the context of the clearing -house mechanism. The CHM is an important starting-point in promoting the exchange of information on the available technological options. The concerns of Article 18, however, go further than this. Article 18(2) appeals to each Contracting Party to romote technical and scientific co-operation with other Contracting Parties, in particular developing countries, in implementing this Convention, *inter li* , through the development and implementation of national policies. In promoting such co -operation, special attention should be given to the development and strengthening of national capabilities, by means of human resources development and institution building".

73. Further, Article 18(4) calls upon the Contracting Parties to, n accordance with national legislation and policies, encourage and develop methods of co -operation for the development and use of technologies, including indigenous and traditional technologies, in pursuance of the objectives of this Convention. For this purpose, the Contracting Parties shall also promote co - operation in the training of personnel and exchange of experts". Finall , Article 18(5) requires that the ontracting Parties shall, subject to mutual agreement, promote the establishment of joint research programmes and joint ventures for the development of technologies relevant to the objectives of this Convention". One of the starting -points for such joint ventures may be the exchange of information on joint-venture experiences and the available technologies. Part of this can be carried out through the clearing -house mechanism.

74. The above provisions form a basis on which the COP might initiate a process to promote a variety of partnerships involving access to genetic resources and access to technology, taking into account the need to build technological capacity in developing countries. The COP may also wish to review the degree to which current financial arrangements promote technical and scientific

cooperation as envisaged in Articles 20 (Financial Resources) and 21 (Financial Mechanism). The role of official development assistance (ODA) may require further re-examination, especially in light of the fact that ODA has often been considered as one of the ways of transferring technolog to developing countries.

75. In addition, the COP may wish to explore ways by which it can contribute to enhancing the capacity of financial institutions, such as the World Bank and the regional development banks, to support the development and transfer of technology in specific fields, such as agricultural biological diversity and marine and coastal biological diversity, in accordance with paragraph 4 of Article 21. As an example, the COP will have before it an information note (UNEP/CBD/COP/3/Inf.7) to assist in consideration of the potential contribution of the multilateral development banks.

4.6 Private-sector involvement

76. As envisaged in Article 18(5), the COP may wish to undertake a detailed exploration of how to involve the private sector in the implementation of the Convention in general, and in technological development in particular. Consideration of the role of the private secto r could be reinforced by Article 10(e), which calls upon each Contracting Party to □ncourage cooperation between its governmental authorities and its private sector in developing methods for sustainable use of biological resources". The role of the private sector in promoting technological cooperation needs to be given priority in the deliberations of the COP.

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