19th McDOUGALL
MEMORIAL LECTURE

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President, National Academy of Sciences, Rome
Rector, University of Tuscia, Viterbo
Italy

Rome,
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The protection of biodiversity and the conservation and use of genetic resources for food and agriculture: potential and perspectives

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Mr Chairman,
Mr Director-General,
Honourable Ministers and Delegates,
Ladies and Gentlemen,

First of all I warmly thank the FAO Committee and the Director-General for having invited me to give the 19th McDougall Memorial Lecture, celebrating the memory of Frank L. McDougall of Australia, one of the founders of FAO.

INTRODUCTION

The loss of biodiversity is often presented as an ecological problem, but the fundamental underlying causes are socio-economic and political. Population growth and the ever more rapid consumption of resources, the effects of the globalization of trade, a lack of understanding of particular species and ecosystems, poorly conceived policies, and a failure to take into account the value of biodiversity itself, are key factors in the continuing degradation and destruction of biological diversity. It

is a vital challenge to our societies to reflect properly the great value of nature's diversity to the world's economy and, as a part of our national assets, promote market exchanges and establish the necessary rules and regulations. At present, the basic genetic raw material with which breeders and biotechnology industries work is essentially available without charge in nature, particularly in farmers' fields.

The costs of conserving biodiversity are high, but far lower than the costs of the dreadful effects of its erosion. The world needs a way to value biological resources which recognizes that their loss is irreversible. Despite modern science and technology, extinction is forever. Our generation has a tremendous social responsibility: to pass on to our children the full wealth of biodiversity that we have inherited from our parents. This will enable future generations to face unpredictable environmental changes and human needs.

Genetic resources are part of biological diversity. They are natural resources which are indispensable for our generation and future generations, and indispensable, at a global level, for the preservation of the environment and the continuation of all forms of life on earth.

Biodiversity is a dimension of the ecological issue. It interacts with the everyday behaviour of each human being and cuts across all fields of

knowledge and action: from experimental sciences to philosophy, politics, economics, religion and ethics.

Our human responsibility towards the earth, with all its ethical, philosophical, religious, anthropological, cultural and legal implications, requires a holistic effort and sustainable action for the protection and conservation of biodiversity and natural resources in general.

The tremendous potentiality and the delicate equilibrium of natural resources and of natural environments can be safeguarded only if humanity acknowledges that nature is for its advantage and benefit, but that it is governed by forces well beyond human control.

Fortunately, awareness and consciousness that humans must consider themselves the caretakers of nature are increasing and prevailing. In fact, evidence is mounting that humans, although adhering to different religions and philosophies, have come to believe in corporate stewardship. This could permit us to attain sustainability for the present and the future, and allow for development with increasing equity.

It is consequently our moral responsibility, and not only to our material interest and convenience, to adopt measures to protect, conserve and utilize biodiversity properly, and in particular genetic resources, that is, the genetic diversity of plants, animals and

micro-organisms useful or potentially useful for human welfare. The extent of biological diversity known up to now, that is the number of species of plants, fungi, algae, protozoans, bacteria, viruses, animals, fishes now described, amounts to 1.6 million. The estimated total number of species living on the planet goes from the prudential figure of 12 million up to a maximum of about 120 million species, mainly insects (Table 1).

In achieving food security and sustainable rural development, genetic resources, information, funds and technology are all essential and complementary resources, and using and sharing these resources in a fair and equitable way is a moral obligation for the present generation and a condition for the survival of future generations.

PLANT AND ANIMAL GENETIC RESOURCES

As is well known, over two-thirds of the world's plant species originate from the regions surrounding the mountain chains stretching from the Pyrenees to the Alps, the Caucasus and the Himalaya and, in South America, the Andean chain. Much agricultural genetic diversity is still nurtured there, developed and utilized by small farmers in their everyday effort to provide food for themselves and their families. Apart

TABLE 1
Biological diversity (known and estimated)

	Species		
	Described	Estimated	
		Working	Highest
		(thousands)	
Viruses	5	500	500
Bacteria	4	400	3 000
Fungi	70	1 000	1 500
Protozoans	40	200	100
Algae	40	200	10 000
Plants (embryophytes)	250	300	500
Vertebrates	45	50	50
Nematodes	15	500	1 000
Molluscs	70	200	180
Crustaceans	40	150	150
Arachnids	75	750	1 000
Insects	950	8 000	100 000
Total	**1 604**	**12 250**	**117 980**

from food, these resources provide clothes and shelter, help cure illnesses, and are the basis for developing and improving agriculture, agro-industry and the larger economy. They also influence climate, air and water quality and soil fertility, mainly as forest trees.

Nature's storehouse is truly huge. It is estimated that out of 250 000 plant species (Table 1) at least 70 000 edible plants exist. In the course of history, however, humankind has utilized only about 7 000 of these for food. Moreover, only a very modest number of plant and animal species play a significant role in present world agriculture and food production. The world depends, in fact, on only seven cereals for the majority of its food: wheat, rice, maize, sorghum, barley, rye and oats. Similarly, a mere seven legumes (peas, beans, soybeans, cowpea, peanuts, alfalfa and clover) are intensively exploited; as few as four tropical fruits (banana, mango, pineapple and papaya) and three tuber or root crops (potato, yam and cassava) are produced on a large scale (Table 2). As for animals, only 30 to 40 species contribute to satisfy the needs of humankind, but only six to seven of them account for more than 90 percent of livestock products.

It is a fact, then, that humanity has so far used only a handful of plant and animal species. By selecting and developing, over 10 000 years of

TABLE 2
Plant biological diversity: agricultural plants domesticated, selected and cultivated worldwide, compared with the number of plant species occurring wild or cultivated locally

Species utilized globally	Out of:
Wheat, rice, maize, barley, sorghum, rye, oats (7)	10 000 grasses
Peas, beans, soybeans, peanuts, cowpeas, alfalfa, clovers (7)	18 000 legumes
Banana, mango, pineapple, papaya (4)	3 000 tropical fruits
Potato, yam, cassava (3)	800 tubers

agriculture, the basic food and agricultural crops, humanity effectively created the portfolio of agrobiodiversity which feeds us today. However, the planting of ever-increasing surfaces to a small number of homogeneous varieties in recent years has led to the loss of much of this inherited capital in farmers' fields. By replacing a multitude of local strains, ecotypes, landraces (examples are given in the photographs on pages 24-25), each particularly adapted to a specific habitat and niche, with homogeneous varieties, we have paradoxically condemned to irremediable loss much of the genetic resources of these plants and animals, in the process known as "genetic erosion". As a result, the intraspecific variation has been dangerously narrowed. But "less variability" means "less biological plasticity" and an insufficient ability to respond to selection and guarantee yield and quality improvements. Such genetic erosion has been particularly frequent and vast in basic crop species such as maize, rice, wheat, banana, cowpea, cassava and plantain, and in the main domestic animal species: cattle, poultry and pigs.

On the other hand, a host of potentially useful crop species has been so far almost totally neglected or considered only locally: these include many tuber crops – quinoa, okra, yam, teff, amaranth, tarwi – several vegetable crops and fruit-trees. A re-evaluation of the potential of such

crops, and the use of their genetic resources in breeding programmes, could develop them into staple crops able to raise the nutritional level of millions of people, although often in geographically circumscribed areas of the world.

In the animal kingdom, the biodiversity of domesticated animals includes approximately 4 000 breeds. Of these, 25 to 30 percent are at a high risk of being lost (Table 3). In Europe, however, the threat is even more serious: it is estimated that as many as half of the breeds which existed there at the beginning of this century have already become extinct. As in the case of plants, diversity of domesticated animals is greatest in developing countries. Such diversity ensures adaptability to environmental changes, upsurges of diseases, variations in market conditions, and future and unpredictable social needs. It also makes possible the response to selection for new breeds or improved stocks.

Research is discovering new ways to use biological materials. According to recent estimates, in the near future plant resources could come to account for more than one-third of all industrial materials, with great environmental and social benefits.

Similarly, humanity has only just begun to explore, for pharmaceutical purposes, the immense wealth of plant, animal and

TABLE 3
Number of animal breeds at risk

Species	No. monitored	No. at risk
Buffalo	72	2
Cattle	787	135
Goat	351	44
Sheep	920	119
Pig	353	69
Horse	384	120
Chicken	606	274
Duck	76	34
Turkey	31	11
Total	**3 580**	**808**

micro-organism species in the equatorial forests. A few such species have been used from time immemorial in traditional medicine; the therapeutical properties of others have been discovered only recently. The potential for further discovery is immense.

CONSERVATION, UTILIZATION AND TRANSFER OF GENETIC RESOURCES AND THEIR ENHANCEMENT THROUGH BIOTECHNOLOGY

Humankind's longstanding interest in the collection and description of biological diversity from different ecosystems and in the exploitation of new characteristics has resulted in the establishment and creation of botanical gardens, zoological parks and aquaria. There are now about 1 500 botanical gardens throughout the world, one-third of which are in Europe: the first of these was established in Padua, Italy, towards the middle of the sixteenth century.

But Vavilov's discovery, during the 1920s, of the centres of origin and diversification of crop plants and related wild species led to a growing number of exploratory and germplasm collecting missions to those regions, mainly from the most agriculturally developed countries. In the

second half of this century, biosamples, mainly seeds, have been gathered in the so-called "gene banks", that is, in storage facilities where ex situ *collections can be conserved for long periods, classified, analysed and used in breeding programmes.*

Many countries have now established their own gene banks. The most significant, however, are held by the International Agricultural Research Centres (IARCs) of the Consultative Group on International Agricultural Research (CGIAR), and by about 20 national institutions of developed and developing countries. Nevertheless, no single country, developed or developing, has all the genetic resources it needs within its borders or in its gene banks. All countries must therefore continue to search for new sources of germplasm, not only through field exploration and in existing collections, but also (and probably mainly) by exchanging germplasm of mutual interest with other countries.

According to FAO studies, an estimated 4 to 4.5 million accessions, mainly seed samples, are currently stored in the gene bank system (Table 4). The IARCs' gene banks in particular, considered globally, represent what is probably the world's largest ex situ *collection of genetic resources of food and fodder crops of importance to agriculture in*

TABLE 4
Ex situ collected accessions, by groups of crops maintained in national and CGIAR gene banks

Crop	National collections	CGIAR centres
	(thousands)	
Cereals	1 750	317
Food legumes	600	118
Forages	374	51
Vegetables	337	
Fruit	174	
Banana		2
Roots and tubers	157	22
Oil crops	90	
Beverages	43	
Sugar cane	17	
Condiments	10	
Cacao crops	9	
Rubber	31	
Fibre crops	70	
Narcotics and drugs	15	
Shelter crops	10	
Ornamentals	5	
Medicinal plants	3	
Dyes	1	
Perfume crops	0.6	
Building materials	0.4	
Unknown	192	
Total	**3 905**	**511**

developing countries, conserving about 12 percent (510 000 accessions) of all germplasm maintained at present throughout the world.

In the last decades, genetic resources in these ex situ *collections have been intensively, if not widely, used in successful, large-scale breeding programmes for the most important crops. The impressive results of the so-called green revolution, which rest basically on wheat, rice and maize breeding programmes, are evidence of the importance of disposing of the widest possible genetic variation of both plants and animals of agricultural interest.*

Collecting and conserving ex situ *biosamples in gene banks is of undoubted technical and economic advantage to both holders and users of germplasm, and it has been instrumental in the success of many national and international plant improvement programmes, leading to significant increases in productivity, as did the green revolution.*

However, while gene banks will continue to play their specific role, biological evolution, that is, the continuous creation of biodiversity, cannot take place in stored material. It can only occur in nature, through the dynamics of continuous contact and interaction among life forms in ecosystems or, for crop plants and domestic animals, in agro-ecosystems.

The need to allow such processes to continue has prompted an increasing engagement in in situ *programmes of biodiversity conservation. The Convention on Biodiversity (CBD) itself, in Article 8, promotes* in situ *conservation when it explicitly calls on signatory parties to "... establish a system of protected areas, or areas where special measures need to be taken, to conserve the biological diversity...", with the aim of ensuring the conservation of ecosystems and agrobiodiversity, and of guaranteeing the sustainable utilization of the latter.*

Outside gene parks and protected areas, in situ *conservation is often carried out at the farm level, where landraces and locally improved material are grown, utilized and conserved as components of traditional farming systems, and where they evolve in response also to their dynamics.* In situ *conservation, again according to the CBD, should also aim to "... respect, preserve and maintain knowledge, innovations and practices of indigenous and local communities embodying traditional lifestyles relevant for the conservation and sustainable use of biological diversity ... and encourage the equitable sharing of the benefits arising from the utilization of such knowledge, innovations and practices".*

On the other hand, several traditional crops, such as traditional

vegetables and fruit varieties or local animal breeds, have shown qualitative and nutritional characteristics worthy of consideration and use with positive effects on farmers' incomes. Thus, in many circumstances, agricultural development can be more effectively pursued by strengthening and improving traditional farming systems, rather than by introducing new, alternative varieties, which generally require high-input farming procedures.

It may be concluded that the in situ *or, under specific conditions, on-farm conservation and growing of crop, domestic animal and agroforestry species may play a significant role not only in the effective maintenance of agrobiodiversity, but also as a component of sustainable development programmes, as also recognized by Agenda 21. Measures, such as the establishment of a multilaterally agreed funding mechanism, should therefore be taken to promote, encourage and implement* in situ *and on-farm conservation.*

In recent years it has become increasingly evident that biotechnology can add value to genetic resources and biodiversity at large. The development and use of biotechnology methods that allow the transfer of DNA sequences from one species to another, and even from one biological kingdom to another, for example from animals,

fish or micro-organisms to plants, has raised the economic value and increased the potential of much biological diversity as a resource in breeding and research. Consequently, it has widened enormously the scope and boundaries of initiatives to protect and conserve biodiversity.

The incorporation in crop plants of genes for biological nitrogen fixation, pests and disease resistance, new and more efficient methods of biological pest control, better yielding and higher-quality animal and plant products and the adaptation of crop plants and livestock to diverse ecological conditions (such as extremes of heat and cold, and water excess or drought) will increase stability, ecocompatibility and sustainability of agricultural production, and could reduce the need for new arable land and the pressure on overexploited farming land, thereby contributing to biodiversity conservation itself as well as forestry maintenance.

Moreover, biotechnologies have been developed and largely adopted first by developed countries, where advanced research projects can be carried out. This is likely to increase the gap between the rich and the poor further, at least temporarily. Therefore, it is now time for developing countries to be involved in the responsible development

and use of appropriate biotechnologies which can meet their specific needs. These countries host most of the biodiversity of relevance to food and agriculture, and biotechnologies may provide new opportunities and a new capacity to speed up the domestication and improvement of promising or neglected species. So far, however, many developing countries lack the resources they need for such activities.

ACCESS TO GENETIC RESOURCES AND A FAIR AND EQUITABLE SHARE OF THE BENEFITS

FAO's initiatives in the field of plant genetic resources started in 1947. Milestones include (Table 5): the constitution of a Panel of Experts on plant exploration and introduction (1965); the convening of three International Technical Conferences (1967, 1973, 1981); the establishment of the International Board for Plant Genetic Resources (IBPGR) (1974); the establishment of a permanent intergovernmental forum, the Commission on Plant Genetic Resources (1983); the adoption in 1983 of the International Undertaking on Plant Genetic Resources; and since then the development of the FAO Global System for Plant Genetic Resources. These scientific and technical achievements have been internationally recognized. In fact, the UN

TABLE 5
FAO's main actions in plant genetic resources

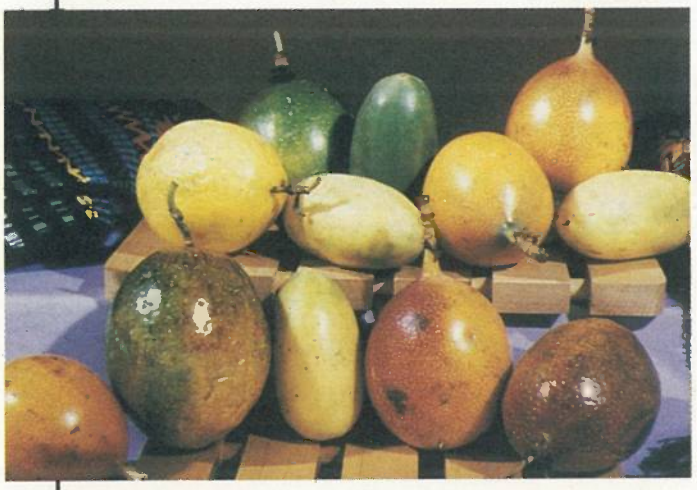
1965	Permanent Panel of Experts
1967, 1973, 1981	The Convening of International Technical Conferences
1974	International Board for Plant Genetic Resources (IBPGR)
1983	Intergovernmental Commission on Plant Genetic Resources (123 countries)
1983	International Undertaking on Plant Genetic Resources (110 countries)
1983	FAO Global System for Plant Genetic Resources (140 countries)

B i o l o g i c a l

... Lentils

... *Phaseolus* spp.

... Passionfruit



... *Triticum* spp.

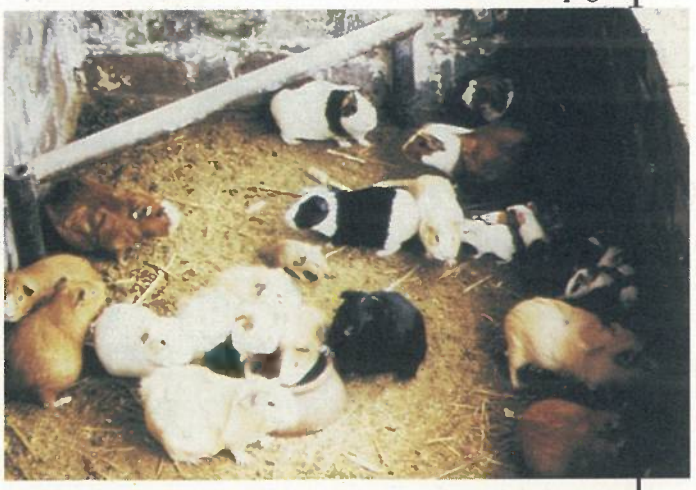
d i v e r s i t y i n ...

... *Solanum* spp.

... Vegetables

... Maize

... Guinea-pigs



Conference on Environment and Development, held in Rio de Janeiro in June 1992, adopted Agenda 21 and opened the Convention on Biodiversity (CBD) for signature; the convention has so far been signed by more than 170 countries and ratified by 117.

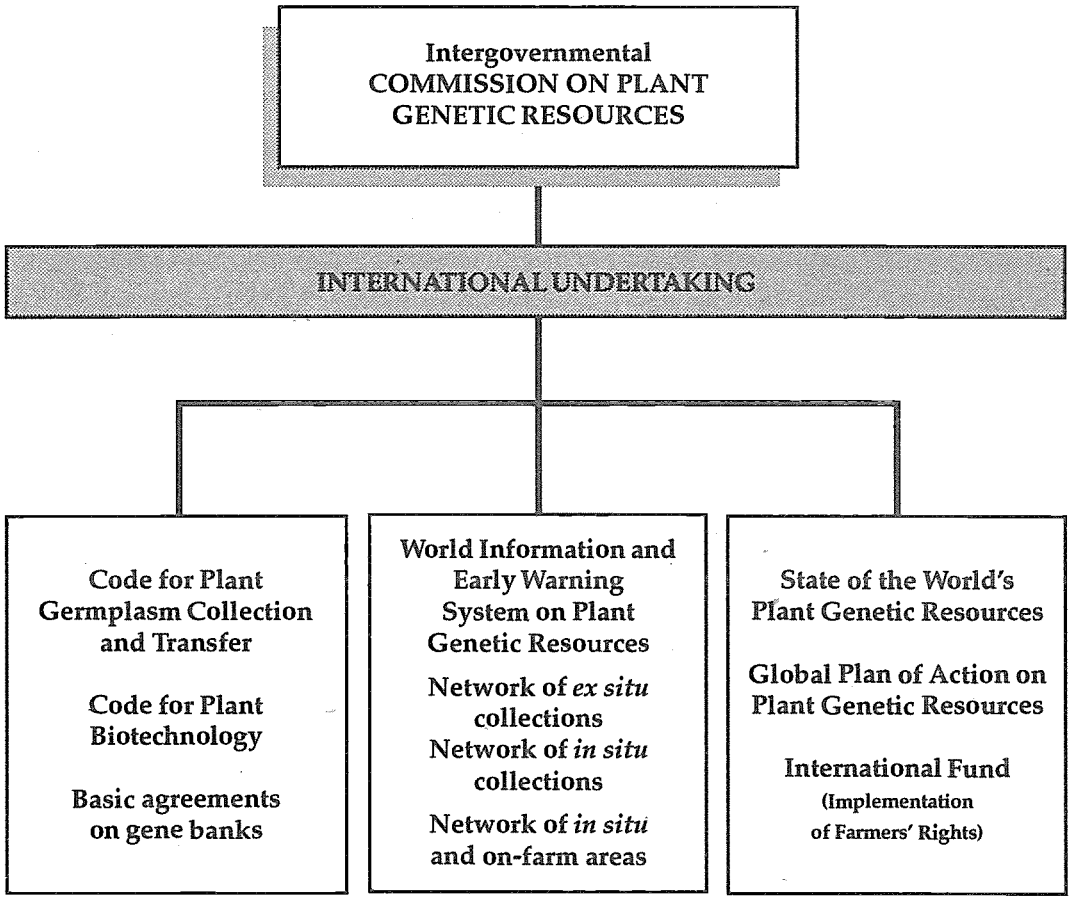
It must be underlined that Resolution 3 of the Conference for the Adoption of the CBD as well as Agenda 21 specifically recognize the importance of genetic resources for food and agriculture and request the strengthening of the FAO Global System for Plant Genetic Resources.

In response, to develop the Global System for Plant Genetic Resources further (see Chart), FAO has taken a number of initiatives:

1. The convening, in 1996, of the Fourth International Technical Conference on Plant Genetic Resources. The participatory, country-driven process leading to this Conference will prepare two major elements of the Global System: the first report on the State of the World's Plant Genetic Resources and the first Global Plan of Action on Plant Genetic Resources. Together, these will provide guidelines for future action.

2. The negotiation of a revision of the International Undertaking, in harmony with the CBD, including the realization of Farmers' Rights

Illustrative chart of the Global System for the Conservation and Utilization of Plant Genetic Resources



and the regulation of access to plant genetic resources for food and agriculture. In this respect, it is worth mentioning that access to genetic resources is regulated by Article 15 of the CBD as follows:
"1) Recognizing the sovereign rights of the States over their natural resources, the authority to determine access to genetic resources rests with the national governments and is subject to national legislation;
2) Each Contracting Party shall endeavour to create conditions to facilitate access to genetic resources for environmentally sound users by other Contracting Parties and not to impose restrictions that run counter to the objectives of this Convention."

3. The further development of the International Network of Ex Situ *Collections under the auspices of FAO, it being borne in mind that the CBD does not itself regulate the legal status of* ex situ *collections assembled prior to its entry into force.*

Resolution 3 of the Conference for the Adoption of the CBD specifically requested FAO to seek a solution to the problem of access to such ex situ *collections within the Global System for Plant Genetic Resources. These collections include those held by the IARCs of the CGIAR, as well as those of their partners (particularly the National Agricultural Research Services in developing countries) and many*

more. These collections were assembled with the cooperation of the countries donating germplasm, on the understanding that the material collected would be made available to the world community.

With a high sense of responsibility, 12 IARCs concluded an agreement with FAO in October 1994 whereby they brought their collections of germplasm collected prior to the entry into force of the CBD under the auspices of FAO. By this agreement, the IARCs agree not to claim intellectual property protection over these materials and to ensure that the recipients of samples are bound to the same obligation.

As far as ex situ *conservation is concerned, one needs however to be aware that, if an effective regulation of the status of, access to and sharing of benefits is attainable in the foreseeable future for the IARC collections already brought under the auspices of FAO, much uncertainty remains regarding the future status of and access to germplasm collected before the entry into force of the CBD and conserved in the multitude of gene banks other than those of the IARCs.*

As regards animal genetic resources, initiatives taken by FAO can be summarized as follows: Technical Consultation recommending the development of a global programme in animal genetic resources (1980);

development of an animal breed data bank in FAO (1986); Expert Consultation to design and implement the Global Animal Genetic Resources Management Programme (1992); release of the World Watch list for Domestic Animal Diversity (1993). The implementation of the Global Animal Genetic Resources Management Programme envisages: (i) updating and analysis of the Global Data Bank for Animal Genetic Resources; (ii) establishing national, regional and global focal points to coordinate animal genetic resource management; (iii) launching a global research project to measure genetic variation among breeds; (iv) preparing guidelines for Member Governments for a global survey of all domestic animal species, for monitoring endangered species, for ex situ *and* in situ *conservation, and for preparing national action strategies on domestic animal species.*

PERSPECTIVES AND PROPOSALS

It is extremely urgent that a timely agreement under the terms of the CBD be reached between holders of germplasm throughout the world in order to regulate the status of and access to currently conserved genetic resources and those that will be conserved in the future. In fact, while the conservation of genetic resources is essential, it is equally essential

that they be made available for use by scientists, breeders, farmers and others as a tool for attaining sustainable agricultural and socio-economic development.

I therefore strongly recommend that countries, through the FAO Commission on Plant Genetic Resources, accelerate the process of revising the International Undertaking on Plant Genetic Resources in harmony with the CBD. The revised International Undertaking could provide a multilateral framework, which would both respect the principle of access on mutually agreed terms and provide mechanisms for the sharing of benefits. Countries could agree, for example, to place their genetic resources into such a framework on the basis of prior informed consent. Access to samples of these resources could be unrestricted (although regulated through a legal mechanism such as a material transfer agreement) for all countries which are parties to the agreement. All plant genetic resources covered by the agreement could be used without payment for research and for non-profit purposes.

I also support the creation, as already proposed, of a funding mechanism which would contribute to the implementation of Farmers' Rights (as adopted by the Resolutions of this Conference in 1989 and 1991, following a proposal by the FAO Commission on Plant Genetic

Resources) and, in general, promote the conservation and utilization of plant genetic resources. Developed countries which are parties to the agreement would contribute financially to the funding mechanism, in addition to making their own plant genetic resources available. The agreement would also provide for material in international collections obtained prior to the entry into force of the CBD either to continue to be distributed on the present basis (free of charge), or on the condition that an agreed share of the benefits derived from their commercial use be put into an international fund for the implementation of Farmers' Rights.

Agenda 21 also requested the realization of Farmers' Rights as originally conceived by FAO: an obligation to compensate farmers (translated into an international funding mechanism) for their past, present and future contribution in conserving, improving and making available plant genetic resources, particularly those in the centres of origin/diversity. Farmers and rural societies at large will have to be supported by governments and international institutions in their continued effort to generate and conserve plant genetic resources and to improve their own well-being.

The principle of Farmers' Rights aims at reconciling the view of the "technology-rich" and the "gene-rich" countries in order to ensure the

availability of plant genetic resources within an equitable system. It also provides some balance to "formal" intellectual property rights, Breeders' Rights and Patents intended to reward "formal" innovations, derived from advanced research and resource investments in industrialized countries.

With regard to the application of biotechnologies, their intimate connection with biodiversity itself must be recognized, and access (Article 16 of the CBD) to the know-how of biotechnology companies and research institutions should be facilitated. Joint ventures that help transfer technology from North to South could also be envisaged. Such action should first of all include the training of personnel from developing countries in advanced laboratories of biotechnology companies and research institutions.

There may be unique opportunities for real international cooperation among developing and industrialized countries in building local capacities, in developing countries, for the application of agrobiotechnologies to agrobiodiversity. Equitable and effective cooperation through technology transfer constitutes one of the major mechanisms by which resources of biodiversity can be conserved, managed and used sustainably. Equity demands that developing

countries receive benefits and compensation for the use of these resources. Such benefits will be optimized by activities that "add value". Ways to strengthen developing countries' ability to add value include improving their capacity to maintain their agrobiodiversity in situ *or* ex situ, *to identify and evaluate useful genetic traits for plant and animal improvement and to apply the relevant biotechnologies for the optimal use of genetic resources.*

It is my wish that the proposals I have just made will be considered for implementation during the negotiating process for the revision of the International Undertaking, which could be ready for adoption on the occasion of the World Food Summit late in 1996.

With respect to genetic resources for food and agriculture other than plants, I also hope that the present session of this Conference will adopt the draft resolution aimed at broadening the terms of reference of the Commission on Plant Genetic Resources to include farm animals, forestry and fishery genetic resources.

CONCLUSION

The efforts made so far by politicians, statesmen, managers, diplomats, scientists and journalists of many countries and international

organizations to elucidate the facts, define the problems and propose actions for the conservation, development and utilization of biodiversity have been enormous and praiseworthy.

As might have been expected, special consideration has been given to the genetic resources of plant and animal species of immediate or potential use for the progress of agriculture and to the improvement of human food and nutritional standards. Clear and valuable proposals have also been advanced to find solutions to the problems but, to a large extent, these have not yet been adopted or acted on.

It is the duty of all of us, politicians, managers, scientists, experts and the mass media, to bear in mind that further delays in acting and in abiding by the principles and guidelines provided by the CBD, the International Undertaking and by other relevant multilateral agreements and engagements, could hinder the continuation of many current programmes for the conservation of agrobiodiversity and, of course, of biodiversity in general as well as the start of new ones.

Nevertheless, we are witnessing an extremely dangerous general stalemate, the consequences of which can be easily identified: genetic erosion and the disappearance of species and degradation of ecosystems; a narrowing of intraspecific variation; the impoverishment of existing

ex situ *collections; and the interruption or decline of current initiatives for* in situ *and on-farm conservation.*

Similarly, the disregard of other provisions of the CBD, particularly those related to developing countries' access to technologies developed by industrialized countries, could widen the technological and economic gap between these groups. In the absence of any agreement, the human and financial resources that are concentrated in the economic north of the planet may still allow the realization of effective and proficient breeding programmes. But the results will be that the "added value" of new, progressive cultivars and strains released to the farmers in developing countries will have to be paid for. The ultimate result could be further genetic erosion, higher costs of seed and lower incomes and standards of living for rural communities in many countries.

It is our duty to stop the still largely hidden treasures of biodiversity, of agrobiodiversity, becoming dispersed and no longer available for the benefit of all: individuals and nations, today and in the future. This would be an irreparable, dramatic loss which would damage countries holding genetic resources, with an overall shrinking of biodiversity reserves. This loss would be equally serious and irreparable for all countries and peoples on earth, because it would reduce their power to

face the immense challenges of the future, such as the safeguarding of the environment and natural resources, and the need to feed the ever-increasing world population.

As a matter of fact, the need for food will continue to increase: the world population will reach seven billion at the turn of the century, with most of it, more than 80 percent, concentrated in developing countries. Further increases in food demand are likely to be the result of improved welfare and individual incomes, which will bring about a request for better nutritional and quality attributes.

According to present estimates, food production should increase by more than 60 percent in the next 25 years, if it is to match the population increase. However, world production of cereals, whose yearly increase has been of 3 percent from 1950 to 1980, has dropped in recent years to less than 1.5 percent.

According to FAO, higher cereal productions have so far been generated by three major factors: expansion of arable land; improvement of production technology (particularly application of irrigation and fertilizers) and genetic advances, made possible by plant breeding.

However, new arable land is becoming more difficult to obtain. Moreover, increasingly larger surfaces (in China, for example,

1 million ha) of arable land are lost every year owing to several causes. Furthermore, other factors of production, such as water, are less and less available. Therefore, any future improvement of production will have to be based essentially on increases in production per hectare.

If the world population increase slows down, if there is an improvement in the professional skill of farmers, in services, in socio-political organization and international cooperation, if higher investments in science and technology are able to yield increasingly significative results, then it is reasonable to foresee that food production, both from plants and animals, will be able to face the challenge of demographic expansion.

But food security is inextricably linked to the conservation and sustainable utilization of biodiversity, of the genetic resources necessary for the continuing selection of new crop varieties and animal races, better adapted to agro-ecosystems.

In the context of solidarity among all peoples, it is our moral duty to conserve these biological riches, to protect the life forms that nourish the earth and to use them in an equitable and sustainable way, since they are the guarantee of development for the future generations who will be the protagonists of the third millennium.

This is why it is our duty, and especially that of politicians and the scientists advising them, to do everything we can to overcome the problems that delay the effective adoption of the rules expressed in the CBD and in other international agreements, commendably developed by FAO, and often mentioned in the past.

Complete, international, planetary cooperation is imperative without delay. If the danger is incumbent on all, the benefits of collaboration will also be for all. Let us replenish the ex situ *collections, let us multiply the* in situ *gene parks. Let us truly recognize and respect the farmers' rights as well as the breeders' rights. Let us couple the natural treasures mostly available in the developing countries with the potential of new technologies, in particular the genetic and microbiological technologies, for a sustainable utilization of natural resources.*

There are both great risks and great responsibilities. As a scientist, I feel encouraged to put forward a proposal to my colleagues, to the international scientific community, above all to those who, in every country, in the application of the CBD, have already officially cooperated or are still cooperating to help their respective governments to "... integrate consideration of the conservation and sustainable use of biological resources into national decision-making..." (CBD, Article 10).

To all these people, I propose that we join together in a movement of ideas to support a complete and expeditious application of the principles and rules of the CBD. Let us launch this strong movement of ideas which, together with governments, supranational and international agencies, the mass media and public opinion in general, should support the urgent need for making a reality of the farsighted programmes initiated a long time ago by the UN and FAO in favour of an equitable and sustainable use of biodiversity and agrobiodiversity, which are key elements in the achievement of all global development goals.

I urge scholars of biodiversity and genetic resources, as part of this movement, to express explicitly their willingness to put their knowledge and experience at the disposal of their fellow countrymen, their governments and the UN in order to strengthen the foundations of multilateral cooperation for the betterment of all peoples and the good of generations to come. I believe that an explicit and coordinated action of scientists may contribute to educating public opinion about the fundamental need, and the common interest, to conserve biodiversity, to use its components sustainably and to share fairly and equitably the benefits arising from the utilization of genetic resources. It is a moral duty that all men and women of culture and science have towards humanity.

I am convinced that such a contribution to your difficult and complex task, Mr Chairman, Mr Director-General, Honourable Ministers and Delegates, would be appreciated and accepted as a valid help to advise and support and make the formation of a general consensus easier.

Mr Chairman,
Mr Director-General,
Excellencies,
Honourable Delegates,
Ladies and Gentlemen,

I wish to conclude by pointing out that, among all great questions challenging humanity as the third millennium approaches, I have made special reference to four problems: (i) the need to increase food and agricultural production, to guarantee all human beings a sufficient, healthy and nutritionally balanced diet; (ii) the need to safeguard the natural environment, natural resources, including biodiversity, for sustainable socio-economic development in the interest also of future generations; (iii) the need to promote and support scientific and technological research, in public and private institutions, for the

improvement of the agrofood system and for the development of the environmental sciences; and (iv) the need to guarantee all peoples access to, and use of, scientific discoveries, technologies and innovations, so as to promote a more harmonious cultural and social development of the world's nations, because humanity does not live by bread alone.

These four fundamental problems bring me back to the theme that has been at the root of my speech: the protection of biodiversity in general, and the use of plant and animal genetic resources for modern, ecocompatible and sustainable farming systems.

I have tried to demonstrate the need to reach a common strategic plan for the sustainable use of the natural resources in general, and biodiversity in particular. Let us move from a general consensus on the CBD to active cooperation, from commitment to tangible and definitive action.

I believe that, through the personal experience and sense of responsibility of so many illustrious representatives of the governments of almost all nations on earth as well as experts from most important international agencies and national institutions who are gathered here in Rome for this biennial Conference of FAO, the engagements made in

Rio de Janeiro in 1992 will soon become reality in a spirit of solidarity among all peoples. It is essentially a matter of expediting and implementing an international commitment aimed at improving the human condition and forming a new society in harmony with nature and the environment.

Concrete initiatives and actions will surely be one of the best ways of celebrating the 50th anniversaries of the UN and FAO.

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