Chapter 1 : Genetic resources, breeding and seed production

Chickpeas, faba beans and lentils are important pulse crops in the Mediterranean regi on and Mi ddl e East, where thei r hi gh protei n seed nutritionally complement cereal grain in the human diet.

This Act provides for rights and duties concerning the access to genetic resources, genetic material, and derived products, in ex situ or in situ conditions, existing in the Brazilian territory or having Brazil as their country of origin, to traditional knowledge possessed by indigenous populations and local communities, associated with genetic resources or derived products and with domesticated and semi-domesticated crops in Brazil. Genetic resources and derived products are considered public property of special use of the Brazilian Nation, and the contracts of access to them shall be carried out under the terms of this Act, without prejudice to material and immaterial property rights relating to: I - the natural resources containing the genetic resource or derived product; II - the lands traditionally inhabited by Indians and their exclusive enjoyment of the riches existing in such lands; III - the private collection of genetic resources or derived products; IV - the traditional knowledge possessed by indigenous populations and local communities, associated with genetic resources or derived products; V - the domesticated and semi-domesticated crops in Brazil. The owners and holders of goods and rights referred to in this article shall be ensured of the fair and equitable sharing of the benefits derived from the access to genetic resources, to the traditional knowledge possessed by indigenous populations and local communities associated with genetic resources and derived products, and to the domesticated and semi-domesticated crops in Brazil, under the terms of this Act. The legal classification presented in the previous article does not apply to the genetic resources and any components or substances of human beings, with due regard to the provisions of article 8 of this Act. For the purposes of this Act, the following definitions apply: It is incumbent upon every individual and corporate body, and upon the State, in particular, to preserve the genetic patrimony and the biological diversity of the Country, to promote their study and sustainable use and to control the activities of access to genetic resources, as well as to oversee the institutions engaged in prospecting, collection, research, conservation, manipulation, commercialization, among other activities related to such resources, under the terms of this Act, with due regard to the following principles: The contracts of access to genetic resources, their control and oversight are aimed at the conservation, study and sustainable use of the biological diversity of the Country, the provisions of this Act being applied to all individuals or corporate bodies, either Brazilian or foreign, as well as to: I - any activity of extraction, use, exploitation, storing or commercialization, in the Brazilian territory, of genetic resources or their derived products; and, II - any agreement or contract, public or private, regarding genetic resources and derived products originating in the Country. This Act applies to the inland, coastal, marine and island genetic resources and their derived products existing in the Brazilian territory or having Brazil as their country of origin, as well as to the associated traditional knowledge possessed by local communities and indigenous populations, and to the migrating species which, for natural causes, are present in the Brazilian territory. This Act does not apply: I - to the genetic materials and any components or substances of human beings, with any collection or use of these resources, components or substances being subject to approval by the Executive Power, upon justified prior consent of the individual concerned, while a specific act regulating the matter does not come into force; II - to the exchange of genetic resources, derived products, traditional crops or associated traditional knowledge, carried out by the local communities and indigenous populations, among themselves, for their own purposes and based on their customary practices; Article 9. The use, either direct or indirect, of biological resources, genetic resources, or genetic materials and derived products in biological weapons or in practices which are harmful to the environment or to human health is forbidden. To ensure compliance with the provisions of this Act, the Federal Government shall appoint an agency of the Direct Administration to carry out the functions of competent authority and to be responsible for authorizing access to genetic resources. The decisions of the competent authority with respect to the national policy of access and to the authorizations of access shall be signed by a Genetic Resources Committee, to be established by the Executive Power, made up of representatives of the Federal Government, the state governments and the Federal District,

the scientific community, the local communities and indigenous populations, the agencies of access, the non-governmental organizations and private companies, with parity of representation of members of the Government and of the communities and non-governmental institutions, the institutions of education and research being included among the latter. The competent authority shall carry out the functions of executive secretariat of the Genetic Resources Committee, according to the regulations. In addition to signing contracts of access, it is incumbent upon the competent authority, upon opinion of the Genetic Resources Committee and with due regard to the provisions of this Act and of any other legislation and environmental policy tools: At any time, in case of danger of serious and irreparable damage deriving from activities carried out under the terms of this Act, the Government, based on a technical opinion and on proportionality criteria, shall adopt measures to prevent such damage and may even stop the activity, especially in the following cases: I - endangered species, subspecies, lineages or varieties; II - reasons of endemism or rarity; III - vulnerable conditions of the structure or functioning of ecosystems; IV - adverse effects on human health or on the quality of life or cultural identity of the local communities and indigenous populations; V - environmental impacts which are undesirable or difficult to control, upon urban and rural ecosystems; VI - danger of genetic erosion or loss of ecosystems, of their resources or components, because of undue or uncontrolled collection of germplasm; VII - non-compliance with biosafety or food safety rules and principles; and VIII - use of resources for purposes contrary to national interests and to the agreements entered into by the Country. The lack of absolute scientific certainty regarding the cause and effect relationship between the activity of access to genetic resources and the damage may not be presented as a reason to disregard the adoption of the necessary effective measures. Any procedure of access to genetic resources in the Brazilian territory, in in situ conditions, shall be subject to prior authorization of the competent authority and to the signing and publication of a contract between the competent authority and the individuals and corporate bodies concerned. The competent authority shall keep a reference file of public institutions and non-profit private organizations which carry out activities related to the conservation and sustainable use of natural resources, referred to as "agencies of access" for the purposes of this Act, empowered to request access on behalf of third parties, discuss additional contracts and clauses for the protection of rights relating to traditional knowledge, and manage projects and investment of funds derived from contracts of access. To obtain authorization and sign a contract of access to a genetic resource, the petitioner or the agency of access must present a petition, together with the project of access, including at least the following items: I - curriculum vitae and complete identification, including those of the respective responsible persons: II - complete information on the timetable, budget and sources of financing for the activities scheduled; III - detailed and specified description of the genetic resources, derived products or traditional knowledge to which access is intended, including their current and potential uses, their environmental sustainability, and the risks which may arise from such access; IV - detailed description of the methods, techniques, collection systems and tools to be used; V - precise location of the areas where the procedures of access will be carried out; VI -indication of the destination of the material collected and of its probable future use. In the case of access to traditional knowledge, the project referred to in this article shall include an authorization to visit the local community or indigenous population, as well as the information collected, from an oral or a written source, related to the traditional knowledge concerned. The competent authority shall also, when it deems necessary, require the presentation of an environmental impact study and report related to the activities to be carried out. If the petition and project of access are considered complete, the competent authority will grant it a date, hour and number of registration and, within 15 fifteen days as of such date, it will take the following steps: I - publication of an abstract of the petition and of the project of access in the Federal Official Gazette; II - publication of an abstract of the petition and of the project of access, for 3 three consecutive days, in the newspaper of highest circulation figures in the region where the access will take place; III - when the institution assigned by the petitioner or by the agency of access is not approved, indication of at least three institutions which may be assigned to monitor the procedures of access under the terms of this Act. If the petition and the project of access are deemed incomplete, they may not be accepted by the competent authority, who shall immediately return them for correction. Within 60 sixty days as of the publication of the petition and project of access, the competent

authority shall start its examination, analyzing the information provided according to article 15, carrying out the necessary inspections, and, based upon a technical-juridical opinion and upon the opinions expressed by any interested party, submitted within the legal time period, it shall make a decision whether to accept the petition or not. The deadline stipulated in the caption may be extended, at the discretion of the competent authority. The petitions of access to take place in conservation units shall be subject to an opinion of the competent agencies, to be issued without prejudice to the deadline stipulated in the caption. The petitions of access to take place in indigenous areas shall be subject to an opinion of the competent agencies, to be issued without prejudice to the deadline stipulated in the caption, as well as to the justified prior consent of the indigenous community concerned, under the terms of this Act. Before the end of the time period for examination, the competent authority, based on the opinion provided for in the previous article, shall grant or dismiss the petition by means of a justified decision. The decision to dismiss shall be communicated to the interested party and shall be the final step of the procedures, without prejudice to the admissible administrative or judicial appeals. The decision to grant the petition shall be communicated to the interested party within 10 ten days and published in the Official Gazette and in the newspaper of highest circulation figures in the region where the access will take place, being followed by the discussion and preparation of the contract of access. The following are the parties to the contract of access: When the petition of access involves a traditional knowledge or domesticated crop, the contract of access shall include, as an integral part, an annex referred to as a supplementary contract on the utilization of traditional knowledge or domesticated crop, undersigned by the competent authority, by the provider of traditional knowledge or domesticated crop, by the petitioner and the agency of access, as the case may be, stipulating a fair and equitable compensation with respect to the benefits arising from such utilization, the form of such participation being expressly indicated. During the stage of discussion of the contract of access, the petitioner or agency of access shall submit to the competent authority the additional contracts they may have entered into with third parties, under the terms of this Act. The public or private institution operating as national support, under an additional contract set forth in this Act, shall be accepted by the competent authority. The acceptance set forth in the previous paragraph shall not, by any means, render the competent authority responsible for compliance with the respective additional contract. The contract of access, as determined by the terms and clauses mutually agreed upon by the parties, shall include, in addition to the information provided by the petitioner or the agency of access, all of the conditions and duties to be fulfilled, as follows: The term of the contract of access shall be determined by the competent authority, the maximum period being 3 three years as of the date of its signing, renewable for periods of the same length as the first one. Without prejudice to other rescissory clauses agreed upon, the competent authority may rescind the contract of access at any time by virtue of a provision of this Act. The data and information contained in the petition, proposal, authorization and in the contract of access may be subject to confidential treatment, in case third parties may make unfair commercial use of them, except when their disclosure is necessary to the protection of public interest, of the environment or of rights regarding traditional knowledge. For the purposes stated in the caption, the petitioner or the agency of access shall submit a justified petition, together with a non-confidential summary, to be part of the published documents. The confidential data shall be kept by the competent authority and may not be disclosed to third parties, except by means of a court order. Confidentiality may not be applied to the information referred to in items I, IV and V of article The competent authority may sign, with state-owned or public utility research centers and universities, domiciled in the Country, agreements to provide for the carrying out of one or more contracts of access, in compliance with the procedures stated in this Act, it being waived, in such cases, the need to assign an institution to monitor the activities of access, in accordance with the provisions of articles 15 and The contracts signed in violation of this Act shall be null and void, and their nullity may be decreed ex officio by the competent authority, or at the petition of any person. Authorizations may be requested and contracts of access may be signed without compliance with items III and VI of article 15, in which case they shall be referred to as provisional authorizations and contracts, in areas having their location and size defined by the competent authority, with due regard to the ecological zoning of the Country, the following being observed: The additional contracts of access are those necessary to the implementation and development of activities

relating to access to genetic resources, and that have been entered into by the petitioner or the agency of access and: The additional contracts shall stipulate a fair and equitable share for the parties in the benefits arising from access to the genetic resource, the form of such sharing being expressly indicated. Without prejudice to the provisions of the additional contract and notwithstanding such a contract, the public or private institution shall be required to cooperate with the competent authority in the monitoring and controlling of the activities of access, and to submit reports about the activities under its responsibility, in the manner and as often as the authority determines, the suitability to the nature of the activities under the contract being ensured. The signing of an additional contract does not authorize access to a genetic resource, and its contents must be compatible with the provisions of the contract of access and of this Act. The additional contracts shall include a suspensive clause, conditioning their implementation to the carrying out of the contract of access. The nullity of the contract of access causes the nullity of the additional contract. The competent authority may rescind the contract of access when the nullity of the additional contract is declared, if the latter is essential to the completion of the access. The alteration, suspension, or rescission of the additional contract may imply the alteration, suspension, or rescission of the contract of access by the competent authority, if they have a substantial effect on the conditions of the latter. The procedures of access must be monitored by a Brazilian institution of education or of research, either public or private, of undisputed repute in the area subject to the procedure, approved by the competent authority and hired by the petitioner or by the agency of access, before the authorization. The institution so assigned has joint and several liability for the fulfillment of the obligations undertaken by the individual or corporate body authorized to carry out the procedure of access. It is incumbent upon the competent authority, together with the institution assigned to monitor the authorized activities, to monitor the compliance with the provisions of the authorization and of the contract of access and, especially, to ensure that: I - access is obtained exclusively to the authorized genetic resources and derived products, when it is not the case of a provisional contract, and in the established area; II - the environmental conditions of the region where the activities take place are preserved; III - there is permanent direct participation of an expert from the monitoring institution; IV - a detailed account of the activities carried out and of the destination of the samples collected is presented; V - samples of the species collected are handed over to be conserved ex situ by the institution assigned by the competent authority. Section VI -- Compensation Article In addition to the payments and sharing of benefits agreed upon by the petitioner, the agency of access, the providers of traditional knowledge and the other parties to the additional contracts, a fair compensation is ensured to the State, in the form of money or commercialization rights, in the manner stipulated by the contract of access signed by the competent authority and the other parties. The forms of compensation stated in this section shall make up a special fund for the conservation, research and inventory of the genetic patrimony, designed to be a tool of financial support to projects related to the access to and the conservation of genetic resources and to the knowledge associated with genetic resources. The projects stated in this article shall be selected by the competent authority, whose decision shall be confirmed by the Genetic Resources Committee, subject to the availability of funds and to compatibility with the principles established in this Act. The permits, authorizations, licenses, contracts and other documents regarding the research, collection, acquisition, storing, transportation, or any other similar activity related to the access to genetic resources, in force at the date of publication of this Act, in accordance or not with the provisions thereof, do not condition neither presuppose the authorization for access. The individuals or corporate bodies authorized to develop activities of access to genetic resources are required to transmit to the competent authority any information regarding the transportation of the material collected, and they also have civil, criminal and administrative responsibility for the inadequate use or handling of such material and for the adverse effects of such activities. The authorization or contract of access to genetic resources do not imply authorization to remit them abroad, in which case authorization must be previously requested and justified before the competent authority. It is totally forbidden to remit single samples abroad, without due regard to the provisions concerning the mandatory deposit of samples of every genetic resource or derived product which may have been subject to access. It is illegal to use genetic resources and derived products for purposes of research, conservation, industrial or commercial applications, or any other purposes, if the access has not taken place

according to the provisions of this Act. The rights upon genetic resources and derived products obtained or used in violation of this Act shall not be recognized, and the certificates of intellectual property or similar certificates upon such resources or derived products or upon products or processes resulting from access under such circumstances shall not be considered valid. The depositors of intellectual creations subject to protection by copyright, industrial property, crops or any other mode of intellectual property, being based on any genetic resources or traditional knowledge, as well as those based on the cultural or artistic traditions of local communities or indigenous populations, must present a certificate of approval by the communities or populations, to be obtained before requesting legal protection of the creation and in compliance with the laws of the country of origin of the genetic resource or of the traditional knowledge. The competent authority may sign contracts of access to genetic resources which are deposited in ex situ conservation centers located in the Brazilian territory, or in other countries, provided that Brazil is the country of origin of the resources. The provisions regarding access to resources in in situ conditions shall apply, where appropriate, to access to resources in ex situ conditions. The genetic material transfer agreements or similar agreements between ex situ conservation centers or between such centers and third parties, either within the Brazilian territory or through importation or exportation, constitute modes of contracts of access. The conservation center providing the genetic resource shall submit a petition of access to the competent authority, who will publish an extract of the petition in the Official Gazette within 15 fifteen days as of the respective date. The agreements stated in the caption shall be valid provided that they are compatible with the conditions agreed upon in the original contract of access to the resource exchanged, and with the intellectual property rights concerned. In its analysis of the petition of access, the competent authority may demand financial compensation, under the terms of this Act, which compensation shall be mentioned in the genetic material transfer agreement or similar agreement. In its analysis of the petition of access, the competent authority must take into consideration the opinions presented by any interested party. The agreement may only be signed by the conservation center and the interested party after validation of the proposal of agreement by the competent authority. The State recognizes and protects the rights of local communities and indigenous populations to benefit from their traditional knowledge collectively, and to receive compensation for the conservation of genetic resources, by means of payments in money, goods, services, intellectual property rights or other mechanisms. It is incumbent upon the Public Prosecution to take judicial and extrajudicial measures to protect Brazilian genetic resources and to defend the interests and rights of local communities and of indigenous populations. The competent authority shall create a national reference file, where the local communities, the indigenous populations, and any other interested party may deposit records of knowledge associated with genetic resources. Every record deposited in the national reference file shall be submitted to an ethnologic appraisal, and shall be used as a basis for decisions concerning the terms of the contract of access. By means of agreements, the collections of traditional knowledge belonging to other institutions, either Brazilian or foreign, may be deposited in the national reference file, for the same purpose of the preceding paragraph. The records mentioned in this article are not mandatory, and their non-existence are not a condition for, neither does it preclude the exercise of any right set forth in this Act. The local communities and indigenous populations have exclusive rights over their traditional knowledge, and they alone are entitled to surrender them, by means of the types of contract set forth in this Act. The proposal of contract of access may only be accepted if it is preceded by justified prior consent of the local community or indigenous population, obtained according to clear and precise rules which shall be stipulated for this procedure by the competent authority. The local communities and indigenous populations are ensured of the right to the benefits arising from access to genetic resources carried out in the areas they inhabit, defined under an additional contract referred to in this Act, and following justified prior consent as stated in the preceding article. The local communities and indigenous populations may request that the competent authority deny access to genetic resources in the areas they inhabit, if they believe that such activities threaten the integrity of their natural or cultural patrimony. Intellectual property rights with respect to products or processes related to traditional knowledge associated with genetic resources or derived products shall not be recognized if the access has not taken place according to the provisions of this Act. The State shall promote and support the development of national sustainable

technologies for the study, use and improvement of autochthonous species, lineages and varieties, and shall support the traditional uses and practices of local communities and indigenous populations. For the purposes of this article, the State shall promote the survey and evaluation of national and traditional biotechnologies. The use of foreign biotechnologies will be permitted, whenever these comply with this Act and with other regulations on biosafety, and the interested company takes full responsibility for any damage to health, the environment or traditional cultures. Arrangements shall be set up to guarantee and facilitate, for the national researchers and providers of genetic resources, the access to and transfer of technologies that are relevant to the conservation and sustainable use of biological diversity, or that use genetic resources without harming the natural and cultural environment of the Country. In the case of technologies which are subject to patents or other intellectual property rights, it shall be guaranteed that the procedures of access and transfer of technology shall be effected with adequate protection to such rights.

Chapter 2 : Genetic Resources | blog.quintoapp.com

members of a global network of genetic resources centres, whose activities will serve to safeguard and make freely available, for crop improvement purposes, the genetic variability of major food crops and other plants of economic importance.

Click to print Opens in new window IP-Watch is a non-profit independent news service and depends on subscriptions. To access all of our content, please subscribe here. You may also offer additional support with your subscription, or donate. Apart from the conservation challenge, utilisation and sharing of benefits from plant genetic resources and traditional and associated knowledge among communities has also remained opaque despite constitutional guarantees. The Kenya Industrial Property Institute KIPI is thus partnering with other institutions and county governments to assist communities in the country to preserve all aspects of traditional or indigenous knowledge in areas such as health, agriculture,and climate change mitigation. This includes protection of genetic resources against undue exploitation and biopiracy. Busia County in Western Kenya is the pioneer in the implementation of the initiative with focus on biodiversity protection. It has drafted a biodiversity policy currently awaiting debate and approval by the county government. Atsali says KIPI has been working with the World Intellectual Property Organization WIPO where he is the link person for support on matters relating to protection of traditional knowledge, cultural expressions and genetic resources in Kenya. Moses Osia, Busia County Minister for Agriculture and Animal Resources, notes that the county like the rest of Kenya is endowed with different unique plant species, including naturally occurring vegetables and mushrooms as well as wild animals. He said the draft biodiversity policy recognises that the county has not been fully exploiting its traditional knowledge and genetic resources. According to Osia, when enacted, the policy will aid in educating people about preservation of genetic resources in view of the increased research and commercial exploitation as well as environmental degradation that is causing interference to the ecosystem. Osia said the move to put a policy in place has been occasioned by fear of loss of knowledge ownership particularly traditional knowledge associated with medicinal plants and traditional foods. Besides that, he noted, the policy is relevant due to the absence of a regulatory framework governing access to biodiversity and associated knowledge and benefit sharing mechanisms from utilisation of biodiversity resources. Victor Wasike, director, Plant Genetic Resources Research Institute GeRRI, also said Kenya is endowed with a diverse heritage of plant and animal genetic resources due to its location in the tropics, varied relief, landscapes and habitats which can support the wellbeing of its people. GeRRI is charged with coordinating genetic resources management to international best practice that provide for conservation, access and benefit sharing arising from the use of plant genetic resources. However, said Wasike, communities have poor recognition of benefits of biodiversity among other traditional practices and innovations. This is happening, he said, despite the fact local communities have for centuries relied on the resources as a source of food, medicine and raw materials for various products, hence accumulated enviable associated knowledge. Like other stakeholders, he noted that genetic resources heritage is faced with genetic erosion as a result of human activities and climate change. He stressed that the introduction of new plants, including invasive species, has further contributed to the decline of the indigenous flora and fauna. Wasike revealed that for a long period, Kenya lacked a formal national institutional framework for conservation of genetic resources. Wasike observed that the institutions largely implement activities in line with their mandates and have formed both formal and informal partnerships. He said, however, that in spite of them collaborating at institutional and individual levels in the implementation of specific activities for genetic resources protection, overall coordination among them is lacking. He supports the project in provision of scientific evidence to encourage the integration of locally available biodiversity into local Kenyan food systems. Provision of scientific evidence to consumers about plant genetic resources is important for its beneficial to communities owning the resources, he said. Already, women and youth groups in Busia County have established indigenous vegetable gardens as well as preservation of medicinal plants. The policy is at the same time set to shield them women and youth groups from biopiracy. Moreover, explained Wasike, they collaborate with experts from the County

Ministries of Agriculture, Health, Education, Environment, Public Health and Forestry, the Kenya Agricultural and Livestock Research Organisation and members of the local community-based organisations. The initiative enables communities to have a say on conservation of genetic resources and traditional knowledge, he said. It is aimed at improving nutrition and human health. National partners come from relevant ministries, the scientific community, NGOs, civil society and local communities. Wasike said that under the programme, emphasis is put on ensuring conservation of plants is mainstreamed into development programmes in the country. Kabaka Watai, head of bioprospecting for the Kenya Wildlife Service, a state corporation which runs community wildlife programmes that encourage biodiversity conservation by communities, said increased over-exploitation, bio-piracy and destruction of habitats as well as loss of indigenous knowledge is a key challenge globally. Communities in Kenya are grappling with access, utilisation and benefit sharing genetic resources, he said. According to Watai, application of intellectual property rights to biological resources should not be exploitative but unfortunately patent rules tend to favour corporations rather than indigenous communities. He said the global Convention on Biological Diversity CBD grants states the right to put in place legislative mechanisms where access and utilisation of genetic resources and traditional knowledge is enforced by permits or mutually agreed terms based on prior informed consent. But as the country endeavours to incorporate communities in ensuring protection of genetic resources and traditional knowledge, several challenges have to be surmounted. Communities need protection even on research findings relating to plants which they consider medicinal, Watai said. In Kenya, he added, traditional medicine has not been adequately documented. Kenya has citations in patents on use of its genetic resources, he said, yet little benefit has come of it. The country does not have a substantive law on genetic resources and traditional knowledge protection because the law that was enacted in became obsolete with the promulgation of a new constitution in , said Watai. The scenario, he said, exposes communities with knowledge on food, medicinal plants and valuable traditional knowledge to exploitation. Watai further states that Kenya has no defined platform to defend rights of communities that rely on traditional medicine like the case of Brazil. He cites poor record keeping as another challenge. Traditional knowledge he adds is being lost due to poor documentation. Another observation by Watai is that information access, whereby open access is increasingly becoming the norm, prevents communities from benefiting from their indigenous knowledge relating to genetic resources. According to Watai, genetic modification and digital gene sequencing curtails monitoring of genetic resources use thus undermining prospects of benefit sharing on the side of communities. Capacity building and initiating of infrastructure to support communities in preserving their genetic resources and traditional knowledge is vital, he said. The Kenya Wildlife Service is working with communities and farmers in conservation and protection of genetic resources and traditional knowledge to ensure their sustainable utilisation and proper benefit-sharing schemes especially where their commercial exploitation is involved.

Chapter 3 : Wheat Genetic Resources And Their Exploitation For Sustainable Food Security In India |

Genetic Resources and Their Exploitation - Chickpeas, Faba beans and Lentils by William Erskine, , available at Book Depository with free delivery worldwide.

Page 29 Share Cite Suggested Citation: Managing Global Genetic Resources: Agricultural Crop Issues and Policies. The National Academies Press. It introduces the subject for those readers without a background in genetic conservation. Germplasm consists of the genetic materials that can perpetuate a species or a population of an organism. Germplasm is thus a genetic resource that can be used both to reproduce and, through hybridization and selection, to change or enhance the organism. Conserving genetic resources is a means of safeguarding the living materials exploited by agriculture, industry, forestry, and aquaculture to provide food, feed, medicinals, fiber for clothing and furnishing, fuel for cooking and heating, and the food and industrial products of microbial activity. Genetic resources are of tremendous practical and historical significance for human life from daily survival to generating the wealth of nations, yet their crucial role in supporting human society is frequently overlooked and undervalued. Genetic conservation is an integral part of a much broader activity concerned with protecting the many plants, animals, microorganisms, and communities of organisms that help to mold and stabilize the environment and maintain the quality of air, water, and soil. This part of the report is intended as an introduction to the subject of genetic resources management for the nonspecialist. Agricultural Imperatives in undertaking this study was to examine the effectiveness of germplasm conservation and management on a global scale and to make recommendations on how they might be improved. The cultivated plant materials that are conserved are of five general kinds: Landrace, folk, or primitive varieties are local varieties developed by indigenous farmers in traditional agricultural systems, over hundreds of years. By modern standards such varieties are often highly variable. Landrace cultivars have generally been replace by modern scientifically bred cultivars in most crops but may still be locally important in some farming systems. Obsolete varieties are varieties developed since the advent of scientific agriculture in the late nineteenth century and that are no longer cultivated. Although no longer grown commercially, such varieties are usually maintained in collections for use in current and future breeding programs. Commercial varieties or cultivars are elite high-yielding lines in current use, developed by scientific plant breeding for modern intensive agriculture. The average life of modern varieties is relatively short 5 to 10 years when they are replaced by more recent products of breeding programs. Plant breeders lines are as-yet unreleased lines, mutations, or parents of hybrids maintained by breeders as part of their working stocks. Breeders usually develop and carry many lines in their programs, of which only a very small number are ever released into commercial production. Genetic stocks are genetically characterized lines of a species principally used in genetics and plant breeding research. They rarely have any commercial value but are nevertheless an important germplasm resource because of their usefulness in basic and applied research. Genetic stocks can be conveniently divided into the following three classes: Page 31 Share Cite Suggested Citation: For the most part, this report concerns crop plant germplasm with some reference to the germplasm of agriculturally important livestock and microbes. For some readers, this focus will represent an unduly narrow and restricted view of the crisis now faced in conserving global biological or genetic diversity. Despite the truth of the observation "there are no useless plants, only plants we have not yet found a use for" Falk, , this report was limited to the staple Single gene or single trait variants are lines carrying artificially generated or naturally occurring variants for qualitative characters. Examples include differences in morphological and physiological characters, electrophoretic variation in proteins, and fragment length variation generated by restriction enzymes in DNA. Multi-allelic stocks include multiple gene marker stocks useful for linkage studies and stocks with special combinations of loci necessary for the expression of a single trait. Cytogenetic stocks include all variants whose chromosomes structures differ from the norm because of the deletion, duplication, inversion, or translocation from one chromosome to another of specific DNA segments. These stocks are important in determining the chromosomal location of specific genes. Genetic stock collections are the province of the specialist because they require skill and experience in regeneration to ensure that they remain

viable and true to type. Wild and weedy relatives are species that share common ancestry with crops, but that were not domesticated. Most crops have wild or weedy relatives which differ in their degree of relationship to the crop. The ease with which genes can be transferred from them to the crop varies. They may be classified into the following three gene pools: A primary gene pool consisting of the cultivated species and wild relatives, which are readily intercrossed so that gene transfer is relatively simple. A secondary gene pool composed of all the biological species that can be crossed with the crop but where hybrids are usually sterile. Gene transfer is difficult but not impossible. A tertiary gene pool made up of those species that can be crossed with the crop only with difficulty and where gene transfer is usually only possible with radical techniques. Biotechnology has, at least in theory, greatly enlarged this pool because of transformation a radical technique makes possible the introduction of DNA from any species. Page 32 Share Cite Suggested Citation: The conservation of the genetic resources of these species is vital to agriculture and humanity. Simply put, cultivars have been selected for traits that fit a particular agronomic technology; wild species undergo natural selection to acquire traits that maintain their ability to survive in an ecosystem. The obsolete crop varieties and livestock breeds and the unadapted wild relatives of crop plants frequently carry useful genes or alleles that, if not preserved, may no longer be available in the future. Modern, high-yielding crop varieties have largely replaced older landrace varieties even in many remote parts of the world. For many crops sown as seed, rather than as roots or tubers, few of the varieties that were widely grown 40 to 60 years or more ago can still be found in areas of commercial agricultural production. In some cases people have destroyed or altered many natural habitats of wild relatives of crop plants so that it is no longer possible to collect them at the original sites. Even if collection is still possible at undisturbed sites, the range of genetic variation present in the original collections may no longer be available. Before they can be used by breeders, the collected materials must be evaluated, tested, catalogued and properly conserved. They can then be made available to others who may wish to use them. There is widespread concern about the status of conserved germplasm worldwide. Is enough being done? Are the materials already conserved in germplasm banks and other facilities adequately described, documented, properly managed and stored under conditions to safeguard their viability, and freely available to anyone who needs them? Do they include enough of the potentially important germplasm that can still be collected now but that may not be available much longer? Are sufficient financial and other resources being applied by national governments to their own and to global needs? What priorities have been established and are they correct? Page 33 Share Cite Suggested Citation: The selected materials were not used for food but were kept for planting or herd increase when conditions improved or were carried from place to place during human migrations. In setting aside the better forms for future use, humanity began the long process of selection and improvement responsible for the development of agriculture. The first crop plants and livestock were undomesticated wild species that gave rise, thousands of years later, to modern varieties and breeds. Among the first plants to be domesticated were several wild species that had been most useful to hunter-gatherers as energy food plants, probably annual, large-seeded grasses; legumes; and starchy tubers. In Southwest Asia these were barley, tetraploid wheat, peas and lentils; rice and soybeans in Southeast Asia; sorghum in Africa; and corn, common beans, and lima beans in South and Central America. This evidence also suggests that the domestication of cereals and legumes began about 10, years ago and that the domestication of each species was not a single event but a continuing process at many ecologically different places over many centuries. The two main evolutionary processes during the earliest stages of domestication were almost certainly: As agriculture expanded and increasing numbers of plants were grown under cultivation, there was a corresponding increase in the number of novel mutations observed, and those favored under agricultural conditions were, as noted by Darwin , preserved by selection, greatly increasing the accumulated store of economically useful variability. The earliest written records show that major evolutionary changes had already taken place. For example, the many cultivars of wheats and pulses described by Theophrastus, who lived from to B. The apples he described were very different from those of their small-fruited, acidic, and astringent ancestors, which are still found growing wild in Southwest Asia. Rates of evolutionary change accelerated in the eighteenth and nineteenth centuries. Seed growing developed as a business, and competition provided an incentive for selecting and rapidly distributing distinctive types of field

and vegetable crops and ornamentals. The work of Knight , who was one of the first to observe differences in disease resistance among wheat hybrids, stimulated the deliberate crossing of different types, promoting genetic recombination and the production of rich arrays of segregants from which to select. Obsolete varieties and breeds and closely related wild species were sources of useful variation that could be introduced into new forms by hybridization. Breeders assembled collections of useful and new materials that were described, cataloged, and tested and that THE U. From until , when the U. Patent Office distributed seeds and plants from overseas to U. However, it became necessary to introduce plants and animals in such a way as to minimize the risk of bringing in pests and diseases at the same time. In the United States the first plant quarantines were the initiative of individual states. California, in , was the first to pass an act to prevent distribution of the grape gall louse. Federal plant quarantine regulations were not adopted until , although drastic legislation had been accepted in Europe and Australia by to restrict the introduction of the same grape pest from the United States. Plant materials collected by the USDA that entered the United States were given numbers to create an inventory of the plant introductions. Page 35 Share Cite Suggested Citation: These collections were the first to be systematically conserved, although often only during the working lifetime of the breeder. The emergence of plant and animal breeding programs during the first half of this century created a demand for germplasm exchange among breeders and for collecting expeditions and explorations to satisfy the growing need for such crop plant characters as earliness, stiff stalks, grain quality and resistance to diseases and insects. Foremost among the plant explorers was the Russians scientist, N. Vavilov whose work in the s defined the centers of origin now known as centers of diversity for many important crop plants. In Vavilov The tremendous potential source of species and varieties requires thorough investigation employing all methods. The problem of the immediate future is a classification of the enormous diversity of the most important cultivated crops not only on the basis of their botanical and agronomic characters but also with the use of physiological, biochemical, and technological methods. Catalogues of properties of accessions, listed by their plant inventory numbers, were useful to breeder who could obtain seeds or cuttings from the U. In this way the U. In a report of the National Research Council a , the present structure of the U. National Plant Germplasm System is analyzed, and recommendations are offered to make it a more effective national organization, rather than the collection of loosely coordinated regional and sectional programs that it is today. Although germplasm conservation would appear to be designed to serve the interests of plant breeders, most modern breeders are interested primarily in highly adapted breeding lines that can be directly introduced into the crossing programs. Poorly adapted materials are less useful to them but can be source of variation to remedy the limitations of their better lines. Breeders are rarely interested in using wild relatives directly because of the effort and expense of eliminating their many undesirable traits. Biotechnology may change this by making it easier to transfer only the gene or genes of interest.

Chapter 4 : Genetic resources in plants-their exploration and conservation.

18th EUCARPIA GENETIC RESOURCES SECTION Plant Genetic Resources and their Exploitation in the Plant breeding for Food and Agriculture PieÅ¡Å¥any, Slovak Republic 23 May 26 May

Silva in Hawksworth and Greuter, Page Share Cite Suggested Citation: The Genetic Resources of Microorganisms. Managing Global Genetic Resources: Agricultural Crop Issues and Policies. The National Academies Press. Most collections do not specialize to the extent of individual genera or species, but to varying degrees, they concentrate on particular systematic or biological groups. Such specialization is usually in response to the requirements of the funding bodies of the collections or the particular research interests of the staff or institutions where they are located. Most also have strains predominantly isolated from the geographical area in which they are located. In view of these factors and bearing in mind the extent of infraspecific genetic variability that may well occur in many species, it is prudent to consider the existing culture collections as being essentially complementary rather than duplicatory. Even when strains derived from the same original isolation are retained in more than a single collection, they cannot be assumed to be genetically identical. This phenomenon results from the often inherent genotypic variability, so different genotypes may be deposited in different collections; inadvertent selection during maintenance for survival under the different preservation methods used; or contamination with other strains Bridge and May, ; Bridge et al. The present efforts have developed on an ad hoc basis over the past 80 years, and at present, they do not appear to be capable of adequately conserving this vital world resource. Informal and often unwritten agreements to specialize in different areas exist between collections, as their curators are generally alert to the need to maximize their combined efforts to adequately preserve the microbial gene pool. Microorganisms, with the exception of some larger fungi, lichen-forming fungi, and larger algae, in general lack a history of inventory production on a regional basis equivalent to those of the floras and faunas covering, for example, vascular plants, bryophytes, birds, mammals, arthropods. This is an inevitable consequence of the labor intensiveness of sampling, culturing, and identifying massive numbers of microorganisms. Numbers and Richness of Microbial Species The numbers of species described and currently accepted in most groups of microorganisms worldwide can be estimated with some confidence from available catalogs of names Table However, about new species of bacteria and 1, new species of fungi are described as being new to science each year, clearly demonstrating that knowledge of these groups is grossly inadequate. It is hazardous to extrapolate from such figures to the numbers that can reasonably be expected to occur in nature, particularly because the numbers of newly described species can be taken as an indication of the limited numbers of microbiologists actively engaged in systematic work rather than of the numbers of species to be found. With respect to culture collections, this indicates that, overall, only 2 percent of the species expected to be found are currently preserved in them. For all groups of microorganisms other than bacteria and viruses, only 1 to 18 percent of the described and currently accepted species are represented in culture collections, representing a mere 0. The higher proportions for bacteria, 73 and 7 percent, respectively, may be due at least in part to an underestimate of the known but now not validly published species and a consequently low value for the estimated figure worldwide. This is of major concern not only from the conservation standpoint but also to industry, agriculture, and medicine, for which particular biochemical, pathogenic, or other attributes need to be safeguarded. The problems are particularly acute with respect to plasmids and viruses, which must be preserved within the cells of the host organism. In the case of plasmids in bacteria and yeasts and of viruses in filamentous fungi, there is a Page Share Cite Suggested Citation: Strains cited in patents are deposited in specially recognized collections Bousefield, ; such collections have a responsibility to maintain patent strains in an unaltered state for a minimum of 30 years Crespi, Traditional Preservation Methods Traditional preservation methods involving regular subculturing of growth at low temperatures or maintenance under mineral oil are subject to inadvertent selection and contamination, especially when collections lack sufficient numbers of specialists to operate adequate quality control protocols. While growth is continuing, albeit at a much reduced rate, normal sexual processes involving changes in the genome can occur; these can include

sexual and parasexual recombination, aneuploidy, and polyploidy. Freeze-Drying and Liquid Nitrogen Preservation In bacteria, yeasts, and filamentous fungi with discrete propagules, freeze-drying lyophilization in a cryoprotectant is currently the preferred long-term storage method; regular viability checks are still needed, however, as the long-term value of the method is not considered to be fully established. Freeze-drying gives very low survival rates for algae and protozoa and is not yet applicable in these groups. Liquid drying drying without freezing is used in some bacterial and yeast collections for strains that are difficult to maintain by freeze-drying Banno and Sakane, and is adequate for at least 10 years. Rates of freezing and the cryoprotectant used can affect survival of the freezing process, but it is possible to tailor procedures to ensure optimal survival for particular groups Morris et al. The development of protocols for cooling and thawing are also critical for many groups of algae and protozoa. At present even genetically important stocks of algae must be maintained by subculturing on agar plates, in liquid media, or in water. Light is essential for photosynthetic algae maintained by subculture techniques. The main disadvantage of the use of liquid nitrogen storage systems Page Share Cite Suggested Citation: In the case of microorganisms that cannot be grown on artificial media, such as many plant pathogenic fungi for example, Puccinia rust and plant viruses, they can sometimes be successfully maintained by placing the infected host tissue in liquid nitrogen. At present, the major service culture collections lack the substantial resources necessary to take advantage of the enormous potential for such on-host preservation. In both freeze-drying and liquid nitrogen storage techniques, as all metabolic processes are suspended, the possibility of genetic change taking place during extended periods of storage is precluded. However, instability can arise from differential survival of propagules during the freezing and thawing processes, and there is consequently some risk of inadvertent selection during the process. This is unlikely to be significant when a high percentage of the propagules survive the freezing process. Current research aims at improving protocols to maximize survival rates of individual propagules Morris et al. Various aspects of stability have been discussed by Kirsop ; for further information on the preservation methods for microorganisms see Gherna , Kirsop c , Kirsop and Snell , Malik and Claus , Smith b , and Smith and Onions The concepts of the classification of plant communities and centers of plant diversity that are proving of value in the conservation of vegetation types International Union for the Conservation of Nature and Natural Resources, are difficult to translate into microbiology. Some of the problems encountered with respect to the fungi have been reviewed by Apinis In addition, while a scientist wishing to collect a particular flowering Page Share Cite Suggested Citation: Interesting and novel strains are not uncommonly found at low frequencies. Furthermore, many of the larger fungi, rusts, smuts, and other host specific species are strongly seasonal in occurrence, may not be visible in every year, or may have fruiting bodies that mature and disappear within a few hours. The probability of a research worker being able to obtain another isolate of a strain from a particular habitat in situ is, consequently, often extremely low. It could also be both exorbitantly expensive, time-consuming, and cost-ineffective. In addition, because the ecological roles and extent of functional redundancy among microorganism populations are unknown, management schemes to preserve then in situ cannot, in most cases, be made with confidence. Once isolated in culture and found to be new or to have new properties, the only realistic option available to ensure that it continues to be available is in most cases ex situ conservation in a culture collection. Only in the case of perennial lichen-forming fungi is habitat conservation a realistic measure for the maintenance of microbial diversity Seaward, Although the conservation of unmodified natural habitats should be supported by microbiologists, as they are sources of numerous novel organisms, in general, in situ conservation is not a viable option for the supply of already isolated and characterized microbial genetic material to researchers. Worldwide, the positive economic value of microorganisms must be calculated in at least many tens of billions of U. However, the economic potential of only a small percentage of the microorganisms already present in culture collections has been investigated. Exploitation of Metabolites An indication of the richness of microorganisms is by the number of secondary metabolites from these organisms that are exploited. The filamentous fungi are particularly promising from this standpoint: Cyclosporin, first approved for use in and obtained from a fungus regarded for almost a century as unimportant, helps prevent the human body from rejecting organ transplants Winter, Secondary metabolites have been reported from only about 2, species of fungi, or 3 percent of the known species, and

most species have been represented by single strains studied when grown under a single set of conditions. Numerous biologically active metabolites remain to be isolated and characterized. Genetic Engineering Genetic engineering methods increase the potential applications of the beneficial products that are discovered. Gene sequences producing desired enzymes or other compounds from one organism can be introduced via plasmids into the cells or, in some cases, the genomes of hosts, which can be cultured in bulk. Examples are the transfer of the insecticidal crystal protein gene from Bacillus thuringiensis into Escherichia coli Qi and Yunliu, ; manufacture of human insulin, alpha interferon, and other products from similarly engineered E. The range of possibilities is immense, and the technology is rapidly advancing Bennett and Lasure, Hybridization between protoplasts of different species of fungi and the subsequent production of recombinants has been effected and has opened an area with tremendous promise Peberdy, Application of Microorganisms in Agriculture The range of applications of microorganisms in agriculture is already substantial and is rapidly developing into new areas.