CHAPTER FOUR

BIODIVERSITY AND SECURITY

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ABSTRACT:
Agricultural biodiversity, which is crucial to feed humanity, for the environment and sustainable development, is being lost at an alarming rate. Considering the enormous interdependence of countries and generations on this diversity, its loss raises socioeconomic, ethical, political and strategic questions that are capable of endangering Food Security, National Sovereignty and Global Security. The negotiation and ratification of a binding international treaty for countries and the development of technologies to conserve and use these resources more effectively are some reasons for hope, but it is necessary to act now before it is too late. This chapter also identifies the challenges that we face in this area and makes recommendations to the national and international level to overcome them successfully.

Key words:
Agricultural biodiversity, ABD, Plant Genetic Resources for Food and Agriculture, PGRFA, germplasm, World Security, Food Security, Biopiracy, International Cooperation, Bioespionage.

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INTRODUCTION

The non-specialised reader may ask what a chapter on Agricultural Biodiversity (ABD) does in a book about Global Security and Food Security. In this introduction we attempt to illustrate the strategic importance of conservation and access to ABD for Food Security and therefore for Global Security.

ABD and its genetic resources represent the basis for agricultural development and at the same time a genetic adaptation storehouse which acts as a buffer against environmental and climate change. The erosion of these resources poses a threat to world food security. The need to conserve and use plant genetic resources as a guarantee for an unpredictable future is well recognised. The prospect of decreasing plant genetic diversity, together with the increased demand for these resources, has become the focus of environmental and sustainable development debates worldwide.

From the utilitarian agricultural point of view, genetic resources can be considered limited and perishable natural resources. They provide the raw material (genes) which, when used and combined correctly, produce new and improved plant varieties, and are an irreplaceable source of traits such as resistance to disease, local adaptation and productivity. Genetic resources are now, and will continue to be in the future, of great value, whether used by scientists for conventional plant improvement or for modern genetic engineering. These genes are dispersed throughout local cultivars and wild plant populations that have been selected over thousands of years, respectively by farmers and nature, for their traits of adaptation, resistance and/or productivity.

In recent years the development of new technologies, the replacement of local varieties with imported ones, the colonisation of new lands, the changes in cultivation methods, etc. have caused a rapid and dramatic genetic erosion of plants. This affects both cultivated and wild species that offer direct, indirect or potential agricultural contributions. The erosion of these resources could lead to the extinction of valuable material that has not yet been cultivated. The path to a constant increase in production and quality of food necessarily passes through the protection and efficient use of plant genetic resources, which requires their conservation, evaluation, documentation and exchange.

In a certain way, the history of humanity is represented in the history of the exchange of genetic resources. The fight for access to useful plants for agriculture and food from other places has been one of the principal motivations of human exploration since the beginning of time, and has often given rise to encounters and alliances as well as conflicts and wars between different cultures.

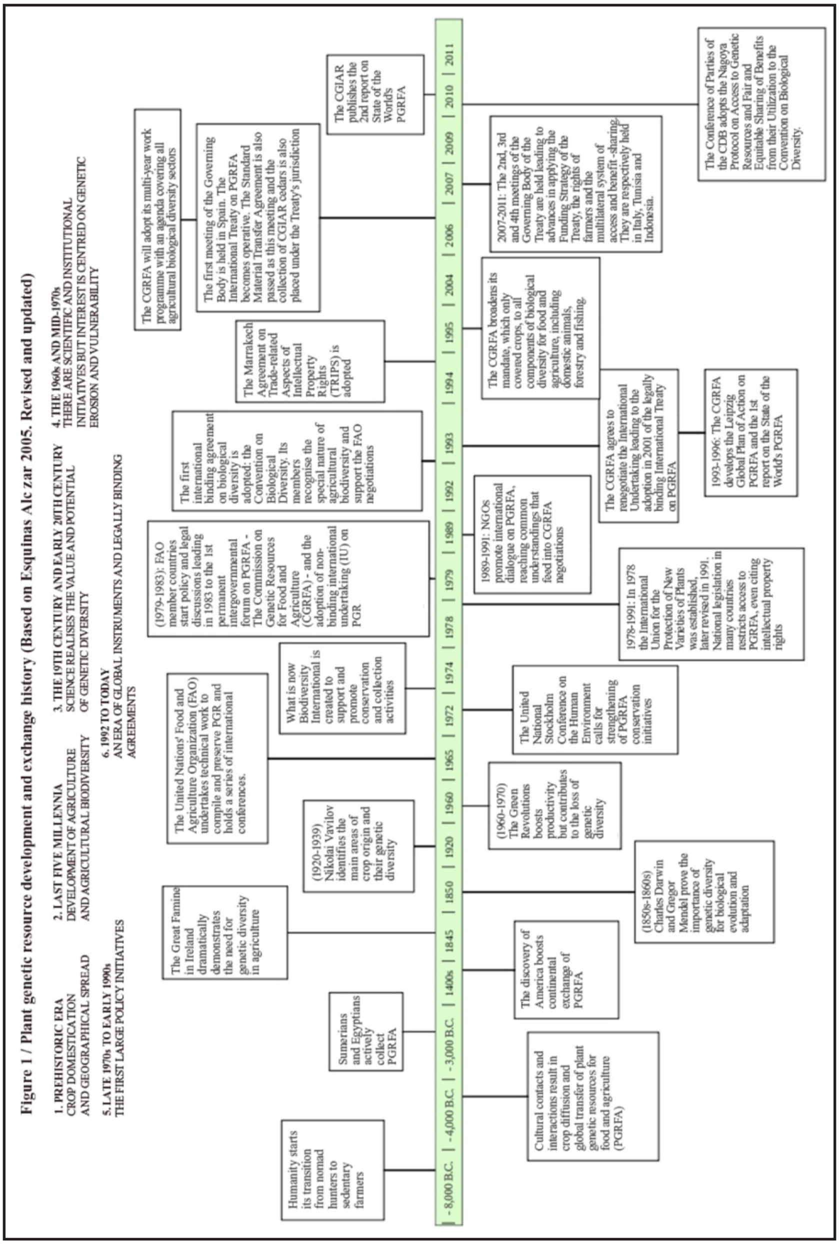

Figure 1[(2)]

[(2)] Esquinas-Alcázar, J. 2005. *Protecting crop genetic diversity for food security: political, ethical and technical challenges.* Nature Rev. Genet. 6:946-953.

This chapter will help us to illustrate the strategic importance given to ABD throughout history. Many examples demonstrate the recognition of the strategic value of genetic resources to reduce vulnerability and to increase the adaptive capacity of nations and people, and precisely how, because of its value, ABD has often been subject of embargoes, espionage, counterintelligence, biopiracy and bioterrorism.

The discovery of America itself was accidental as the real objective of Christopher Columbus's voyage was to find a shorter route to India in order to facilitate the trade and exchange of spices and Asian food species. The arrival in America, nevertheless, allowed introducing in the old world crops as valuable as beans, tomatoes, peppers, tobacco, maize, and potatoes. It is precisely the potato that gave us, centuries later, one of the most illustrative examples of the importance that access has, not just to the species but also to the genetic diversity of its traditional varieties, to prevent and fight against famine.

The notorious «famine» that ravaged Europe in the 1840-50s, causing the death of millions of people, was most devastating in Ireland where more than two million Irish died of starvation and many others were forced to emigrate to the USA. Most people are unaware that the cause of this famine was the lack of genetic diversity of the potatoes cultivated in Europe, originated from uniform material brought from Latin America in the 16th century. In the 19th century the potato had become the basis of the Irish diet and a violent and massive attack of blight (*Phytophora infestans*) devastated the European potato crop. To solve the problem it was necessary to locate blight resistance genes and to introduce them in the commercial varieties used in Europe. These genes were found in numerous traditional varieties of potato cultivated by Andean farmers in Peru, Bolivia and Ecuador. This example shows the danger of basing the national production of a crop on a small number of uniform and interrelated varieties. It also shows the need to have access to heterogeneous original material, often located beyond our borders, where to look for resistances and desired traits.

Another illustrative example of the strategic importance of biological diversity occurred in the late 19th and early 20th centuries with natural rubber derived from *Hevea brasiliensis*, a species with its centre of origin and diversity in the Amazon region. The rubber trade for vehicle tires and other industrial uses in the late 19th century made Manaus a very important trade centre and placed Brazil on the economic map of the world. In 1876 Henry Alexander Wickham had smuggled tens of thousands of seeds of different rubber trees from the Tapajos River area in the rainforests of Brazil and had given them to English scientists at the Kew Royal Botanical Gardens, from which 30 years later they were taken to the Imperial British colonies in Asia for commercial production. With the high production of rubber in South-East Asia, the extraction of Amazonian rubber began to decrease. At the height of the industrial revolution, this operation brought about the largest economic and social catastrophe in the Amazon basin, ruining the economy of Brazil and other countries on the border of the Amazon and converted Great Britain, through its South-East Asian colonies, in the biggest rubber exporter on the eve of the First World War(3). Many Brazilians consider this to be the first documented case of what is today known as biopiracy. Furthermore, some believe that the increased virulence of a disease that destroyed the rubber trees in the middle of the Amazon rainforest was provoked, and they link it to the beginning of commercial production of large rubber plantations in the aforementioned Asian colonies. It is not strange that in Brazil ABD is considered today one of the strategic resources of national interest and that the Ministry of Defence is part of the *Conselho Nacional de Gestão do Patrimônio Genético* (CGEN) (Genetic Heritage Management Council)(4), the upper deliberative and policymaking body regarding access and conservation of Genetic Resources(5).

The World War II was also witness of the strategic importance given by both sides to ABD and genetic resources of cultivated plants. Control of the world's most important collection, consisting of several hundreds of thousands varieties of major crops from all over the world and maintained in the Pavlovsk station(6) (since 1992, the Vavilov Research Institute -VIR-) in Leningrad (now Saint Petersburg) was an important objective for both the Germans and the Allied forces.

The Germans established, within the SS, a commando unit for genetic resource collection (*'Sammelkommando'*) led by lieutenant Heinz Brücher, a botanist and a geneticist, and capitan Konrad von Rauch. The function of the commando unit was the collection of PGR in territories occupied by German troops, and above all, the seizure of the collections in the Pavlovsk station in Leningrad. While they were never able to seize the hundreds of thousands of samples of the original collection during the siege of Leningrad, they took numerous duplicates of the collection that were conserved in the experimental agricultural stations of the occupied territories in Ukraine and Crimea. The several thousand collections seized of major crops were transported and cultivated with the help of prisoners of war in the experimental stations of the Plant Genetics

(3) Tadeo Ferreira, Lucas. El caucho en el Brasil. Photos: Sueli Correa Marques de Mello and Embrapa, Rondônia. Biotecnologia Ciência & Desenvolvimento. Sept.-Oct. 1999, Year 2. Number 10. p. 20 – 22.
Jackson, Joe (2008). The Thief at the End of the World: Rubber, Power, and the Seeds of Empire. Viking. Penguin Group, 2008, p. 421.
(4) Interim Measure nº 2.186-16 of 2001 governed by Decree nº 3.945 of 2001 (modified by Decree nº 4.946/03).
(5) Ministry of the Environment, Department of Genetic Heritage. Regras para o Acesso Legal ao Patrimônio Genético e Conhecimento Tradicional Associado. Brasília DF, April/2005.
(6) The Paulovsk station in the USSR was founded in 1926 to conserve the most important collections of plant genetic resources in the world. The collections, over 300,000 samples, came from the numerous botanical expeditions by famous geneticist and scientist Nikolai Vavilov and his team during the 1920s and 1930s around the world, while developing his theory on the centres of origin of cultivated crops. Unable to fulfil his dream of ending world hunger, Vavilov was considered an enemy of the state in 1943 and died in a concentration camp.

Institute that the SS had in Lannach, Austria. In 1945, when the Russian front collapsed and the Soviet tanks were already in Warsaw and Budapest, Brücher was ordered by the SS to destroy all collections so they would not be captured by American and Soviet troops. However, Brücher refused to follow the order and hid some of the samples on farms in the villages near Lannach. At the fall of the Third Reich, and although many elite SS members were executed after their defeat, Brücher survived by agreeing to work for the American occupation forces. In 1947, Heinz Brücher himself recovered some of the collections sent to West Germany, most likely to genebanks in Braunschweig and Gatersleben. He also sent some samples to other countries such as the United States and the United Kingdom, as well as to private companies. In 1948 he went to Sweden and from there to Argentina, a refuge for many exiled Nazis. There he worked as a professor of botany and a plant breeder. Later, he visited several Latin American and African countries. There is documented evidence that at the end of the 1950s he sent collections of Latin American potatoes to the USSR. Heinz was accused of espionage and counterespionage in relation to genetic resources. In the end, he was killed in Mendoza, Argentina, in 1991 and to this day, the exact cause of his death has not been determined(7).

Now we will see from the side of the Allied how it was possible and at what cost saving the original collections of the Pavlovsk station by first preventing them from falling into the hands of the invaders, and then protecting them from the besieged and starving population. When the Germans besieged Leningrad (now Saint Petersburg) in 1941, the Soviet authorities, aware of its enormous strategic importance, ordered the scientists in charge of the Vavilov collections to move them from the Pavlovsk station to other places out of reach of the invaders. A few days later, the Germans occupied the research centre and proceeded to cut off all exits from the city of Leningrad, a siege that lasted 872 days and that cost the lives of more than a million people. The Pavlovsk station fell into German hands during the siege of Leningrad, but before the troops arrived, the scientists, with the help of a military unit, were able to move on trains and in army trucks, the majority (over 100,000 seed samples weighing about 5 tons) of the collections of the station for safe storage in a building on Saint Isaac's Square. Another part

(7) Brummitt, R.K. & Powell, C.E., Authors Plant Names, Royal Botanical Gardens, 1992, p. 88.
Deichmann, Ute. Deichmann. Translated by T. Dunlap, Biologists under Hitler, 1996
Gade, D.W. Gade. Converging Ethnobiology and Ethnobiography: Cultivated Plants, Heinz Brücher, and Nazi Ideology, Journal of Ethnobiology, 2006, 261, p. 82-106
Hawkes, J.G. & Hjerting, J.P. The Potatoes of Argentina, Brazil, Paraguay and Uruguay: a Biosystematic Study. Oxford University Press, Oxford, 1969.
JSTOR PLANT SCIENCE. Collection: Plant Collectors: Brücher, Heinz 1915-1991 [online] [Accessed: 4 July 2012] Available at: http://plants.jstor.org/person/bm000011112
Lanjouw, J. & Stafleu, F.A. Index Herb. Coll. A-D, 1954, p. 102
Pearce, F. The great seed blitzkrieg. New Scientist, 2008, 2638, p. 39-41
Thornstrom, Carl-Gustaf & Hossfeld, Uwe. Instant appropriation - Heinz Brücher and the SS botanical collecting commando to Russia. Plant Genetic Resources Newsletter, FAO Bioversity, March 2002, Item 129, p. 54-57.

was transferred as hand luggage by employees evacuated. The winter of 1941 was especially cold and cruel. From then on, all food supplies to the city were cut. When the starving inhabitants of the city, who had heard that there were thousands of edible seed varieties, besieged the collections with the intention of obtaining food, a small group of scientists defended them from within. Twelve of them died of hunger before giving up or eating part of the agricultural biodiversity that was considered vital to the survival of humanity. Amongst them, Abraham Kameraz died surrounded by countless varieties of rice and Olga Voskrensenkaia succumbed in the basement in front of a large collection of potatoes. Similar fate befell A.G. Stuchkin, peanut specialist, and D.S. Ivanov, rice specialist; G.K. Kreier, laboratory chief, L.M. Rodine, curator of the collection of oats, and other workers such as M. Shcheglov, G. Kovalevsky, A. Malygina, A. Korzun, died of starvation surrounded by thousands of packets of grain, seeds and nutritious tubers(8). Only many years after the World War was over were these men and women recognised as heroes(9).

The islands are especially vulnerable to the lack of biological and agricultural diversity, and susceptible to pests and crop diseases. In Cuba there is a belief that the appearance, almost simultaneous, in the late 70s of a sugarcane rust, the tobacco blue mould, and eventually the swine fever attacks, which decimated the production of the two primary commercial crops and pork meat for the local population with devastating economic effects, was not coincidental, but part of a biological war orchestrated from outside aimed at destroying the most important part of Cuban monoculture-based agriculture, bringing the country to its knees. Whether coincidence or intentional, the agricultural disaster of 1979 taught the Cuban people an unforgettable lesson: that homogeneity increases vulnerability and that there is consequently a strategic need to diversify agricultural production, both in terms of number of species and the varieties or breeds within each species. In fact, the national production of the three affected species was based on a very reduced number of uniform varieties and breeds that were susceptible to the diseases mentioned(10).

The political and strategic importance of ABD is also evident in the fact that food embargoes, still imposed today for political reasons on some countries, include the blockade of ABD or Plant Genetic Resources for Food and Agriculture (PGRFA) necessary for their agricultural development.

(8) Krivchenko, V.I. & Alexanyan, S.M. Vavilov Institute scientists heroically preserve world plant genetic resources collection during World War II siege of Leningrad. Diversity, 1991, 7(4):p.10-13.
Loskutov, Igor C. Vavilov and his institute. A history of the world collection of plant genetic resources in Russia. International Plant Genetic Resources Institute, Rome (Italy), 1999.
Osazhdennom, V. Leningrade. Lenizdat, 1969.

(9) In more recent times, international recognition has continued both for them and their successors in office, as is the case of Dr. M. M. Girenko, who received the International Slow Food Award in 2000 for the Defence of Biodiversity

(10) Food and Agriculture Organisation of the United Nations. State of the World Plant Genetic Resources for Food and Agriculture. 1998. [online] [Accessed: 4 July 2012] Available at: http://www.fao.org/agriculture/crops/core-themes/theme/seeds-pgr/sow/en/

The previous examples show how Food Security and finally Global Security are tied to the conservation and access to ABD. Also to ensure our National Sovereignty we must always maintain the capacity to produce our own food and this depends on the ABD, which is needed to confront changing socio-economic and environmental conditions. In this context we cannot ignore that our agriculture depends more than 80% on genetic resources from abroad and that the average dependence for NATO member countries is around 87% (see Figure 5 below).

It must be added that, due to the standardisation / homogenisation of agriculture, in the 20th century we have lost, on a global scale, more than 90% of the diversity of major crops that existed at the beginning of the century and that no country in the world is self-sufficient as regards the agricultural biodiversity needed to feed its population. Consequently, at present, international cooperation for the conservation and access to PGRFA is not an option but a necessity, with strong socio-economic, legal, political and ethical implications(11).

It is not strange then that in recent decades, this has been subject of debate at the UN, where international agreements and regulations have been negotiated and produced, amongst which it stands out for its binding nature the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) approved by the FAO in 2001 and ratified by the Spanish parliament in 2004.

In general, we can say that Diversity, be it biological, cultural, technological, based on knowledge, traditions, identities, etc. is necessary in order to broaden options and to maintain the capacity to adapt to unpredictable and changing environmental conditions and human needs. Maintaining diversity reduces vulnerability and provides a buffer and an outlet to absorb the changes and ensure that the errors we make are not irreversible. If some consider the 20th century as the century of uniformity and standardisation, the 21st century must be the century of diversity or simply it will not be.

AGRICULTURAL BIODIVERSITY AND ITS GENETIC RESOURCES AS THE BASIS OF WORLD FOOD SECURITY

ABD Development

The age of the Earth is estimated at about 5 billion years, and the appearance of the first signs of life on our planet goes back more than 3 billion years. The appearance of *Homo sapiens* is a relatively recent event, which took place less than a million years ago. Agriculture is a more modern phenomenon, barely 10,000 years old,

(11) Esquinas-Alcázar, J. 2009. *Biodiversidad Agrícola, Biotecnología y Bioética en la lucha contra el hambre y la pobreza*. Revista Latinoamericana de Bioética 9(1): 102-113.

which arose when humans began to cultivate wild plants with a food value. This triggered an evolutionary process that has created countless varieties adapted to local conditions, which today constitute an incalculable reserve of genetic material.

Until they have reached this final stage, the evolutionary processes of the earth were controlled only by natural selection that designed the extant genetic variability produced by mutations, migration and recombination. The appearance of agriculture marked the domestication of the species of greatest interest to humanity. Natural selection now works alongside «artificial» selection. As a consequence, the evolution of these species was run by and for men.

Even though it is most likely that agriculture began independently in various parts of the world, the best known is the process that occurred in the Middle East and Central America. The first domesticated plants were cereals, legumes and other species used for their fruits or roots. These and other crops have been expanded and adapted to their present ecological limits, at first transported by migratory movements, and later through trade routes, often over great distances.

When the first crops were brought to new regions, they found major differences in climate, soil and other environmental factors. The natural geographic barriers often separated and isolated farming populations. The genetic variants that appeared in some populations were developed freely and independently; some of them grew like weeds amongst or around crops, which led to the creation of even more variable populations able to tolerate extreme conditions of cold, drought, pests and diseases. Thousands of years of selection by farmers and nature have produced local varieties and genotypes adapted to different locations and agricultural practices which were determined by climate and other environmental factors. Today, the spectrum of invaluable variation is enormous and this visible variation hides an even greater genetic diversity. To the inter-varietal variation it should be added a broad intra-varietal variation, which is the cause of the well-known morphologic heterogeneity of original breeds. This heterogeneity, which reflects local adaptation, also exists for other traits that are not readily observable, such as resistance to diseases, cold or heat, humidity or drought, oil and protein content, amino acid composition, etc.

The Increasing Loss of ABD And the Danger it Represents

Until somewhat recently, a steady increase in diversity was favoured. However, in the last several years, many factors have contributed to a drastic reversal of this trend. The industrial development and the subsequent migration of agricultural labour to industry, combined with the increasingly marked separation between production and consumption areas, tend to eliminate self-sufficient agricultural production units. This adds a new dimension to transportation and commercialisation of agricultural products, promoting the homogenisation and standardisation of crop varieties. Moreover, the increasing mechanisation of agricultural activities and operations requires varieties with uniform traits for planting needs, harvest periods, etc. The mechanization of postharvest processes is based on machinery designed for standardised crops and fruit plants.

Based on market demand, plant breeders of commercial seed companies, as well as national and international institutes, have joined forces to provide new uniform varieties, which are generally more productive, to replace the wide selection of heterogeneous and original varieties best adapted to the needs of previous times. This phenomenon is occurring or has occurred in developing and developed countries both in the East and in the West.

Nevertheless, we should not forget that the heterogeneous varieties of the past are still raw material for plant breeders. These varieties are the foundation for the creation of new varieties through patient and careful selection of plants that carry the desired traits. Subsequently, through a long process of crosses and selecting amongst progenies, all of these traits are combined in a uniform commercial variety. This variety, especially in self-pollinating plants and those that are vegetatively propagated, is reproduced generation after generation and its evolution is practically negligible. It can be said that it remains fixed in a mould set by the plant breeder.

Plant breeding based on controlled crosses and not on the simple selection of genotypes in the field, began in the 18th and the 19th centuries in Europe. At the beginning of the 20th century, many of the cultivated areas of industrialised Europe and North America were planted with varieties that had been obtained or selected by professional plant breeders. However, until the 1940s, this process barely affected regions in warmer areas that contain the greatest genetic diversity. Around 1950, the intense and generalised agricultural development - mostly financed by international aid programmes - began to reduce the areas dedicated to primitive landraces, and the need to conserve the remaining genetic variability began to be recognised. This need became more evident in the 1960s, when millions of hectares in Asia and the Near East (where many centres of diversity of major crops are found) were planted with commercial varieties of semi-dwarf wheat, whilst new rice varieties were being introduced in the plains of southeastern Asia, and modern cultivation methods were expanding in South America and Africa.

Nobody can deny, however, that much of the current global population, growing and malnourished, depends on the introduction of improvements, high yielding varieties and also that this is a key element in the fight against hunger. In this context, the «green revolution» allowed an enormous increase in the productivity of the most important crops during the 1960s and 1970s (Figure 2 illustrates the increase in agricultural productivity and the loss of genetic diversity in recent decades).

This increase has made it possible to boost global food production, but at a very high cost, which may further increase in the future, since there is a greater dependence on energy and technology, and expensive inputs such as fertilisers, pesticides, irrigation, etc.

On the other hand, we cannot ignore that in the effort to increase production, we are removing Nature and the farmer the most important security mechanism provided to them through the ages: diversity.

Figure 2: Increase in agricultural productivity and loss of genetic diversity

TABLE: Average production (kg/ha) performance for the 6 main crops

	1961	1961-70	1971-80	1981-90	1991-00	2000-07
WHEAT	1.089	2.208	1.855	2.561	2.720	2.792
BARLEY	1.328	2.202	1.998	2.412	2.442	2.406
RICE	1.869	3.138	2.748	3.528	3.885	4.152
MAIZE	1.869	3.417	3.154	3.680	4.242	4.971
SOYA	1.129	1.748	1.600	1.896	2.171	2.278
POTATO	12.216	14.738	12.817	15.129	16.339	16.647

Source: FAO agricultural production statistics.

This table shows the dramatic increase in crop production over recent decades. This is mainly due to the use of a series of high-yield varieties (Fehr, 1984) that have taken the place of many traditional varieties. Nonetheless, a negative side to this substitution has been the loss of genetic diversity from the traditional varieties that have been replaced (Harlan, 1992; Frakel & Soule, 1981).

This loss of genetic diversity has been documented in many instances, according to the FAO publication “State of the World’s PGRFA” (FAO, 1998; FAO 2010) that is based on national and regional reports:

In the Netherlands, the three main varieties of the nine most important crops represented between 81% and 99% of their respective planted areas, indeed one farm represented 94% of planted barley. In 1982, the “IR36” rice variety was grown on 11 million hectares in Asia. In 1983, over 67% of wheat fields in Bangladesh were sown with the same “Sonalika” variety. US reports from between 1972 and 1991 showed that less than nine varieties represented between 50% and 75% of the total for the eight main crops. In Ireland in the 1990s, 90% of all wheat growing area was sown with just six varieties.

Around 96% of the 7,098 apple varieties in the US existing at the start of the 20th century has been lost. The same is true for cabbage (95%), maize (91%), peas (94%) and tomatoes (81%). In Mexico, only 20% of maize varieties existing in 1930 has been conserved. In the Republic of Korea, only 26% of the 14 varieties grown on family plots and documented in 1985 were still conserved in 1993. In China, almost 10,000 varieties of wheat were grown in 1949 but by the 1970s, this figure has dropped to 1,000.

The author of this article collected around 350 local varieties of melon across Spain in 1969 and 1972. Today there are no more than 10 on the market.

The primitive varieties are often capable of tolerating conditions that would severely damage many modern varieties, allowing for greater productive stability.

Their greatest value to humanity, currently and in the future, is found fundamentally in the genes they contain that not only are the source of traits such as resistance to diseases, nutritional qualities and adaptive capacity to adverse environmental conditions, but also the source of those currently unrecognised, which one day could have an incalculable value.

Until now primitive varieties and their related wild populations have been fruitful, sometimes the only source of genes for resistance to pests and diseases, adaptations to extreme conditions and other agricultural traits, such as the dwarf type in rice, wheat and other grains, which have contributed to the green revolution in many parts of the world.

With the replacement and consequent loss of a primitive variety, its genetic diversity is erased forever, endangering the possible development of future varieties adapted to the unpredictable needs of the future. To avoid these losses, the samples of replaced local varieties should be adequately conserved for future possibilities.

From a more theoretical point of view, the importance of maintaining genetic diversity is based on the relationships of the variation-selection equation. In fact, variation is the basis of all selection. Selecting is to choose an alternative, and this is only possible when there are various options. In other words, when there is diversity.

Likewise, all genetic selection requires the existence of genetic variation. The greater the genetic variation in a population, the greater the scope for selection, be it natural (driven by evolutionary action) or man-made (driven by agricultural breeding).

In 1970, *Helminthosporium maydes* destroyed more than 50% of the corn fields in the south of the United States, due to the fact that all came from hybrid seeds obtained through cytoplasmic male sterility from a sole variety that was susceptible to the disease. The problem was resolved with resistant local varieties found in Africa. Many similar cases, although with less devastating repercussions, have multiplied everywhere in the last few years, threatening the economic and social stability in some countries.

As a consequence of the *Helminthosporium* attack to maize in 1970, the National Academy of Sciences of the United States established a committee to study the genetic vulnerability of major crops. The committee found that the genetic diversity of many of the important crops in the United States was dangerously narrow. For example, 96% of the peas planted in the country came from only two varieties. Also, 95% of the peanuts cultivated came from only nine varieties.

The phenomenon can be extrapolated to numerous crops and countries, and recent data show a clear tendency of worsening the situation. In order not to jeopardize the future it is essential to ensure that the processes being triggered are manageable and reversible. This implies adequately maintaining the genes of endangered species and those of replaced local varieties through representative samples.

Conservation of Agricultural Biodiversity and the Genetic Resources it Contains

Conserving Agricultural Biodiversity goes far beyond saving the species. The objective should be to conserve sufficient diversity within species to ensure their genetic potential can be used in the future. For example, it was only one population of *Oryza nivara* that provided resistance to the rice virus «Grassy Stunt», and not the species itself.

The conservation of genetic resources can be done both *ex situ* and *in situ*, and both systems should not be considered opposites but complementary:

Ex situ conservation involves collecting representative samples of the genetic variability of a population or a crop and its maintenance in genebanks or botanical gardens, as seeds, cuttings, *in vitro* tissues, entire plants, etc. The period of conservation depends on the species and the technique used. In many species, this period can be extended by reducing the metabolism of the parts conserved by controlling factors such as temperature and humidity. The conserved material should be multiplied periodically, in any case. The practice of fast and deep freezing (cryopreservation), for example using liquid nitrogen can, with the improvement of current techniques, prolong indefinitely the life of the stored germplasm.

Ex situ conservation is used mostly for cultivated plants that reproduce by seed. Its great advantage is the control of material in a small space and under intensive care. Another advantage is its easy accessibility for plant breeders. Its major drawback is that its evolution freezes with the germplasm, permanently detaining the processes of natural selection and adaptation to its habitat. Other drawbacks are the genetic drift due to the collection and reproduction of necessarily small samples, and the selection pressure since, in general, the material is reproduced in eco-geographic areas different from the collecting areas. Both phenomena bring about cumulative genetic erosion, which can on occasion overcome the genetic erosion that occurs in the field.

In situ conservation consists in the protection of the area and the habitat where the species grows, through laws and protectionist measures. It is the preferred method for wild plants. Its great advantage is that the dynamic evolution of the species is maintained, and its principal drawback comes from its cost and, at times, its possible social and political difficulties. This system can, however, be considered economical if the interest is to conserve all species in the area and not just one in particular.

The protection of plant genetic resources of the planet, either *ex situ* or *in situ*, is not exclusive to our century or our civilisation. The ancient Egyptians, more than 3000 years ago, when laying their pharaohs to rest, accompanied them with seeds which would allow them to cultivate the same crops in the afterlife as in the Nile valley. Thus, in 1922, when Carter discovered the undisturbed tomb of Tutankhamen, buried in the 16th century B.C., he found intact a wooden box with small sealed compartments containing barley seeds organised by variety. This box, which is conserved with its contents in the museum in Cairo, can be considered the first genebank in recorded history.

LOCAL VARIETIES AND LANDRACES ARE PART OF NATIONS' IDENTITY AND TRADITIONAL FARMERS ARE THEIR GUARDIANS

PGRFA, on a local and national level, besides providing varieties and genes best adapted through millennia to agro-ecological conditions and local preferences, constitute, along with language, the monuments and works of art, the authentic signs of cultural identity of every community and every nation.

We can rightly say that art and literature are to culture what own PGRFA local varieties of plants and traditional landraces of farm animals are to «agri-culture». PGRFA are authentic works of living art created and perfected by traditional farmers in every community through millennia of selection and adaptation to local preferences and conditions.

It is not strange, then, the worldwide spontaneous proliferation of NGO movements and local action networks committed to the defence of this traditional heritage.

Besides its value as part of the living culture of people and their adaptability to environmental conditions and local needs, these resources constitute a reservoir of unique genes and traits which each village can contribute to the achievement of the millennium goals and the development of all humanity, as illustrated in the examples above.

The genetic diversity that saved the potato in Europe in the 19th century and maize in the United States in the 20th century came from developing countries, and it was not there by accident. It was the product of selection made by thousands of generations of small traditional farmers. They are still today, in a world which often ignores them and sees them sometimes as a social burden relic of the past, the authentic guardians of the majority of agricultural biodiversity which we can still count on; those who continue to develop, conserve and make available to other farmers, professional plant breeders and even modern biotechnologists, the raw material required to confront changing environmental conditions and unpredictable human needs. Are these simple farmers who still have the keys to the future of food for humanity. The ITPGRFA recognises their importance and devotes Article 9 to the definition of their rights(12).

INTERDEPENDENCE WITH REGARD TO ABD. DEPENDENCE OF MEMBERS OF NATO AND THE NEED FOR INTERNATIONAL COOPERATION

Genetic diversity is not distributed at random in the world, but it is located principally in tropical and subtropical areas, which in many cases coincide with developing countries. In the 1920-30s, Vavilov, pioneer in this matter, identified the geographical areas where the genetic richness of food plants is maximum: Central America and México, the Andes, the Mediterranean, Central Asia, Brazil and Paraguay, the Near East, Chile, China, Ethiopia, India and Indo-Malaysia. Consequent studies have not made significant modifications(13). The examples in section 2 and the contents of Figures 3 and 4 illustrate an enormous interdependence amongst countries in regard to agricultural biodiversity necessary for research and agricultural development. In fact we can say that no country in the world today is self-sufficient and that average dependence amongst countries for the most important crops is around 70%(14).

Figure 3: Average maximum and minimum dependency level (%) of countries in different regions on genetic resources for their most important crops.

Region	Minimum (%)	Maximum (%)
Africa	67.24	78.45
Asia and Pacific Region	40.84	53.30

(12) FAO. International Treaty on Plant Genetic Resources for Food and Agriculture. 2009. [online] [Accessed: 12 July 2012]. Available at:
http://www.planttreaty.org/es/content/textos-del-tratado-versiones-oficiales
(13) Zeven, A.C. & Zhukovsky, P.M. Dictionary of Cultivated Plants and Their Centres of Diversity, PUDOC, Wageningen, 1975.
(14) Kloppenburg, J. R. Seeds and Sovereignty. The Use and Control of Plant Genetic Resources, Duke University Press, Durham, London, 1988.

Region	Minimum (%)	Maximum (%)
Europe	76.78	87.86
Latin America	76.70	91.39
Middle East	48.43	56.83
North America	80.68	99.74
GLOBAL	65.46	77.28

Based on: Flores Palacios, X., 1998.

COMMISSION ON GENETIC RESOURCES FOR FOOD AND AGRICULTURE. Background Study Papers Nº 7, REV 1. Contribution to the estimation of countries' interdependence in the area of plant genetic resources, by Ximena Flores Palacios. [online] [Accessed: 6 July 2012] Available at: ftp://ftp.fao.org/docrep/fao/meeting/015/j0747e.pdf.

Paradoxically, many countries that are poor from an economic point of view are rich in genes and genetic diversity necessary for the survival of humanity. In fact, member countries of NATO are, with the exception of Turkey, highly dependent, for their agriculture and food, on genes and genetic resources from other countries (see Figure 4).

Figure 4: Estimated dependency range (%) of NATO member countries on genetic resources for their most important crops.

NATO member countries	Minimum (%)	Maximum (%)
Germany	83.36	98.46
Albania	92.07	99.32
Belgium / Luxembourg	82.26	97.73
Bulgaria	88.17	99.36
Canada	84.00	99.48
Croatia	87.02	98.99
Denmark	81.18	91.96
Slovakia	85.10	96.60
Slovenia	89.99	98.81
Estonia	86.66	95.13
Spain	71.41	84.84
United States	77.36	100
France	75.55	90.67
Greece	54.24	68.94

NATO member countries	Minimum (%)	Maximum (%)
Hungary	86.85	98.04
Iceland	83.82	99.21
Italy	70.82	81.21
Latvia	81.15	90.42
Lithuania	91.66	97.87
The Netherlands	87.94	98.49
Norway	90.67	98.94
Poland	90.06	99.32
Portugal	78.86	90.88
United Kingdom	89.23	99.10
Czech Republic	87.87	97.40
Romania	90.34	99.44
Turkey	32.21	43.16
AVERAGE	81.48	93.10

Based on Flores Palacios, X., 1998

COMMISSION ON GENETIC RESOURCES FOR FOOD AND AGRICULTURE. Background Study Papers Nº 7, REV 1. Contribution to the estimation of countries' interdependence in the area of plant genetic resources, by Ximena Flores Palacios. [online] [Accessed: 6 July 2012] Available at: ftp://ftp.fao.org/docrep/fao/meeting/015/j0747e.pdf

There is also a kind of generational interdependence. Agricultural biodiversity is a precious treasure inherited from preceding generations and we have the moral obligation to transmit it in its entirety to future generations so they can keep their options for the future. However the interests of future generations, which do not vote or consume, are not sufficiently considered by our political and economic systems.

Both the growing loss of ABD as its interdependence amongst countries and generations make international cooperation in this area not an option, but an imperative and urgent necessity.

INTERNATIONAL COOPERATION AND THE ROLE OF THE UNITED NATIONS

Genetic diversity of crops, which is crucial for feeding humanity, for the environment and for sustainable development, is being lost at an alarming rate. Considering the enormous interdependence of countries and generations on this genetic diversity, this loss poses technical, socioeconomic, ethical and political questions of great importance.

Since the 1940s, some international organisations, particularly the United Nations Organization for Food and Agriculture (FAO), started to seriously worry about the loss of genetic resources in the world. First the technical activities and later the political negotiations culminated in the development and approval by consensus of all countries in a binding agreement: The International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA).

This process is explained in the following paragraphs.

The 1960s and 1970s: International Discussions on Technical, Scientific and Economic Factors Preceding Negotiations

In 1961, the FAO convened a technical meeting that led to the creation in 1965 of a Panel of Experts on Plant Exploration and Introduction. From then until 1974, this group met periodically to advise the FAO on the subject and make international guidelines for the collection, conservation and exchange of germplasm.

The first problems to appear were of a technical nature related to the detection of diversity and genetic erosion, identifying collection sites, sampling techniques, germplasm conservation methods and methods of evaluation and documentation. In 1967, 1973 and 1981, the FAO hosted international technical conferences that led to the publication of a series of volumes that compiled the technological advances to resolve these questions[15].

Meanwhile, the first economic problems began. The need to organise and finance the new programmes for the conservation of these plant genetic resources led in 1968 to create the Genetic Resources and Crop Ecology Unit and to establish a fund to carry out these programmes. In 1972, the Consultative Group on International Agricultural Research (CGIAR), following the recommendations of the United Nations Conference on Environment (held in Stockholm) and of its own Technical Advisory Committee, decided to create the International Board for Plant Genetic Resources (IBPGR) with its own budget.

The IBPGR was born in 1974 headquartered at the FAO in Rome, and it promoted and carried out numerous activities related to the collection,

(15) Frankel, O.H. & Bennet, E. Genetic Resources in Plants – Their Exploration and Conservation. IBP Handbook, nº 11, Blackwell Scientific Publication, Oxford, 1970.
Frankel, O.H. & Hawkes, J.G. Crops Genetic Resources for Today and Tomorrow, Cambridge University Press, Cambridge, 1975.
Holden, J.H.W. & Williams, J.T. Crop Genetic Resources: Conservation and Evaluation. George Allen and Unwin, London, 1984.

conservation, evaluation, documentation and use of plant germplasm. In the 1980s, the IBPGR separated from the FAO and was renamed «International Plant Genetic Resources Institute» (IPGRI), and is currently called Bioversity International.

Parallel to the activities of the FAO and IBPGR activities and, in some cases due to their catalytic effect, numerous international, regional, national and private organisations created or strengthened programmes, starting from the 1970s, aimed at safeguarding and using plant genetic resources, especially *ex situ*.

The 1980s: The First Debates and Political Negotiations that Resulted in the Adoption of the International Undertaking and THE Establishment of an Intergovernmental Commission at the FAO/UN

In 1979 the first political debates began at the FAO Conference[16]. These discussions led in a few years to the adoption of the International Undertaking on PGRFA (hereinafter referred to as «the Undertaking») and later to the negotiation and approval of the Treaty. The questions raised by developing countries during the conference reflect the background of the difficult negotiations in later years and are the basis of the Treaty and the Multilateral System of Access and Benefit-Sharing.

The first question was the following:

> *Plant genetic resources are spread worldwide but the greatest diversity is in tropical and sub-tropical areas where there are the majority of developing countries. When the seeds are collected and deposited in genebanks, often in developed countries: who owns the stored seeds ? to the country where they were collected? to the country where they are stored? to humanity?*

The next question was related to intellectual property rights:

> *If new varieties are the result of applying the technology to raw material or genetic resources, why recognising the rights of those who donated the technology (breeders' rights, patents), and not the rights of those who donated the germplasm?*

The answers to these questions were not clear and convincing and on occasion they led to strong dialectical confrontations. To resolve these problems, Spain proposed the development of an international agreement and the establishment of a genebank under the jurisdiction of the FAO. The proposal received much

[16] Highest decision-making body in the Organisation in which all member countries are represented.

support throughout the Conference, but it did not reach the point of becoming a draft resolution.

In autumn of 1981, in the months preceding the FAO conference, Mexico, first with the support of the Latin American and Caribbean Group, and later the Group of 77[17], promoted a draft resolution that included the two essential elements of the Spanish proposal of 1979. During the FAO Conference in November 1981, this draft resolution elicited intense debates between countries. A debate that was scheduled for two or three hours lasted several days. In subsequent meetings, the technical feasibility of an FAO genebank was questioned. The controversy ended in the spring of 1983 when the Spanish government offered its own genebank to be placed under the jurisdiction of the FAO, showing that the problem was not about technical feasibility, but about political will. As a consequence, the FAO Agricultural Committee requested the Director General to draw up a document on the basis of the Spanish proposal, to be presented at the FAO conference that same year.

In November of 1983, the 22nd FAO General Conference was witness of long and difficult discussions in a tense atmosphere in which political tension was chewed. On the last day, after several votes, the Undertaking and the Intergovernmental Commission on Plant Genetic Resources for Food and Agriculture were born between screams, applauses, tears and a standing ovation. Its mandate broadened since 1995, becoming the Commission on Genetic Resources for Food and Agriculture (in this text it will be referred to as «the Commission»), permanently responsible for monitoring adherence to the Undertaking. Nevertheless, eight countries expressed reservations[18].

(17) Informal group in the UN system made up of developing countries.

(18) The delegations of Canada, France, Germany (Federal Republic of), Japan, New Zealand, Switzerland, the United Kingdom and the United States of America expressed their reservations about all or part of the text of the International Undertaking on Plant Genetic Resources (Resolution 8/83) adopted at the 22nd FAO Conference in Rome in November 1983. The same eight countries and the Netherlands also expressed their reservations about the text of the International Undertaking on Plant Genetic Resources (Resolution 9/83) adopted at the 22nd FAO Conference.

Figure 5: International Undertaking on Plant Genetic Resources for Food and Agriculture.

The International Understanding on Plant Genetic Resources for Food and Agriculture was the first international agreement on plant resources for food and agriculture. The FAO Conference passed it in 1983[(1)] as an instrument to promote international harmony in issues relating to access to plant genetic resources for food and agriculture.

According to the approved text, the Undertaking seeks ensure that plant genetic resources of economic and/or social interest, particularly for agriculture, will be explored, preserved, evaluated and made available for plant breeding and scientific purposes. The 11 articles of the International Understanding formally recognise plant genetic resources including improved and commercial varieties as world heritage and attempts to guarantee their free exchange without restrictions through a network of germplasm banks under the auspices and/or jurisdiction of the FAO.

The Undertaking was then the subject of a series of agreed interpretations, negotiated by countries at the Commission of Genetic Resources for Food and Agriculture and adopted in the form of FAO Conference resolutions, which became annexed to it. The aim was to achieve universal acceptance of this international agreement, promoting a balance between the products of biotechnology (commercial varieties and breeders' lines) on the one hand, and farmers' varieties and wild material on the other, and between the interests of developed and developing countries, by balancing the rights of breeders (formal innovators) and farmers (informal innovators).

Resolution 4/89 recognised that Plant Breeder's Rights, as provided for by the International Union for the Protection of New Varieties of Plants (UPOV), were not inconsistent with the Undertaking, and simultaneously recognised Farmers' Rights defined in Resolution 5/89[(2)].

The sovereign rights of nations over their genetic resources were recognized in Resolution 3/91 (FAO, 1991), and it was agreed that Farmers' Rights would be implemented through an international fund for fair benefit-sharing.

(1): FAO.1983. *Report of the 22nd FAO Conference. Resolution 8/83.*
(2): FAO.1989. *Report of the 25th General FAO Conference, Resolutions 4/89 and 5/89.*

During the years following 1983, the Commission acted as an intergovernmental forum where countries continued to negotiate agreed interpretations of the Undertaking, which allowed the removal of reservations of the countries that remained outside of it. Thus, three resolutions were negotiated which became integrated annexes of the Undertaking. They introduced the concept of «national sovereignty», and parallel and simultaneously they recognized the rights of plant breeders and the rights of farmers (Figure 6).

During this process it was also agreed that farmers' rights would be developed by means of an international fund. Some countries felt that this fund should consist of a percentage of the benefits derived from the use of genetic resources, whilst the majority felt that it should be linked to the needs of the countries to ensure the conservation and sustainable use of those resources.

In order to quantify these needs, a process was launched leading to the Fourth International Technical Conference on Plant Genetic Resources, the first intergovernmental conference, held in Leipzig in 1996. At the conference, the Leipzig Declaration was adopted on the conservation and sustainable use of plant genetic resources for food and agriculture.

During this process, 155 countries prepared national reports which defined the situation of their genetic resources, their needs and priorities. Twelve regional meetings allowed the preparation of the corresponding regional reports, and the process culminated in Leipzig with the publication of the first State of the World's Plant Genetic Resources and the approval of the first Global Plan of Action for Plant Genetic Resources. This Plan eventually became the basis of Article 14 of the Treaty.

From the 1990s to Present day: Searching a Binding Agreement for the Agricultural Sector and Food Security. From the Convention on Biological Diversity to an International Treaty specifically for Agricultural Biodiversity

Between 1988 and 1992 the first binding international agreement on biodiversity in general was negotiated in the United Nations Environmental Programme (UNEP). The Convention on Biological Diversity (CBD) was presented for signature at the Earth Summit in Río de Janeiro in June 1992. This agreement, which also included agricultural biodiversity, did not take sufficient account of the specific needs of the agricultural sector, since the representatives of this sector were barely present during the negotiation process.

Only at the last moment, in May 1992 in Nairobi, during the last negotiation meeting, it was possible to bring together representatives from twenty countries, the only ones directly or indirectly linked to the agricultural sector. This group managed to write and introduce in the final act of Nairobi, by which the agreement was being approved, a resolution on agricultural biodiversity which highlighted the importance of the previous agreements reached in the FAO and requested the revision of the Undertaking in harmony with the CBD.

Shortly thereafter, in the context of the Uruguay Round, and also with minimal participation of the agricultural sector, trade agreements were developed and approved in Marrakech that led to the creation of the World Trade Organization, which also affect genetic resources for food and agriculture. These agreements include the Agreement on Trade Related Aspects of Intellectual Property Rights (TRIPS).

The approval of both the CBD and TRIPS as binding agreements was a wake up call to the agricultural sector, which is caught between two binding agreements that did not sufficiently address their specific needs.

The Undertaking, with its purely voluntary character, lacked sufficient clout to defend agricultural interests. The growing pressure of other sectors, in particular the commercial and environmental sectors over the agricultural sector, made possible what seemed unimaginable a short time before: the unity of developed and developing countries, seed industries, and NGO's with a common political objective, transforming the Undertaking in a binding agreement allowing for an equal dialogue with the commercial and environmental sectors. All this was in order to contribute to global Food Security, legally guaranteeing the conservation and access on fair grounds for research and the genetic improvement of plant genetic resources important to agriculture. That is how, in a highly constructive atmosphere, the last phase of negotiations began on what is now the Treaty.

The Conference of the Parties of the CBD (Jakarta, 1995) provided significant support to further this cause with its decision II-15 «recognising the special nature of agricultural biodiversity, its distinct characteristics and problems, which require specific solutions»(19). This decision ended with the reticence of certain countries to the negotiations, which (thanks to Resolution 7/93(20) of the FAO Conference(21)) were taking place at the heart of the Commission.

Indeed, as it would be shown later, the conservation and exchange of PGRFA requires agreements based on multilateralism, since it would be, both economically and politically, very costly to be limited to the bilateralism promoted by the CBD.

The formal negotiations lasted seven more years and were conducted through meetings of the FAO Commission and its subsidiary bodies.

As an example of the complexity of the negotiations and their political connotations, it can be cited what happened at the meeting of the Commission in April 2001, which discussed the crops to be included in the Treaty.

Finally, at the 31st FAO Conference on 3 November 2001, the negotiations concluded with the approval of the Treaty by consensus, in an atmosphere of general euphoria. The Treaty came into force in 2004, ninety days after forty governments had ratified it, and it became operational with the first meeting of its Governing Body in June 2006 in Madrid. The Treaty has been ratified or equivalent so far by the national parliaments of 127 countries.

(19) Convention on Biological Diversity. Report of the Second Meeting of the Parties to the Convention on Biological Diversity, UNEP/CBD/COP/2/19, 6-17 November 1995 - Jakarta, Indonesia. [online] [Accessed: 13 July 2012] Available at: https://www.cbd.int/doc/?meeting=cop-02

(20) Revision of the Treaty.

(21) FAO.1993. Report of the 27th FAO Conference, Resolution 7/93.

Figure 6: A illustrative anecdote on the repercussions of international politics on Treaty negotiations.

An anecdote is better than a text book in explaining the strategic importance of genetic resources and the influence of international political events throughout the treaty negotiation.

One of the most complex and controversial topics in the formal negotiation process was the selection of the types or crops to be included in the Multilateral System of Access and Benefit-Sharing and which appear in Annex 1 of the Treaty. In order to provide a solid technical and scientific basis to negotiators having to decide on the crops to be included in the multilateral system, the following selection criteria were agreed: the crop's importance for global food security and the interdependence of countries with regard to the genetic resources of the crop in question. At the end of difficult negotiations, the countries had pre-selected 67 types.

When the negotiations on the 67 types were coming to a close in April 2001, a conflict surrounding the incursion of Chinese air space by a US plane marred the negotiations. The primary centre of soya diversity is located in China and the day after this event, Chinese delegates removed this crop from the Treaty since the US is one of the main producers and depends on China for the genetic resources of this crop. Brazil, the second most affected country, with the support of Bolivia withdrew the peanut, the maximum diversity of which is that country, so as to force China's hand since the product is very important there.

Nonetheless, China did not change its stance. The pressure from the most affected countries by China's decision meant that Latin American countries withdrew the tomato, which is also very important for the Chinese. In later months, the pressure on China intensified and the EU "troika" included this topic on its agenda during a visit to Beijing.

China, however, did not give way and, therefore, instead of 67 types, only 64 were included in the Multilateral System of the Treaty. Although the Multilateral System crops may be changed in the future, this would mean re-opening talks and have a high economic and political cost since any change, no matter how minimal, to the Treaty text requires a new parliamentary ratification process by all those countries on the Governing Body.

THE INTERNATIONAL TREATY ON PLANT GENETIC RESOURCES FOR FOOD AND AGRICULTURE AS THE FIRST BINDING AGREEMENT ON AGRICULTURAL BIODIVERSITY

In November 2001 the FAO Conference adopted the International Treaty on Plant Genetic Resources for Food and Agriculture through Resolution 3/2001. This Treaty came into force on 29th June 2004 after being ratified by over 30 countries. Today, the parliaments of 127 countries and the European Union have ratified it, and its provisions are therefore legally binding for those countries. Its Governing Body is made up of all the countries that have ratified it.

Objectives of the Treaty

Article 1 establishes that the objectives of the Treaty are the conservation and sustainable use of Plant Genetic Resources for Food and Agriculture (PGRFA) and the fair and equitable sharing of the benefits arising from their use, in accordance with the Convention on Biological Diversity (CBD) for sustainable agriculture and food security.

Essential and Innovative Elements of the Treaty: Multilateral System of Access and Benefit-Sharing, Farmers' Rights, Global Plan of Action and other elements of the Treaty

Through the Treaty, countries agree to promote the development of integrated national approaches for prospecting, characterizing, evaluating, conserving and documenting their PGRFA, including the development of national studies and inventories. They also commit to develop and maintain regulatory and legal measures that promote the sustainable use of these resources, including: *in situ* conservation, supporting research, promoting initiatives for plant genetic improvement, broadening the genetic bases of crops and promoting greater use of crops, varieties and underutilized species adapted to local conditions. These activities will be supported, as appropriate, by the international cooperation under the Treaty.

The heart of the Treaty is its innovative Multilateral System of Access and Benefit-Sharing, which ensures the continued availability of genetic resources for research and plant improvement, guaranteeing at the same time an equitable distribution of benefits, including the gains from commercialisation. This system includes 64 genera that constitute approximately 80% of human food obtained from plants.

The recipients of material from the System shall not claim any intellectual property rights or other rights that limit access to plant genetic resources for food and agriculture, or their genetic parts or components, in the form received. «The benefits arising from the use, including commercial, of plant genetic resources for food and agriculture in the Multilateral System shall be shared fairly and equitably through the following mechanisms: the exchange of information, access to and transfer of technology, capacity building and the sharing of the benefits arising from commercialisation, taking into account the priority activity areas in the rolling Global Plan of Action, under the guidance of the Governing Body»[22].

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[22] FAO. International Treaty on Plant Genetic Resources for Food and Agriculture. 2009. [online] [Accessed: 12 July 2012] Available at:
http://www.planttreaty.org/es/content/textos-del-tratado-versiones-oficiales

Even though the material included in the Multilateral System shall not be subject to any type of intellectual property, new products or varieties that incorporate material from the Multilateral System can be. Nevertheless, if the type of intellectual property applied to these derived materials is such that it limits their use for research or posterior improvement, 1.1% of the sales of the commercialised product must be entered in the fund established for «benefit-sharing».

This fund, administered by the FAO, will be used to support projects and activities related to the conservation and sustainable use of plant genetic resources according to the priorities and criteria established by the Governing Body of the Treaty.

But there is also a second alternative in which the contribution to the Benefit-Sharing Fund is only 0.5% of commercialised product sales by companies, which being interested in the material of the Multilateral System for certain species, commit to pay this percentage in all their commercial varieties of these species, regardless of whether or not they use material from the Multilateral System. This alternative is more transparent, easily verifiable and thus reduce transaction costs. All of this is regulated by the Standard Material Transfer Agreement, which was negotiated and approved by the member countries of the Treaty through its Governing Body in 2006, and its terms will be revised periodically by the Governing Body.

The Treaty establishes a funding strategy to mobilise funds for activities, projects and programmes that enhance its implementation, particularly in developing countries and in line with the priorities identified in the Global Plan of Action. The monetary benefits obtained under the Multilateral System, as well as from the Global Crop Diversity Trust, are part of the funding strategy. The Governing Body of the International Treaty will periodically establish an objective for the funding strategy.

Another innovative feature are the measures for Farmers' Rights. It recognizes the enormous contribution that local and indigenous communities and farmers of regions worldwide have made and will continue to make for the conservation and development of plant genetic resources. The Treaty affirms that it is the responsibility of national governments to ensure their farmers' rights, including the protection of traditional knowledge, the right to participate equally in the sharing of benefits, and to intervene in the decision making process regarding national policies.

The International Treaty includes several supporting components, based on the elements previously prepared by the Commission on Plant Genetic Resources for Food and Agriculture, in particular the Global Plan of Action, the Global

Information System, international networks, and terms and conditions for the conservation and access to the *ex situ* collections maintained by the International Agricultural Research Centres (IARC).

Implementation: Process and achievements of the Treaty

The Treaty became operational with the first meeting of its Governing Body[23] in June 2006 in Madrid. This meeting approved the Rules of the Governing Body, the Financial Regulations of the Treaty[24] and the Funding Strategy of the Treaty. The Governing Body also approved an Standard Material Transfer Agreement (MTA) that determines the amount, form and method of monetary payments related to the commercialisation through the Multilateral System of Access and Benefit-Sharing of the Treaty. The Agreement on relations between the Governing Body of the Treaty and the Global Crop Diversity Trust was also signed during the meeting, an essential element of the Treaty's funding strategy. It was also approved the agreement between the Governing Body and the CGIAR Centres on the *ex situ* collections they hold.

In successive meetings of the Governing Body, held in Rome (2007), Tunisia (2009) and Bali, Indonesia (2011), progress was made on issues such as the implementation of the funding strategy, cooperation with the FAO Commission, cooperation with the CGIAR and the sustainable use of genetic resources, the development of Farmers' Rights and the Multilateral System of Access and Benefit-Sharing of the Treaty.

Over the years, there has been significant progress in the implementation of some of its provisions:

To date, the Treaty has been ratified or equivalent by 127 countries and the European Union. The countries have committed to contribute $116 million dollars to support activities for the implementation of the Treaty's funding strategy over the next five years, of which $14 million were obtained during the first year. In addition, one of the essential elements of the Treaty's funding strategy, the Global Crop Diversity Trust[25] for activities related to *ex situ* conservation, had received $136 million dollars as of March 2010, and another $32 million are firmly committed, including contributions from both public and private sources.

Regarding non-financial resources, 444,824 samples were transferred to potential users in just one year through the Treaty's Multilateral System and

[23] FAO.2006. Report of the 1st Meeting of the Governing Body of the International Treaty on Plant Genetic Resources for Food and Agriculture, Resolution 2/2006.
[24] Some provisions relating to contributions from the countries were put on hold, to be addressed in subsequent meetings.
[25] http://www.croptrust.org/

the corresponding Standard Material Transfer Agreement, which represents over 8,500 accessions per week.

FUTURE CHALLENGES AND PROSPECTS

The International Treaty is a starting point to address the new scientific, economic, legal and ethical challenges that the 21st century presents for food and agriculture. Remaining challenges include the full implementation of the Treaty both domestically and internationally, the solution to problems that were left out of the Treaty and, finally, those due to new challenges that have emerged after the negotiations as a result of climate change forecasts and new threats to food security and environmental sustainability.

It also discusses the difficulties encountered by our economic system to incorporate externalities, giving ABD the immense value it deserves, and also the issues related to increasing privatisation of these resources through intellectual property rights and other restrictive laws.

Technical and Scientific Aspects: Conservation and use of Agricultural Biodiversity to Promote Food Security, Achieve Environmental Sustainability and Face Climate Change

- *Food Security*

The main challenge for increasing food security is not the global production of food but rather its access. In addition, it is not simply a matter of giving more calories to more people. It is important to highlight that most of the poor in the world (70%) live in rural areas in developing countries. Solutions are needed to improve the stability of local production, to provide more options to small farmers and rural communities, and to improve the quality and quantity of available food.

Nutrition security should be considered a vital component of food security; and in this context, the diversification of diets plays an important role. To achieve this it is necessary to emphasise the use of diversity both in major crops and in neglected and underused crops. Researchers and plant breeders have neglected these crops, although they often contain great diversity and require little investment to obtain good progress.

To ensure that the benefits derived from plant genetic resources reach all those in need, research must be carried out by the public sector in those areas in which the private sector does not conduct research. Most commercial varieties are not adapted to the needs of the poorest farmers, especially in many developing countries, which have little or no access to irrigation, fertilisers or pesticides.

It is necessary to develop public programmes to support and improve traditional crops and varieties capable of withstanding adverse conditions such as drought, high salinity, low soil fertility and resistance to local pests and diseases. Such programmes could be developed for traditional varieties and existing local crops containing these traits of interest and, where possible, through participatory research. This would reduce dependence on the volatility and unpredictability of prices in international markets, reducing the risk of food crises like that of 2008, which was due to the dramatic increase of international prices of agricultural products.

The emphasis of research should be placed at the local level, supporting genetic improvement of a broad range of crops and varieties adapted to local conditions and needs rather than seeking universal uniform genotypes. It is therefore desirable to follow a systematic and participatory process of cooperation between researchers, farmers and consumers.

- *Environmental sustainability*

Reducing the negative impact that agriculture has on the environment (water, energy, pesticides, herbicides...) must become a top priority. This requires an increase in the use of diversity in production systems by developing a broad range of varieties and crops to maximise the efficiency of the agricultural system.

A good example would be the use of strategies diversity-rich to reduce damage by pests and diseases. It is necessary to boost research to make these strategies more efficient and productive through the appropriate use of new and traditional technologies.

- *Climate change*

All scenarios presented by the Intergovernmental Panel on Climate Change (IPCC) predict significant consequences on the geographical distribution of crops, their varieties and the wild species related to them. In this context, some studies have used current climate data and models to predict the impact of climate change in certain areas and crops[26].

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[26] Jarvis A., Lane A. & Hijmans RJ. The effect of climate change on crop wild relatives. *Agriculture, Ecosystems and Environment, 2008,* 126 (1), p.13-23.
Fischer, G.; Shah, M; van Velthuizen, H. Impacts of Climate Change on Agro-ecology. En Fischer, G.; Shah, M; van Velthuizen, H. *Climate Change and Agricultural Vulnerability.* International Institute for Applied Systems Analysis IIASA Publications Department, Vienna Austria, 2002, [online] [Accessed: 16 July 2012] Available at:

In any case, there is no doubt that the best way to reduce our vulnerability to climate change is to increase the diversity of species and crop varieties cultivated in order to provide the system with the necessary capacity to adapt to coming unpredictable changes. In this context, the so-called underutilized species and farmer's traditional varieties have great importance.

The development of varieties adapted to changing climatic conditions is also important. Although many crops have the genetic diversity to address many environmental conditions, it is necessary to take into account that:

a) The magnitude of change will require great capacity for adaptation.
b) The potential of underutilized crops and other promising species increases.
c) The need to broaden the genetic base used in improvement programmes using new sources of diversity.
d) There is a growing need to increase the adaptability and homeostasis of cultivated varieties, which has not always been sufficiently taken into account for improvement.
e) Production in different and unstable environmental conditions would require new improvement approaches.

Socio-Economic Aspects

The cost of the conservation of genetic diversity is high but the cost of inaction is far greater. The financial resources for the conservation and use of agricultural genetic resources are well below adequate. This problem is particularly acute in the case of *in situ* conservation of traditional varieties and, increasingly, of wild relatives of cultivated plants, very important today for the application of new technologies, and which are mainly located in developing countries. The shortage of economic resources in these countries is not only an obstacle to the protection of this diversity, but also a major cause of genetic erosion.

From a macroeconomic perspective, PGRFA have been used as an unlimited source of continued benefits. They are actually a limited and vulnerable resource to be used by future generations. The total value of these resources for the future is still not reflected in market prices. A sustainable economic solution to the problem is the internalisation of the costs of resource conservation in the production costs of the product. For example, when buying an apple it is necessary not only to pay the production costs but also the costs of maintaining the genetic resources that enable future generations to continue eating apples. The International Treaty provisions on benefits, including the monetary sharing of benefits arising from commercialisation[27], represent a first step in that direction.

http://indiaenvironmentportal.org.in/files/climate%20change%20agri%20vulnerability%20JB-Report.pdf

[27] Article 13.2. d.

Taking all of the above into account, we can conclude that there exists an urgent need for economics research to provide a better description and quantification of the actual value of genetic resources. While we have a conceptual framework in terms of use value, future value, and option value, an adequate quantification mechanism is missing for channelling investment decisions and research planning.

Legal and Institutional Aspects

The entry into force of the Treaty is a milestone, as it provides a universally accepted legal framework for plant genetic resources. However, mechanisms should be developed to carry it out, and the Funding Strategy of the Treaty must become fully operational.

After ratification by the countries, the provisions of the Treaty must be applied at the national level, which requires the development of measures at this level. In some cases, legislation will be necessary to avoid genetic erosion, promote conservation, characterisation and documentation of local genetic resources, implement farmers' rights, facilitate access to genetic resources for research and improvement, and promote equitable benefit-sharing.

The Multilateral System of Access and Benefit-Sharing established by the Treaty to facilitate the exchange of crops became operational in January 2007 and its first Funding Strategy projects were approved in 2009. Once the benefits are fully realized, future negotiations could reach consensus on other controversial and difficult issues, such as the broadening of its scope by increasing the number of crops that are exchanged through the Multilateral System.

Access to genetic resources and to biotechnology are limited by the increasing number of national laws that restrict access and use of genetic resources in some countries and by the proliferation of Intellectual Property Rights and the expansion of their scope.

In this context, the adoption of the Treaty is an important step to facilitate such access. However, the Treaty, which was developed by representatives of the agricultural sector, cannot be seen in isolation from other international agreements on biodiversity and related technologies, such as the Convention on Biological Diversity (CBD) and the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) of the World Trade Organisation (WTO), developed by the environmental and trade sectors, respectively.

Sometimes the priorities of these three sectors do not match and difficulties in compatibility can arise in the way these agreements are implemented at a national level. To avoid this and to ensure complementarity, cooperation and inter-sectorial coordination become necessary in the interpretation of its provisions and in the development of possible national regulations for its implementation.

FIGURE 7. Balance the value of PGRFA and biological technologies that use them (Source: Esquinas-Alcázar, 2005. revised and updated)

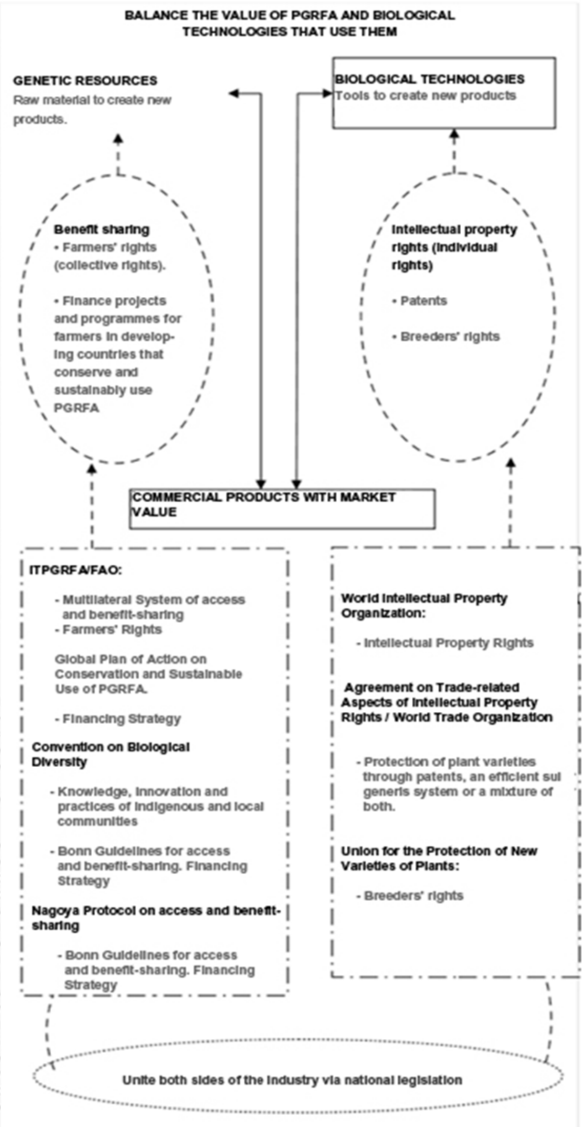
PGRFA provide the basic components allowing classic plant breeders and biotechnologists to develop new commercial varieties and other biological products. Despite their undeniable importance, neither genetic resources nor the biological technologies applied to them, have in themselves a relevant commercial value. Nonetheless, there is often a clear market value for commercial products derived from their use.

Since the 1960s, several international bodies and agreements (e.g. the Union for the Protection of New Varieties of Plants, the World Intellectual Property Organization and the Agreement on Trade-related Aspects of Intellectual Property Rights) have dealt with this topic.

In this sense, measures have been established that award individual rights to biological technology professionals (intellectual property rights such as rights and patents of plant breeders) that allow them to earn financial benefit for commercial products that could be the result of using those technologies.

From the 1990s, other international agreements, especially the International Treaty on Plant Genetic Resources for Food and Agriculture have recognised collective rights (the rights of the farmer and benefit-sharing) for those supplying the genetic resources.

This could contribute to a more harmonious and balanced incentive system that promotes the development and use of new biotechnology, but that also ensures the continuous conservation, development and availability of genetic resources to which these technologies are applied (see figure). It is now the job of national governments to put these measures into practice. For this, each country shall draft the appropriate national legislation that takes into account both sides of the system shown in the figure, in this way promoting harmony and synergy in putting different binding international agreements into practice.



Furthermore, the interests of the agricultural sector should be well represented in these three fora. The effectiveness of the Treaty to halt or reverse the current trend towards restricting access to these resources will depend on how the provisions of the Treaty are interpreted and implemented by countries and by the international community.

International Cooperation

PGRFA should be considered in the context of the agroecosystem where they develop and are used, whether from the point of view of ecological balances, or in relation to the traditional knowledge associated with them, or to achieve food security. The guarantee of a diversified, sustainable and nutritionally diverse food production requires the conservation and sustainable use of all genetic resources, including those of animals, forests, fish and microorganisms of interest to food and agriculture. The FAO's intergovernmental commission, which since its establishment in 1983 was concerned only with plant genetic resources, expanded its field of competence in 1995 to also cover other sectors of agrobiodiversity.

In 2007 the member countries of the FAO negotiated and adopted, through the commission, a Multi-Year Programme of Work (MYPOW), including a timetable for the development and periodic publication of reports on the global state of the different components of agricultural biodiversity for food and agriculture(28), identifying the needs, shortages, emergencies, and priorities of each sector (crop plant genetic resources, livestock, forests, aquaculture, and microorganisms). This Work Programme would culminate in 2017 with the first publication of the State of the World's Biodiversity for Food and Agriculture. This document, with emphasis on agroecosystems, would also have specific modules for each sector.

The priorities and timetable set for the MYPOW(29) will allow better coordination of activities amongst all countries and provide guidance and an incentive to coordinate cooperation between them and international organisations working in this field and which include, at a global level, the FAO and its Commission, the Agrobiodiversity Programme of the CBD, Bioversity and the international centres of the Consultative Group on International Agricultural Research (CGIAR).

(28) The first publication on the State of the World and the first Global Plan of Action for Animal Genetic Resources for Food and Agriculture was adopted by over 100 countries in 2007, at the International Technical Conference on Animal Genetic Resources in Interlake (Switzerland). The FAO Commission is responsible for monitoring and evaluating the implementation of the Global Plan of Action and the development of the funding strategy for its implementation.

(29) FAO. 2009. Report of the 3rd Meeting of the Governing Body of the International Treaty on Plant Genetic Resources on Food and Agriculture.

CONCLUSIONS AND RECOMMENDATIONS

Agricultural biodiversity constitutes Humanity's common pantry. In an increasingly globalised and interdependent world, both the increasing loss of biodiversity and the difficulties of its access are a threat to Peace and Global Security.

There is no doubt that the negotiation of the ITPGRFA and its subsequent ratification by the majority of countries has been an important step forward in the right direction, but much remains to be done both internationally and domestically. The following recommendations, based on the findings of important meetings and recent publications, can help us walk the remaining road.

Conclusions and Recommendations at an International Level

The designation by the United Nations of 2010 as the International Year of Biodiversity, and subsequently this decade as the Decade of Biodiversity, reflects the importance attached to safeguard biodiversity for achieving the Millennium Development Goals and the essential contribution of biodiversity to development and human well-being. It is imperative that this recognition is accompanied by a strong commitment to the biodiversity that feeds the world: agricultural biodiversity.

In September 2010, the world's leading experts in the field of Agricultural Biodiversity met in Cordoba with senior representatives of national and international organisations related to the theme[30] to celebrate the International Year of Biodiversity, and developed the Cordoba International Declaration on Agricultural Biodiversity in the Fight against Hunger and Climate Change. This Declaration was distributed at the request of the Spanish government, as an official document A/65/485 in the 65th Session of the United Nations General Assembly in New York.

The following considerations and recommendations are based on this Declaration, which thinks that urgent actions are necessary to meet the challenges of food security and climate change and to stop the unacceptable and continuing loss of biodiversity. To this end the following actions are proposed:

[30] The Declaration was the result of an international seminar organised by the Chair of Hunger and Poverty Studies (CEHAP) of the University of Cordoba and jointly organised by the Spanish government (Ministry of Environment and Rural and Marine Affairs and the Ministry of Science and Innovation), international organisations (FAO, International Treaty on Plant Genetic Resources for Food and Agriculture, Biodiversity Convention, Biodiversity International), local entities (Delegation of Cordoba, University of Cordoba, Cordoba City Council), and the Chair of Studies on Hunger and Poverty as host. It included the participation of developed and developing countries and members of civil society, farmers' organisations, industry and consumers, at international and national levels. The seminar was opened by the Secretary of State for International Development Cooperation and closed by the Minister of the Environment and Rural and Marine Affairs.

1. *Place agricultural biodiversity next to hunger in the centre of the international political agenda.*

Agricultural biodiversity must become a top priority in order to meet the challenges of food security and climate change. Its importance and value must be recognised by governments and politicians at all levels. Decisions are needed that:

- Contribute to halting the loss of diversity of cultivated plants, domestic farm animals and other diversity that is essential for food security.
- Ensure the provision of agro-environmental services that contribute to health, nutrition, human livelihood and well-being.
- Include agricultural biodiversity as a key component in the accounts of the «wealth of nations».
- Increase the share of international development aid that goes to agricultural biodiversity.

2. *Strengthen collaboration between relevant international organisations and develop common international programmes and strategies on agricultural biodiversity.*

To develop the full potential of agricultural biodiversity, multilateral and multisectorial actions must be carried out and ties must be strengthened, especially between the environmental and agricultural sectors. This would ensure consistency and synergy in the implementation of the various agreements and instruments. We call for:

- The development of a common roadmap for the United Nations with verifiable goals and milestones, including the establishment and strengthening of ties between relevant multilateral financial mechanisms.
- The development and strengthening of multilateral solutions on access and benefit-sharing through collaboration between the Convention on Biological Diversity, the International Treaty on Plant Genetic Resources for Food and Agriculture and the Commission on Genetic Resources for Food and Agriculture.
- The adoption under the Convention on Climate Change of a work programme on agriculture that recognises the importance of agricultural biodiversity and the development of synergies between the Convention mechanisms and fora on agricultural biodiversity.

3. *Accelerate the national implementation of the provisions of existing international agreements and instruments related to agricultural biodiversity.*

This requires countries to:

- Develop laws and regulations, or review existing ones if applicable, to implement international commitments.

- Develop and implement strategies and programmes that translate international instruments into national realities. This will require international assistance.
- Integrate agricultural biodiversity into national and local development plans and strategies for the reduction of poverty.
- Establish greater cooperation between sectors and institutions involved, especially amongst environmental and agricultural sectors and between the private sector and civil society.
- Give high priority to research and training in agricultural biodiversity.

4. *Improve support to small-scale food producers, in recognition of their work in developing and safeguarding current and future agricultural biodiversity.*

Many of the provisions of international agreements, such as those related to on-farm management of agricultural biodiversity and its conservation *in situ*, can only be developed locally. It is urgent to find mechanisms to give high priority to supporting the local agro-ecological approaches that recognise famers' rights and the fundamental role of women. The visions exposed by the International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD) can be used and reflected in local actions. We urge to the following:

- Improve the livelihoods and welfare of small-scale food producers to enable them to continue their development work and safeguard agricultural biodiversity.
- Strengthen food systems rich in biodiversity with a local focus and promote the local knowledge and techniques related to them.
- Improve participation in decision-making, ensure access to necessary local resources and respect the rights of farmers.

Conclusions and Recommendations at the National Level

- *The role and potential of Spain in the world as regards ABD*

For cultural and geographical reasons, Spain has served as a bridge throughout its history for the exchange of genetic resources from different cultures and continents. The southeastern strip of the Peninsula is part of one of the centres of diversity identified by Russian scientist Vavilov in the last century. From the first centuries of the modern era, Spain has been the bridge between Africa and Europe and a crossroad for agricultural and cultural techniques and genetic resources from the Arab world to Europe.

Thus, some crops from Asia such as citrus fruits, rice and aubergine were incorporated into Spain's agriculture. Subsequently, beginning in the 16th century, Spain was the bridge between the New and the Old World. Key crops in the Old World such as wheat, barley and faba beans reached Latin America through Spain, and major crops unknown in Europe, Africa and Asia, such as maize, potatoes, beans, tomatoes and squash reached Europe via Spain from Latin America.

Perhaps for these reasons Spain has also played a leading role, recognised and appreciated by all countries during the negotiations of FAO for the conservation, sustainable use, access to research and benefit-sharing derived from these resources. In 1979 at the FAO Conference, our country presented the first proposal for an international agreement on genetic resources and an international genebank.

Spain also had the honour in 1983 of unlocking the political impasse in the negotiations of that agreement thanks to its generous offer to put its national genebank under the auspices of the FAO for the conservation of *ex situ* collections of plant genetic resources from all over the world. Spain was again the country that, in 1987, presented the first proposal for the development of Farmers' Rights.

The Spanish parliament was among the first to ratify the Treaty in 2004 and the first meeting of its Governing Body took place in Madrid (June 2006), in which the Treaty became operational. Throughout the negotiation process, first the International Undertaking and then the brand new binding International Treaty, Spain has been the Chair of the negotiating committee twice, and the Secretary of the negotiating committee was a Spaniard, appointed by the Director-General of FAO, since its creation in 1983 up to 2007.

Consistent with this, Spain should maintain its international leadership on this important issue, meeting existing expectations, both in the development of international policies and international cooperation and technical assistance to developing countries. This does not necessarily imply any additional expense, but a redefinition of priorities in the context of the fight against hunger and the Millennium Goals 1 and 7. In addition to the UN, other additional multilateral policy frameworks could be the Alliance of Civilizations and the Quintet Against Hunger (or Alliance against Hunger), both Spanish initiatives.

- *The ABD situation in Spain:*

Spain is the richest country in Europe when it comes to agrobiodiversity, with a huge variety of species as well as within species. This does not mean, however, that it depends on more than 80% of genes from other countries for our most important crops, as has been shown in previous sections.

The National Inventory of Plant Genetic Resources for Food and Agriculture has about 32,000 local Spanish varieties of cultivated species and the Official

Catalogue of Spanish livestock breeds in 2008 had a total of 153 breeds catalogued. Nevertheless, the loss in recent decades of the enormous genetic heritage representing agricultural diversity has been, and continues to be, substantial, difficult to quantify and often irreparable. In recent decades, rural depopulation and rapid modernisation of agricultural, forestry and fishery production systems have led to the disappearance of countless varieties of crops, livestock breeds, microbial strains, forest species populations and fishery resources. With them, many genetic resources with enormous potential value have also been lost for use in Spain and outside of Spain today and in the future.

The destruction of Spanish agricultural biodiversity constitutes the loss of a very important part of our national heritage. Also, the traditional knowledge associated with the use of agricultural biodiversity is being lost, and consequently an entire culture, because genetic resources are an essential component of local identity in the areas where they were developed and adapted and they are crucial as a cultural element throughout the entire territory.

The first national genebank was established in the 1970s and the first legal and institutional measures that were taken in Spain to stop the erosion of genetic resources for food and agriculture are more than 30 years old. Since then, thanks to different initiatives such as the national sectorial programmes of conservation and use of genetic resources, many diverse materials have been gathered for conservation in long-term maintenance collections, and they have been made available to users. An interesting point is that the majority[31] of the material conserved in Spanish genebanks is of national origin, contrary to what happens in other industrialised countries. Much progress has also been made in the knowledge of our genetic resources, the awareness of its value has been promoted among farmers and consumers, and many materials have been used in genetic improvement programmes for the benefit of agriculture.

- *Recommendations for the improvement of national coordination: the development of a national ABD strategy.*

It is necessary to develop and better coordinate a national, regional and local ABD policy, dispersed up to now, through the creation of an interministerial Committee, as have other European countries, and promoting laws, regulations and initiatives in this area. The objectives should include: the implementation of the International Treaty, plans of action and international programmes ratified or signed by Spain on this subject; the conservation of our PGRFA, *ex situ* and *in situ,* in genebanks and protected areas; the application of farmers' rights referred to in Article 9 of the ITPGRFA; the promotion of agricultural research and the broadening of the genetic base of our crops; the promotion of public awareness and education of the Spaniards in this matter.

[31] It is estimated around 65%.

Our Autonomous Communities should play a crucial role in safeguarding their traditional landraces and varieties. In fact, some autonomous communities are taking regional initiatives aimed at the sustainable conservation and use of their own ABD. The case of Andalusia is noteworthy, which has just published a White Paper[32] on PGRFA of interest in Andalusia, as a first step for the development of the future strategy for the conservation and sustainable use of plant genetic resources with risk of genetic erosion and of interest to agriculture and food in Andalusia. This White Paper includes recommendations at a regional level, such as developing an inventory of plant genetic resources of Andalusian origin, constituting a Panel of PGRFA Experts in Andalusia, addressing the regulatory development of the provisions of the International Treaty on Plant Genetic Resources and Law 30/2006 on seeds, contributing to the preparation of reports on the national and international situation of the PGRFA, providing regular information on the status of these resources at the regional level and valuing the potential of Andalusian indigenous plant resources.

In recent years we are witnessing the birth of public and private initiatives specifically concerned with genetic resources. An example of this is the presentation in 2006 of the Spanish Strategy for the Conservation and Sustainable Use of Forest Genetic Resources[33], the development of which is presently being attempted by means of several national plans. In 2009, the Ministry of Science and Innovation decided to launch the OPIS 2020 Strategy, establishing the ten issues in which the country should show levels of excellence by the year 2020. One of these issues is that of genetic resources, including in this case, plant , animal and microbial resources. Should also be mentioned the various associations that are emerging in civil society to conserve and promote the use of these resources and the associated traditional knowledges.

The coordination of all the parties involved in the conservation and use of genetic resources in Spain must be reinforced. There are areas in which there has been little or no progress and that require taking action at the national level, common to all subsectors of agricultural biodiversity, such as the issues related to access to genetic resources or to intellectual property rights, biosafety and recognition of farmers' rights in relation to genetic diversity for food and agriculture.

Furthermore, each of the subsectors (cultivated crops, farm animals, forest species, fish species, microorganisms) require new and effective measures to secure and improve their infrastructure for conservation and use, streamline

(32) Libro blanco de los recursos fitogenéticos con riesgo de erosión genética de interés para la agricultura y la alimentación en Andalucía /Sevilla: Ministry of Agriculture and Fishery, Publishing and Dissemination Service: Directorate-General of Agricultural and Livestock Production, 2012. [online] [Accessed: 16 July 2012]. Available at:
http://www.juntadeandalucia.es/export/drupaljda/1337159508LIBRO_BLANCO_sin_portada.pdf

(33) MINISTRY OF THE ENVIRONMENT. *Estrategia de Conservación y uso sostenible de los recursos genéticos forestales.* DGB, Madrid, 2006. [online] [Accessed: 16 July 2012] Available at: http://www.inia.es/gcontrec/pub/ecrgf_11mayo_imprenta_1151661517156.pdf

management and transfer systems, and strengthen national and international cooperation. Also, in recent years new challenges have emerged such as, amongst others, the role that genetic resources must play for agriculture to adapt to climate change, the recognition and use of ecosystem services provided by agricultural biodiversity and the mechanisms to compensate those who preserve and develop it, as well as the growing demand from consumers for diverse, safe, highly nutritious products from an accredited source.

It is therefore necessary to frame all measures and actions currently being taken in a common Strategy that serves the national interests of conservation and sustainable use of our agricultural biodiversity, and that establishes measures for the problems that persist and for the new challenges that are already emerging. This strategy must have mechanisms for a joint and coordinated action of all stakeholders (various public administrations, farmers, universities, research centres, NGOs, private companies, etc.), and establish priorities, distribute responsibilities and allocate the necessary resources. All of this should contribute to the corresponding policies and regulations in force, complementing the existing national strategies and programmes, and incorporating the provisions arising from international commitments assumed by Spain and the future trends in the Common Agricultural Policy.

In a Declaration[34] developed by the Ministry of Environmental, Rural and Marine Affairs and the Ministry of Science and Innovation, with contributions by experts from international institutions, there are recommendations to effectively combat the loss of agricultural biodiversity in Spain and for its sustainable use in benefit of the agricultural sector and society in general, especially in view of sustainable food production and climate change expected in the future. In particular, the development and implementation of a National Strategy is proposed, developed with the participation of all stakeholders in the conservation and use of agricultural biodiversity, combining efforts in this area, creating synergies, establishing common principles and objectives, and setting the basis of national and international cooperation on this topic.

- *Specific recommendations on the purpose and objectives, process for their development and possible content of a spanish strategy for the conservation and use of agricultural biodiversity of national interest.*

1. Goal and Objectives.

A National Strategy for the Conservation and Use of Agricultural Biodiversity should pursue the following objectives:

[34] This Declaration is the result of the International Seminar on the role of Agricultural Biodiversity in the fight against Hunger and Climate Change, convened by the Chair of Studies on Hunger and Poverty (CEHAP) of the UCO and held in Cordoba from 13-15 September 2010, organised as a contribution to the International Year of Biodiversity and as a complement to the International Declaration that was drafted. The seminar was opened by the Secretary of State for International Development Cooperation and closed by the Minister of the Environment and Rural and Marine Affairs.

- Achieve long-term conservation of genetic resources for food and agriculture and their broad use for the benefit of agriculture and society.
- Balance the sustainable use of agricultural biodiversity through the protection and restoration of natural ecosystems and endangered species.
- Compliance and development of international conventions and treaties ratified by Spain and other international commitments in this area.
- Strengthen national and international cooperation and joint action for the management of genetic resources for food and agriculture.

The National Strategy should guide and frame all actions and programmes for the conservation and use of agricultural biodiversity. It should set the principles and objectives that should govern the subsequent proceedings and establish the creation of new mechanisms and tools when necessary. Also, the implementation of the objectives of the international agreements and initiatives in this area should be considered, such as the Convention on Biological Diversity, Convention on Climate Change, International Treaty on Plant Genetic Resources for Food and Agriculture, and the Multi-Year Programme of Work of the Commission on Genetic Resources for Food and Agriculture of the FAO, amongst others. In this context, it will be necessary to consider the regulatory development and the implementation mechanisms of the measures included in these instruments, such as the systems and protocols to access genetic resources and benefit-sharing derived from their use, and the application of farmers' rights.

The Strategy should also incorporate appropriate mechanisms to acknowledge the work of farmers, cattle-raisers and fishermen as primary custodians of agricultural biodiversity and their major contribution in the past, present and future to the conservation, development and availability of a variety of genetic resources. In this context, the primary role of women should be highlighted.

This Strategy should be integrated into the new orientations derived from the debate on «the Common Agricultural Policy beyond 2013». It should especially contribute to the essential role that agriculture must play in the sustainable use of resources, the conservation of natural habitats, biodiversity and the fight against climate change and its ability to supply healthy, safe and quality food, in line with the document «Europe 2020: a strategy for smart, sustainable and inclusive growth.»

2. Process.

For the National Strategy to be truly effective it must be developed by means of a process of dialogue between all stakeholders involved in the conservation and use of cultivated biodiversity in its various subsectors (crops, animals, fish, microorganisms, forest species, etc.). Coordinating the development of the Strategy corresponds primarily to the Ministry of the Environment and Rural and Marine Affairs that has the competence in this area, but it is also essential to rely on the active participation of the following, among others:

- Relevant agencies of the Central Government: Ministry of Science and Innovation, Ministry of Industry, Tourism and Trade, Ministry of Foreign Affairs and Cooperation, Ministry of Development, as well as relevant Autonomous Agencies (National Institute for Agricultural and Food Technology Research, Spanish National Research Council, Spanish Agency for International Development Cooperation).
- Autonomous Regions.
- Other National administrations involved (councils, regional administrations, etc.).
- Associations and organisations of producers (farmers, ranchers, fishermen, etc.).
- Private companies from different sectors (genetic improvement, seed production, food industry) and their associations.
- Foundations (such as Biodiversity Foundation) and specialised NGOs (such as the Seed Network).
- Public research centres.
- Universities.

3. Content.

With regard to content, the following elements must be considered:

- Extensive diagnosis of the present situation, with special emphasis on the major shortcomings and needs of the current system of conservation and use of agricultural biodiversity and on the opportunities and threats that arise for the future, such as climate change.
- General Measures:
  - Infrastructures.
  - Management systems.
  - Funding.
- Sectorial approaches:
  - Cultivated crops and other plant species of interest to food and agriculture.
  - Livestock.
  - Fishery resources.
  - Forest species.
  - Microorganisms of relevance to food and agriculture.
  - Other important components of biodiversity for food and agriculture.
- Cross-cutting themes:
  - Access and exchange of genetic resources and aspects related to intellectual property.
  - Relationships between agricultural biodiversity and climate change.
  - Relationships between agricultural biodiversity and wild biodiversity, including the ecosystem perspective.

- Relationships between agricultural biodiversity and the sustainable development of rural areas.
- Relationships between agricultural biodiversity and edapho-climatic biodiversity.
- Analysis of the contribution of agricultural biodiversity as a key component of the «wealth of the nation».

- Research, Development and Innovation. To this end, the Ministry of Science and Innovation, and where appropriate, the relevant institutions of the Autonomous Communities, should include agrobiodiversity as a priority line of research.
- Creation of new markets and product diversification.
- International Cooperation
- Training, congresses and seminars.
- Communication and dissemination, especially those directed to consumers.

For the implementation of the Strategy it is necessary to take into account the following:

- Mechanisms for management decision-making regarding the Strategy (National Commission, or similar).
- Mechanisms for inter-territorial cooperation with representation of the Autonomous Communities.
- Mechanisms for the best use of existing funding and additional funding mechanisms.
- Mechanisms of coordination and administrative management of the Strategy.
- Mechanisms for implementation of the Strategy in the short to medium term (plans of action).
- A network of infrastructures supported by the Strategy.

FINAL CONSIDERATIONS

Although regulatory issues remain crucial, legal provisions alone are not enough because they must be understood, accepted and implemented by both citizens and their governments. For this to occur, it is essential the awareness of the general public. In fact, it is very important that stakeholders and citizens improve their knowledge of the provisions of the International Treaty. Training in this area, as well as public awareness of the importance of genetic diversity and the dangers of its loss, are important challenges.

It must be remembered that genetic erosion is only a consequence of human exploitation of the planet's natural resources. The fundamental problem is the lack of respect for nature, and any lasting solution must involve the establishment of a new relationship with our planet and the understanding of its limitations and fragility. If humanity is to have a future, it is imperative that children learn this in school and that adults include it in their daily lives.