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UNDERSTANDING DIVERSITY FOR HARMONIOUS AND SUSTAINABLE DEVELOPMENT

ABSTRACT

Diversity is as crucial for the survival of humanity as the air we breathe and the water we drink. Understanding diversity is a prerequisite for the promotion of the sustainable utilisation of crop diversity (the raw material for improving and adapting crops to meet future challenges), essential to respond to the unprecedented demands on agriculture posed by increasingly unpredictable and changing climate as well as the increasing pressure of constantly evolving pests and diseases, by providing extra source of material and knowledge.

In spite of the many challenges ahead impacting in agricultural production, like the threat of genetic erosion, deforestation, changes in key climatic features (*i.e*. temperature increase) and food insecurity, there are a number of elements that play a crucial role in contributing to attaining the goals of harmonious and sustainable development such as the genetic diversity in germplasm collections maintained at local, national, regional and global level, that need to be harnessed, by means of understanding the diversity, for the benefit and improved well-being, ensuring food and nutrition security and healthy life for present and future generations of humankind.

Keywords: Genetic diversity, Germplasm collections, Utilisation, Sustainability, Sustainable development

INTRODUCTION

Presently, and in spite of all the progresses made in all fields of sciences, humanity faces unprecedented challenges that put in risk its very own ability to survive.

Ill-informed decisions, undervaluation of risks and a disregard for nature balances, have taken a heavy toll bringing the occurrence of extreme and unpredictable weather events namely drought spells, torrential rains, hurricanes, unusual and out of the season heath waves that, together with irrational and unsustainable depletion of natural resources, impact agricultural production and put at risk the survival of plants and animals, hence, the survival of humanity itself.

It is urgent and mandatory that measures are taken to reduce or even halt the present rate of loss of biodiversity in order to grant the populations'

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harmonious and sustainable development. However, notwithstanding the good intentions, the target agreed by the world's Governments in 2002, "to achieve by 2010 a significant reduction of the current rate of biodiversity loss at the global, regional and national level as a contribution to poverty alleviation and to the benefit of all life on Earth", has not been met (Secretariat of the CBD, 2010).

Planning, organising and carrying out germplasm collecting missions have started, in a scientific manner, in the 20's of last century lead by the understanding of the importance biodiversity play in the production of more and better foods and, more recently, the role that it plays in helping to address the challenges posed by climate change and constantly evolving pests and diseases, by providing extra source of material and knowledge (Bettencourt, 2011).

Globally, an estimated 1,750 genebanks hold *ex situ* germplasm collections with approximately 7.4 million accessions (FAO, 2010a).

Understanding the diversity conserved in worldwide germplasm collections (*in situ*, *ex situ*, on-farm), harnessing its potential for improving and adapting crops to meet the challenges faced by world populations, *inter alia* food and nutrition security, contributing to alleviating poverty and to a better nourishment through a more balanced and healthy diet, is a prerequisite to accomplish harmonious and sustainable development.

Concurrently, the valorisation of the traditional products, making the conservation of diversity in general and the agro-biodiversity in particular, into a profitable economic activity capable of generating extra and diversified income to the farmer's communities while contributing to the conservation and maintenance of genetic diversity, is the key element for local and regional sustainable development (Bettencourt, 2008a).

MATERIALS AND METHODS

Although considerable progress has been made in understanding diversity, there are still many challenges ahead and there are yet many reasons why we should concern about the loss of biodiversity as crops and their wild relatives (CWR) are threatened by genetic erosion and genetic pollution. Humankind has much to be concerned about the problems that affect the maintenance, even survival, of the plant diversity, as it depends much on it for its own survival. The world's food security is at stake and urgent and vigorous actions are needed. Genetic erosion and genetic pollution afflicting any plant species in any part of the world, at local, national, regional or global level, is certain to have repercussions globally. The reduction of biodiversity (erosion) or its contamination (pollution), by whatever causes and means, have a 'domino effect' as, in the present times, agriculture in practically every country in the world is, to a great extent, dependent on species originating from other regions (Bettencourt *et al.*, 2008b).

RESULTS AND DISCUSSION

Challenges

Species threat

The number of flowering plant species around the world is closer to 400,000 of which, an estimated 307,674 species (including mosses, algae and ferns and allies) have being described, being a significant percentage (42% upper estimate) of this plant wealth threatened (IUCN, 2012).

Besides the threat, we know very little of this plant species wealth. It is estimated that only about 10% of the plants have been evaluated for their medicinal or agricultural potential. It means that there are many new drugs and even new crops yet to be discovered. Moreover, for the vast majority of these plant species, there is little or no idea of the extent of their individual genetic diversity, that is, the range of useful genes present within these species (Prance, 1997).

Genetic erosion

Genetic erosion also affects crops. The Food and Agriculture Organisation of the United Nations (FAO), for the preparation of the Second Report on the State of the World's Plant Genetic Resources for Food and Agriculture (FAO, 2010a), received country reports giving an account of the problem and identifying the possible causes. Table 1 summarises the available information.

Table 1 – Number and percentage of countries reporting the occurrence of genetic erosion per crop group (adapted from FAO, 2010a)

Crop group	**# of countries reporting genetic erosion (out of 113)**
Cereals and grasses	**30** (26.5%)
Vegetables	**18** (15.9%)
Fruits and nuts	**17** (15%)
Food legumes	**17** (15%)
Roots and tuber	**10** (8.8%)
Medicinal and aromatic	**7** (6.2%)
Forestry species	**7** (6.2%)
Miscellaneous	**6** (5.3%)
Stimulants and spices	**5** (4.4%)

The reporting countries mention a substantial number of causes for genetic erosion, the major including: Replacement of local varieties; land clearing; overexploitation; population pressures; environmental degradation; changing agricultural systems; overgrazing; inappropriate legislation and policy and, pests, diseases and weeds.

Deforestation

The world's total forest area in 2010, at just over 4 billion hectares, covers 31% of the total land area. The rate of deforestation, although showing signs of decreasing, is still alarmingly high. Deforestation affected an estimated 13 million hectares per year between 2000 and 2010, compared to 16 million hectares per year in the 1990s. In developing countries, wood based fuels are the dominant source of energy for more than 2 billion poor people. In Africa, over 90% of harvested wood is used for energy. Primary forests account for 36% of forest area but have decreased by more than 40 million hectares since 2000 (FAO, 2010b).

The net loss of forest area globally in the period 2000–2010 is estimated at -5.2 million hectares per year. Figure 1 illustrates the annual change in forest area by region in the period 1990-2010 (FAO, 2010b). Exception made for Europe and Asia, where a noticeable net gain in forest area has been a reality during the last two decades for the first and during the last decade for the latter, all other regions of the world show a clear net loss in forest area, although a slight improvement can be noticed, except for one region, between the two periods of time in analysis.

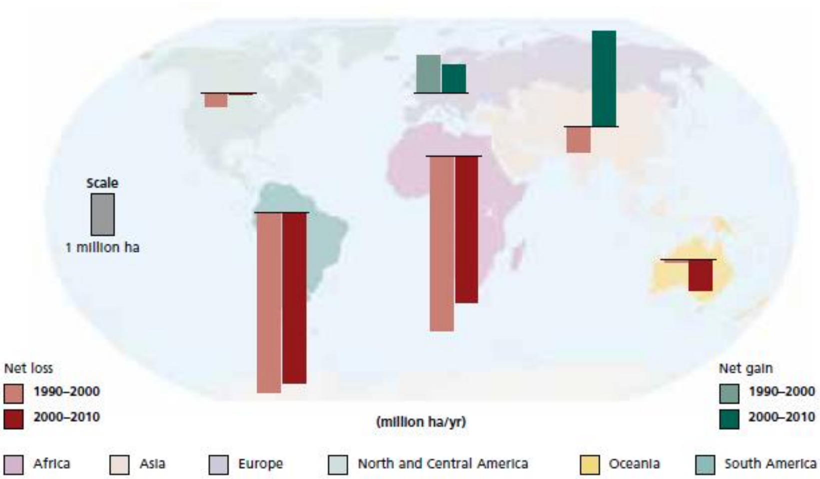

Figure 1 Annual change in forest area by region, 1990-2010 (after FAO, 2010b)

Twelve percent of the world's forests (more than 460 million hectares) are designated for the conservation of biological diversity, an increase of more than

95 million hectares since 1990, of which the largest part (46%) was designated between 2000 and 2005. Most, but not all of these designated areas for the conservation of biological diversity as the primary function, are located inside protected areas (FAO, 2010b).

Climate change

Global temperatures have warmed significantly since 1880, the beginning of what scientists call the "modern record." As greenhouse gas emissions from energy production, industry and vehicles have increased, temperatures have climbed, most notably since the late 1970s.

The world has warmed by approximately 0.7 degree Celsius in the 200 years since fossil fuels began to be used on any significant scale, but the warming has not been uniform. The biggest temperature rises have been around the North Pole, and some worrying self-reinforcing feedbacks have already developed. For example, the Arctic ice has been melting unexpectedly rapidly, increasing the rate at which the planet is warming because the white ice that reflected solar energy back into space has been replaced by dark, heat-absorbing sea. Similarly, the melting of the permafrost in Russia is now releasing large amounts of methane, a powerful greenhouse gas, into the atmosphere (Douthwaite, 2010).

The year of 2011 was a record-breaking year for extreme climate and weather events. Leading scientists are investigating the relationship between such events and climate change. According to the latest insights, climate change is leading to changes in the frequency, intensity, length, timing and spatial coverage of extreme weather events. It was also the tenth warmest year and the warmest La Niña year on record, as well as the year in which the second lowest seasonal minimum extent of Arctic sea ice was recorded. At the global level, in the first half of 2011 alone, costs arising from severe natural events exceeded those in the total previous costliest year, 2005 (UNEP, 2012).

A recent study found out that climate changes are having an impact on the availability of natural resources and on food security, and are leading to shifts in migration patterns. The study looked at increased competition for natural resources, mainly land and water, resulting in conflicts among different communities and livelihood groups (UNEP, 2011).

As an example, the globally-averaged temperature for April 2012 marked the fifth warmest April since record keeping began in 1880. April 2012 also marked the largest departure from the 20th century average temperature in more than a year. This was the 36th consecutive April and 326th consecutive month with a global temperature above the 20th century average. The last April with below average temperature was April 1976. The last month with a below-average temperature was February 1985 (NOAA, 2012).

Food insecurity

In spite of the efforts to achieve the Millennium Development Goal (MDG) “halve, between 1990 and 2015, the proportion of people who suffer from hunger" and the World Food Summit (WFS) goal "halve, between 1990–92 and 2015, the number of undernourished people", FAO estimates that the number of people suffering from chronic hunger in 2010 was 925 million (FAO, 2012).

Even if the MDG were to be achieved by 2015 some 600 million people in developing countries would still be undernourished and, having 600 million human beings suffering from hunger on a daily basis is never acceptable (FAO, 2011).

Insufficient progress has been made and only five percent of the developing world is on track to meet the UN target. One in five infants and children are moderately or severely underweight, amounting to 110 million children around the world. In 2011, 314 (296 to 331) million children younger than 5 years were mildly, moderately, or severely stunted and 258 (240 to 274) million were mildly, moderately, or severely underweight. Developing countries as a whole have less than a 5% chance of meeting the MDG 1 target; but 61 of these 141 countries have a 50 to 100% chance (Stevens *et al*., 2012).

With a child dying every six seconds because of undernourishment related problems, hunger remains the world's largest tragedy and scandal (FAO, 2012).

Global economic crisis and rising food prices cause the increase of inequalities. The countries most exposed to price swings on international markets were typically poor and food importers. Most of these countries were in Africa and, between 2007 and 2008, the number of undernourished was essentially constant in Asia (an increase of 0.1%), while it increased by 8% in Africa (FAO, 2011).

Figure 2 depicts the prevalence of undernourishment and progress towards the WFS and the MDG goals.

WORLD Region/subregion/country	Total population	Number of people undernourished						Proportion of undernourished in total population					
	2006–08	1990–92	1995–97	2000–02	2006–08	Change so far	Progress towards WFS target[4]	1990–92	1995–97	2000–02	2006–08	Change so far	Progress towards MDG target[4]
	(millions)	(millions)				(%)		(%)				(%)	
WORLD	6 652.5	848.4	791.5	836.2	850.0	0.2		16	14	14	13	–19	

Figure 2 - Prevalence of undernourishment and progress towards the WFS and the MDG goals (adapted from FAO, 2011)

The analysis of the figure above shows that, as for the number of people undernourished (WFS target), no progress, or deterioration of the situation has been registered. On what the proportion of undernourished in total population (MDG target) is concerned, the progress registered is insufficient to reach the target if prevailing trends persist.

Food waste

"Even today, we produce enough food, despite that we have 1 billion people undernourished" (José Graziano da Silva, DG FAO).

Food waste is, paradoxically, a consequence of developing and development. While in the first case food waste mostly occur due to the lack of appropriate harvesting and product's processing and handling technologies and storage infrastructures, in the latter it occurs due to distorted market notions and regulations and socio-economic factors and pressures.

A large part of the harvest does not reach the consumer. Containing losses in developing and industrialised countries is a key step in developing agriculture towards the green economy. The viable options include plants that are better suited as foods, improved technologies and the introduction of logistical precautions, for instance with regard to storage, drying, packaging, refrigeration and transport. There is still considerable further scope for reducing losses all along the food chain and for including the final consumers in this. Food losses must be tackled on all levels of economic activity. This includes high-performance marketing infrastructures and consumers should also rethink their approach to food (GFFA, 2012a).

One third of the food produced in the world every year is lost or wasted, amounting to 1.3 billion tons, enough to feed 3 billion people. In the developed world, 40% is lost through processing, retail and consumers, while in the developing world 40% is lost through harvest and processing. The irrigation water used globally to grow food that is wasted would be enough for the domestic needs (at 200 litres/person/day) of 9 billion people - the number expected on the planet by 2050 (Stuart, 2012).

That is a scandalous waste of financial resources, a waste of natural resources, a waste of energy and also a waste of labour force all of which, in the face of the imperious necessity for a green economy, is not, by all means, acceptable.

In order to promote a more rationalised way to handle food production and consumption and to involve consumers in the process, the Global Forum for Food and Agriculture, in its Final Communiqué (GFFA, 2012b), adopted, *inter alia*, the following resolution:

g) call upon the FAO to draw up concepts for reducing the loss and waste of food and to implement these in cooperation with countries, farms, the private sector and civil society.

Good examples can arise from unexpected sectors of society as the one recently announced in the UK where big food companies, along with 65 UK hotels, restaurants, contract caterers and government departments, have all voluntarily agree to cut food and associated packaging waste by five percent by 2015.

The Hospitality and Food Service Agreement, formally launched 27 June 2012, is a voluntary agreement to support the sector in reducing waste and recycling more. The Agreement will use 2012 waste and C02 emissions levels as a baseline, and if successful, could result in a CO_2 reduction of 234,000 tonnes and save the equivalent of about 100 million meals from the landfill.

The voluntary Agreement also targets an increase in the overall rate of food and packaging waste being recycled, sent to anaerobic digestion or composted, to at least 70% by the end of 2015. If just 25% of the food sector committed to meeting the targets in the Agreement, they could save up to 95 million euro and reduce their CO2 emissions impact by 570,000 tons by the end of 2015, according to WRAP the research organization that helped develop the voluntary programme (WRAP, 2012).

Research by WRAP (2012) also indicates that if avoidable food waste was prevented and unavoidable food waste diverted to anaerobic digestion, the potential savings to industry would be more than 900 million euro a year.

In a world of ever so scarce resources, it is forceful that food loss and waste be reduced to an acceptable minimum or even eliminated as it would enormously contribute to a peaceful, just and equitable world. If food loss and waste will be reduced to a minimum or even eliminated, it would probably not be necessary to stress even more the food production factors (soil and water) as it is many times said that global food output must rise 70% by 2050 to feed a world population expected to grow to 9 billion from 7 billion now, as the presently produced food is already enough to meet the needs of a growing population.

Solutions

Botanic Gardens

Along their history, BGs activities have included the cultivation of plants of importance to mankind for medicinal, economic and ornamental purposes (FAO, 2010a). Although BGs played, play and will continue to play an important role in the conservation and study of plant genetic resources, are rarely seen as important elements in the solution chain.

In recognition of that important role, the International Technical Conference on Plant Genetic Resources held in Leipzig in 1996, emphasised the important role that BGs can play in plant genetic resources (PGR) conservation strategies. That role is reflected in the Global Plan of Action for the Conservation and Sustainable Utilisation of Plant Genetic Resources for Food and Agriculture (FAO, 1996) and reiterated in the Second Global Plan of Action for Plant Genetic Resources for Food and Agriculture (FAO, 2011).

There are over 2,500 BGs worldwide growing over 80,000 plant species (approx. 1/3 of all known plant species). At least 160 BGs have seed banks maintaining substantial *ex situ* collections although only a percentage of these are important for food and agriculture.

CWR are well represented in BGs collections. For example, over 2,000 CWR taxa are maintained in Europe’s Botanic Gardens *ex situ* collections (FAO, 2010a).

Herbaria

Herbaria are a valuable source of information for genebank curators and users, assisting in the planning of germplasm collecting missions, as a reference source for the identification of new entries and material, and studies on crop distribution. The unmistakable identification of a germplasm sample is a prerequisite for the application of an appropriate conservation strategy and the promotion of its sustainable utilisation (Pinheiro de Carvalho *et al.*, 2012) as, accessions, which cannot be identified due to the absence of a herbarium specimen, tend not to be utilised for longer periods of time than those which have been assigned verified names (Moss and Guarino 1995).

In addition, due to advances in biotechnological sciences, it is also possible to extract DNA from herbarium vouchers for genetic diversity studies (Liston *et al*. 1990; Jones *et al*. 2008; Leino and Hagenblad 2010).

There are an estimated 3,400 herbaria worldwide with approximately 10,000 associated curators and biodiversity specialists. These herbaria, collectively, maintain an estimated 350 million specimens that document the earth's vegetation for the past 400 years (Index Herbariorum, 2012).

Genebanks

The *ex situ* conservation of germplasm continues to represent the most commonly used, significant and widespread means of conserving plant genetic resources.

Globally there are an estimated 1,750 genebanks holding *ex situ* germplasm collections with approximately 7.4 million accessions. There was a significant increase in the number of accessions collected and introduced in germplasm collections. From 1996 to 2007, more than 240,000 new accessions were collected and added to the *ex situ* collections (FAO, 2010a).

How are these germplasm collections composed? Figure 3, shows the crop species coverage of the globally held *ex situ* germplasm collections. About 45% of all accessions are cereals. Food legumes is the second largest group, accounting for 15% of the total, followed by forage species amounting to 9%. Vegetables and fruits each account for 7 and 6% respectively, while roots and tubers, oil and fibre crops each make 2 and 3% of the total (FAO, 2010a).

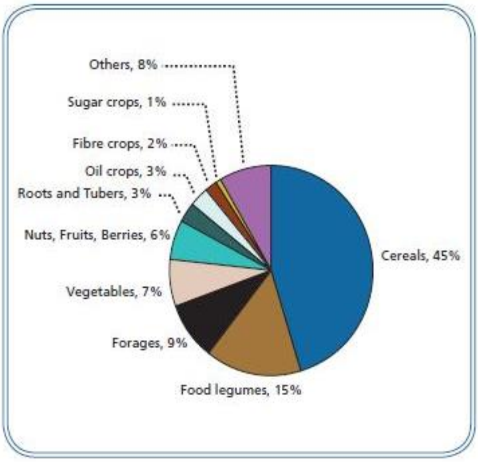

Figure 3 – Contribution of major crop groups in total *ex situ* collections (after FAO, 2010a)

As Figure 4 shows the number of accessions of landraces, breeding material and wild species maintained globally has increased since 1996, possibly reflecting the growing interest in conserving this material before genetic erosion can take its toll as well as to respond to the growing interest in using these materials in crop improvement programmes.

Landraces is the predominant type of material in the collections accounting for almost half of all materials maintained in worldwide germplasm collections, while the other three groups (advanced cultivars, research/breeding material and, wild species) are not very far from each other on their relative importance in the collections (FAO, 2010a).

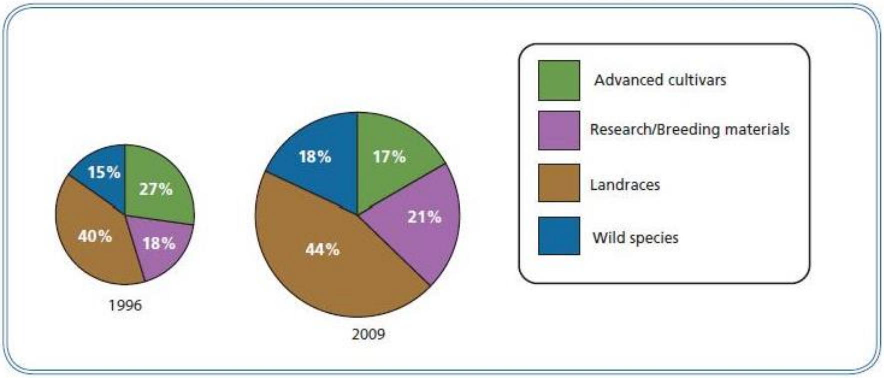

Figure 4 – Types of accessions in *ex situ* germplasm collections in 1996 and 2009 (the size difference in the charts represents the growth in total numbers of accessions held *ex situ* between 1996 and 2009) (after FAO, 2010a)

Understanding the diversity we conserve

The real value of germplasm resides in its potential utilisation for research, training and crop improvement. It is not only important to have the adequate conservation strategy but as well to have a good understanding of the conserved diversity. The knowledge of the characteristics (traits), morphological, agronomical and chemical, is of paramount importance for the full understanding of the diversity of the crops and crop wild relatives.

Morphology is still the most common method for germplasm characterisation. In a survey covering Africa, Americas, Asia and the Pacific, Europe and Near East, resulted that between 42 and 76% of accessions are morphologically characterised, while the utilisation of molecular markers have been used relatively little (between 7 and 12% of the accessions characterised), except for one region that reports a total of 64% of the accessions studied through this method. As for the traits, great effort has been put into agronomic traits, with the regions reporting between 38 and 86% of the accessions agronomically evaluated, while for biochemical traits the percentage of accessions evaluated according to that method varies from 8 to 23%, with one of the regions reporting a total of 57% of the accessions evaluated. Evaluation for biotic and abiotic stresses also shows relatively low percentages of materials evaluated (FAO, 2010a).

At crop group level, a survey was carried out covering 262 stakeholders in 40 countries, to assess the extent to which selected national germplasm collections have been characterised and evaluated. The survey's results made evident that while most crop commodity groups have been considerably morphologically characterised (an average of 64%), comparatively little biochemical evaluation has been completed (an average of 14%). Interesting to note that, among the commodity crops, the fibre and spices groups are the most extensively morphologically characterised and evaluated (respectively 89 and 82%) while biochemical evaluation has been mainly pursued in the oil crops and spices groups (respectively 52 and 39%) (FAO, 2010a).

Documenting the diversity we conserve

Despite data being available in greater quantity and quality than ever before, it is not always recorded and maintained in a format that makes it easily, readily and universally available (Bettencourt, 2011).

Besides the adequate conservation strategy and the acquired understanding of the diversity we conserve, it is of paramount importance that related and associated data is maintained and managed in electronic storage-and-retrieval systems where it can be safely stored, easily accessible and readily retrieved.

Poor documentation continues to be a substantial obstacle to the increased use of genetic resources in crop improvement and research. Where documentation and characterisation data do exist, there are frequent problems in standardisation and accessibility, even for basic passport information (FAO, 2010a).

In spite of this gloomy scenario, there are good examples of progress and well operating state of the art information systems at regional and global level. Below, there are examples of four dedicated information management systems at regional (Europe, EURISCO) and global level (GBIF, GENESYS and WIEWS).

EURISCO – The European Plant Genetic Resources Search Catalogue, a web-based catalogue, was established in 2003 as a European *ex situ* information portal on plant genetic resources with the objectives to provide technical support to allow countries to develop and build their national inventories; and to develop and maintain a European PGR search catalogue with passport data on *ex situ* collections maintained in Europe (Dias *et al*., 2012).

The European Search Catalogue provides information about *ex situ* plant collections maintained in Europe and contains passport data on more than 1,1 million accessions of crop diversity representing 5,586 genera and 36,327 species (genus-species combinations including synonyms and spelling variants) from 43 countries (EURISCO, 2012).

GBIF - The Global Biodiversity Information Facility is focused on making biodiversity data available online for scientific research, conservation and sustainable development. Enabling access to 388,680,911 data records (340,362,391 with coordinates), the GBIF information infrastructure is an internet-based index of a globally distributed network of interoperable databases that contain primary biodiversity data: information on museum specimens, field observations of plants and animals in nature, and results from experiments. The search interface also supports searches about the occurrence of species at particular times and places (GBIF, 2012).

GENESYS – Is a global portal to information on PGRFA. It is a gateway from which germplasm accessions from genebanks around the world can be easily found and ordered. In addition to passport data it provides access to characterisation and evaluation data. It maintains passport data on 2,348,398 accessions (GENESYS, 2012).

WIEWS – Maintains meta-data on an estimated 1,750 genebanks holding *ex situ* germplasm collections with 7,189,015 million accessions (WIEWS, 2012).

Securing the diversity we conserve

Although a substantial number of the world's collections are partly or entirely duplicated in more than one genebank, available data and information often do not allow identification of the same accession in different genebanks and the clear distinction between safety and redundant duplicates. It is estimated that less than 30% (1.9–2.2 million) of the total number of accessions maintained in genebanks worldwide are distinct, as a result of exchange and unplanned duplication (FAO, 2010a).

To ensure the safety duplication of the germplasm collections worldwide, the Global Crop Diversity Trust (The Trust), has established the Svalbard Global Seed Vault (The Vault), a fail-safe, state of the art seed storage facility build inside a mountain on a remote island in the Svalbard Archipelago, halfway between mainland Norway and the North Pole, with the purpose to store duplicates of all seed samples from the world's crop collections.

Presently, the Vault maintains a total of 747,141 accessions of seed samples, of 4,289 species, belonging to 820 genera, originated from 231 countries and deposited by 47 institutes, the Vault already holds the most diverse collection of food crop seeds in the world (SGSV, 2012).

On the 26th February 2008, the Vault's inaugural day, Ban Ki Moon, UN Secretary-General said: "Sustainable food production may not begin in this cold Arctic environment, but it does begin by conserving crop diversity". It certainly does!

Strengthening collaboration and sharing of responsibilities

Networks dealing with plant genetic resources are important platforms for: scientific exchange; information sharing; technology transfer and; research collaboration. They are also important for the determination and sharing of responsibilities for such activities as: collecting; conservation; distribution; evaluation; genetic enhancement; documentation, safety duplication and; crop improvement (FAO, 2011).

For what the European region and the Southeast European sub-region are concerned, there are two important networks:

The European Cooperative Programme for Plant Genetic Resources (ECPGR) (formerly "European Cooperative Programme for Crop Genetic Resources Networks - ECP/GR) was founded in 1980 on the basis of the recommendations of the United Nations Development Programme (UNDP), the Food and Agriculture Organization of the United Nations (FAO) and the Genebank Committee of the European Association for Research on Plant Breeding (EUCARPIA).

ECPGR is a collaborative Programme among most European countries, aimed at contributing to national, sub-regional and regional Programmes in Europe to rationally and effectively conserve *ex situ* and *in situ* plant genetic resources for food and agriculture and increase their utilization.

The Programme, which is entirely financed by the member countries, is coordinated by a Secretariat hosted by Bioversity International. The Programme operates through broadly focused Networks dealing with groups of crops or general themes related to plant genetic resources.

SEEDNet (South East European Development Network on Plant Genetic Resources) was established in 2004. The main objective of SEEDNet is the long-term conservation and sustainable utilisation of the diversity of PGR within the region through a well co-ordinated network of functional national programmes.

The network has 13 signatory partners and is organised in 6 crop oriented and 1 thematic regional working groups.

Montenegro is a full member of both networks and is actively participating and benefiting from the network activities.

Biodiversity's contribution to sustainable development

In 2011, with the assistance and support from the Government of The Netherlands, Montenegro began a Technology Needs Assessment (TNA) project. With this project, the country aims at identifying options for climate change mitigation and adaptation which also support national sustainable development.

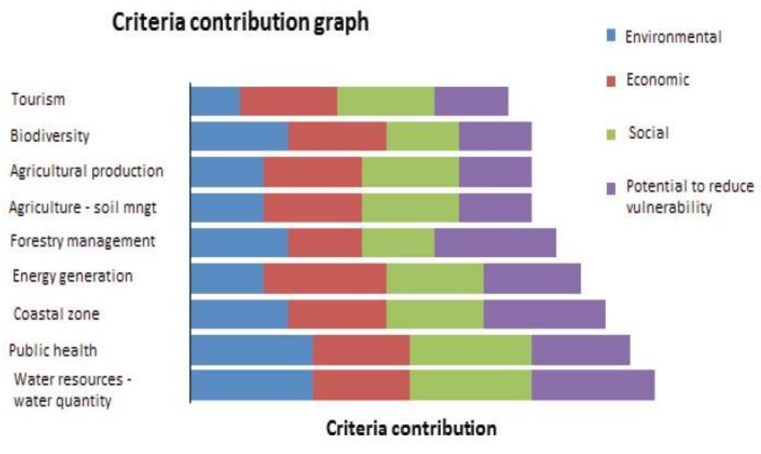

Figure 5 – Cumulative scores for sectors in Montenegro against climate (adaptation) and development criteria (after Markovic and van der Gaast, 2012)

On November 2011, stakeholders from different sectors and regions in Montenegro met to consider the country's medium to long-term development priorities in the context of climate change and to identify strategic sectors for realising these priorities.

The identified strategic sectors for realising the priorities in the context of climate change are summarised in Figure 5, showing sectors where stakeholders expect the largest potential improvements on adaptation and contribution to sustainable development (Markovic and van der Gaast, 2012).

Rewarding to notice that biodiversity was taken into consideration and held by the stakeholders as an important strategic sector contributing to all four criteria at stake: environmental, economic, social and, with potential to reduce vulnerability.

Another relevant area where biodiversity can play an important role is its potential beneficial impact in people's health. In a recently published paper (Hanskia *et al.*, 2012), it is suggested that loss of biodiversity could cause problems for public health as well as for the environment.

A decrease in the amount of time spent in contact with the natural environment and changes in the population of microbes resident on the skin could be contributing to the increase in inflammatory disorders such as allergies. To test these ideas, it was measured immune reactions to common allergens and the composition of skin microbes in 118 adolescents in eastern Finland, using the mixture of plants in the young peoples' gardens and local land use as measures of biodiversity. They found that people living in areas of reduced biodiversity were more prone to allergies, and that allergic individuals had distinct populations of bacteria on their skin.

What remains to be done?

Characterisation and evaluation

Qualitative traits (such as many disease resistances and stress tolerances) and quantitative traits (such as indices of yield and productivity) are typically the targets for improvement in plant breeding programmes and for the characterization of genebank collections. Nonetheless, the information produced has been underused due largely to a lack of standardisation and to accessibility constraints (FAO, 2010a).

The existing and available information systems on plant genetic resources are priceless sources of information, although data on characterization and evaluation tend to be poor or absent. Closing this gap by adding this information, thus fostering the use of germplasm, would represent a giant step towards addressing the threats these resources and agriculture are facing, from changes in climate and constantly evolving pests and diseases (Bettencourt, 2011).

Documentation

The poor documentation available on much of the world's *ex situ* germplasm collections is a substantial obstacle to the increased use of plant genetic resources in crop improvement and research (FAO, 2010a).

Although documentation and characterization data on collections have progressed somewhat, there are still large data gaps and much of the existing data is not accessible electronically.

In order to improve the management of collections and encourage an increased use of germplasm, documentation, characterization and evaluation, need to be strengthened and harmonized and the data need to be made more accessible. Also, greater standardization of data and information management systems is needed (FAO, 2010a).

Promoting the use

One of the most significant obstacles for greater use of PGR for food and agriculture (PGRFA), especially of underutilized crops and wild relatives, is the lack of adequate characterization and evaluation data and the capacity to generate and manage such data (FAO, 2010a).

The development of new varieties of crops critically depends on breeders and farmers having access to the genetic diversity in order to develop varieties with higher and more reliable yields, resistant to pests and diseases, tolerant to abiotic stresses, making more efficient use of resources and producing new and better quality products and by-products (FAO, 2010a).

Greater characterization and evaluation are a major priority in the GPA. Characterization and evaluation can also aid the identification of germplasm with potential for further improvement by breeders and farmers, as well as for direct use by farmers for production and marketing (FAO, 2011).

Political understanding and support

The raise of awareness, both at the general public level and official, decision-making level, is essential for the progress and in sustaining the efforts to conserve and sustainably use diversity as an important element to support sustainable development. The following steps need to be pursued (FAO, 2010a):

Special efforts are still needed to raise awareness of senior managers and policy-makers about the complex legal and policy issues relating to plant genetic resources.

Efforts to raise additional resources to support work on plant genetic resources require new and innovative approaches, better coordination in fundraising among different institutions and greater efforts to increase awareness among policy-makers, donors and private sector as to the actual and potential value of plant genetic resources.

More education and training opportunities for young researchers and for upgrading the knowledge and skills of existing staff.

Stronger coordination in the development of policies, legislation and regulations among the various stakeholders at global, national and regional level.

CONCLUSION

Notwithstanding much progress registered in the different fields of biodiversity, namely the considerable genepool conserved in germplasm collections, the characterisation and evaluation of genetic resources using standard descriptors, the increased use of biochemical evaluation hand-in-hand with agronomical evaluation and morphological characterisation and the significant advances in making information on germplasm holdings and its associated data publicly and readily available, there is still much room for improvement in the advancement of conservation and the promotion of sustainable utilisation of genetic resources for the general wellbeing of humanity, contributing to a better nourishment, through a more balanced and healthy diet.

The valorisation of the traditional products, contributing to extra and diversified sources of income to the farmer's communities while contributing to the conservation and maintenance of genetic diversity, is a key element contributing to rural sustainable development.

Understanding diversity is of paramount significance, playing an essential role in attaining the goals of harmonious and sustainable development for the benefit and improved wellbeing, ensuring food and nutrition security and healthy life for the present and future generations of mankind.

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RAZUMIJEVANJE DIVERZITETA U CILJU USKLAĐENOG I ODRŽIVOG RAZVOJA

SAŽETAK

Diverzitet je za opstanak ljudi neophodan koliko vazduh koji udišemo i voda koju pijemo. Razumijevanje diverziteta je preduslov za unaprjeđenje održivog iskorišćavanja diverziteta usjeva (sirovina za poboljšanje i prilagođavanje usjeva radi suočavanja sa izazovima budućnosti), što je od presudnog značaja za rješavanje do sada neviđenih zahtjeva koji se nalaze pred poljoprivredom - koje nameću sve nepredvidivije klimatske promjene i povećanje pritiska od štetočina i bolesti koji stalno evoluiraju - pružanjem dodatnih izvora materijala i znanja.

Uprkos mnogim izazovima koji su pred nama a koji utiču na poljopirvrednu proizvodnju, poput rizika od genetičke erozije, deforestacije, promjene ključnih klimatskih odlika (t.j. povećanje temperature) i nepostojanje sigurnosti hrane, postoji određen broj elemenata koji daju ključan doprinos postizanju ciljeva usklađenog i održivog razvoja, kao što su genetski diverzitet u kolekcijama germplazme koja se čuva na lokalnom, nacionalnom, regionalnom i globalnom nivou, kojima treba upravljati kroz razumijevanje diverziteta, radi koristi i blagostanja, obezbjeđujući sigurnost hrane i ishrane i zdrav život sadašnjim i budućim generacijama čovječanstva.

Ključne riječi: Genetički diverzitet, kolekcije germplazme, korišćenje, održivost, održivi razvoj