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GENE BANKS AND CASE STUDY OF EGYPT

Hassan Z. Allam and Kasem. Z. Ahmed

Genetic Engineering and Biotechnology Center, Faculty Agric, Minia University,

ABSTRACT

In recent years there has been a dramatic and very welcome increase in awareness, worldwide, of the critical contribution that genetic resources for food and agriculture can make to food security, poverty alleviation and environmental sustainability. The ultimate goal of efforts in building up capacities in conservation and use of plant genetic resources at national and global levels, especially establishing gene banks, is to maximize the utilization of these collections through selection and breeding programmers and hence contribute to increasing farmers income and agricultural production to meet the demand for food and nutrition security while protecting the natural resource base of the agricultural production system. Routine gene bank operations usually involve the collecting, handling and management (including research) of germplasm, its storage, regeneration, characterization/evaluation, documentation and dissemination to users. It is now widely accepted that conservation can be done on-site (in situ) and off-site (ex situ). In situ conservation i.e. protected areas, conservation on-farm and home gardens covering both wild and domesticated species. Ex situ conservation, is concentrated mainly on cultivated species, including of seed storage, pollen storage, field gene banks, in vitro conservation, botanical gardens and DNA storage. Egypt is one of the earliest civilizations known to have adopted some form of nature conservation. And it has been active in the in situ conservation of wildlife, natural resources and natural habitats. Ex situ conservation in many botanic gardens, entomological collections and herbaria are carrying out. Last year (2004), the National Gene Bank was opened officially and the Genetic Resources Policy Initiative (GRPI) project in Egypt was officially launched.

Key words: ***In situ conservation, Ex situ conservation, Conservation on-farm, Home gardens, Pollen storage, Field gene banks, In vitro conservation, Botanic gardens, arboreta, DNA storage, GPRI-Egypt***

INTRODUCTION

The global successes of science-based plant breeding can be traced back to the early 1960s and largely resulted from increased use of land races in breeding programmes (Engels and Visser 2003). The establishment of large, crop-gene pool specific germplasm collections significantly assisted in this. These collections were based on donations from existing breeding collections and on targeted collecting efforts. One of the most significant biological consequences of this progress in agriculture was the steady replacement of locally adapted, diverse traditional landraces grown by farmers over long periods of time. This situation led to a more systematic, globally coordinated approach to collecting threatened germplasm and to the development of concepts for effective, long-term conservation of useful plant genetic resources. These concepts were based on monitoring storage and viability of seeds in gene banks, predominantly cereal grains, on the assumption that plant breeders and other researchers frequently use the germplasm and that strong linkage between conservation and utilization efforts would be developed (Engels and Visser 2003).

Conservation activities have increased manifold over the past two decades. These have encompassed not only threatened crops and their wild relatives in gene banks but also increasing attention has been paid to conservation and management of genetic resources in their natural or traditional environments. The role of humans has been recognized as integral to such conservation efforts. The result has been greater participation of stakeholder groups in planning and implementation of conservation and use of plant germplasm. Moreover, improved seed storage techniques have been developed over recent decades, including *in vitro* methods and cryopreservation. In addition, many new gene banks have been established since the 1960s.

Developments in molecular genetics over the past ten years have had a dramatic impact on plant breeding. These developments are also set to revolutionize genetic resource conservation. The future impact of genomics and bioinformatics can be expected to have an even greater effect. In addition to these technological developments, the political arena has also undergone significant changes, especially since the early nineties when the Convention on Biological Diversity ("CBD" UNEP 1992), was concluded. During this period the notion of ownership and access to biodiversity completely changed as a result of two developments. The first was a shift from a common heritage principle to one of national sovereignty over genetic resources, which resulted in emphasis on bilateral exchange. The second development was based on changing concepts of property rights. Increasing application of patents to protect innovations (including identification of genes and the production of new crop varieties) has had profound effects on willingness to share genetic resources freely (Engels and Visser 2003).

These developments had little immediate impact on the concepts and strategies characterizing gene bank operations. There was however increasing pressure on gene banks to improve cost efficiency and be more effective. Reduced budgets and paucity of adequately trained staff led to a thorough revision of the predominating gene bank management approaches. This entailed a revision of concepts and recognition of opportunities for increasing cooperation at regional and international levels.

Ex situ germplasm collections have increased enormously in number and size over the last three to four decades as a result of global efforts to conserve plant genetic resources for food and agriculture (PGRFA). These collections are maintained under widely differing conditions, depending on national and international policy frameworks, institutional environments, available expertise, facilities and budgets, and on the extent of national and international collaboration. In addition, the various types of germplasm that constitute these collections require different management regimes. The importance of maintaining the highest standards in management of collections cannot be over emphasized given the sheer numbers of accessions contained in the global *ex situ* collections. In 1996 these totaled about 6 million (FAO, 1998). The conservation and utilization of plant genetic resources (PGR) is in continuous evolution. Early in the twentieth century the emergence of science-based plant breeding resulted in large collections of germplasm being made. This genetic diversity was readily at hand to be used in plant breeding programmes. Substantial germplasm collections were created, including those of the Vavilov Institute in St Petersburg (VIR) and the Institute of Plant Genetics and Crop Plant Research (IPK) in Gatersleben, as well as those of the Consultative Group on International Agricultural Research (CGIAR). In the 1950s and 1960s genetic erosion was identified as a growing threat to the genetic diversity in food crops and their wild relatives (FAO, 1996, 1998). This threat, which also led to the creation of the International Board for Plant Genetic Resources (IBPGR), represented an important reason to collect plant genetic resources. It resulted in initiatives for systematic conservation of plant germplasm to ensure adequate and representative diversity for future use. Some of these collections are currently used in plant breeding, but others have become conservation collections for which there are at best only weak linkages with crop improvement programmes.

1. Gene bank management procedures

Routine gene bank operations usually start from germplasm collection, conservation, and the distribution of samples (Engels and Visser 2003). Here, we discuss the most known methods for collecting and conservation strategies of plant genetic resources

1.1 Collecting strategies

Sampling strategy is determined by the precise mandate of the gene bank and the objectives of the collecting mission, i.e. gap filling, targeted collection of specific genotypes, or reducing loss of genetic diversity from genetic erosion. A comprehensive technical guide on collecting plant genetic resources providing many practical and managerial suggestions was published by Guarino *et al* (1995).

For several crops, well-established protocols, procedures and equipment for the collecting and transport of the material exist that can be adapted to other species. These include collecting budwood described for cocoa (Yidana 1988), extraction of zygotic embryos described for coconut (Assy Bah *et al* 1989), use of stem nodal cuttings for cotton and related species (Altman *et al* 1990), and use of herbaceous plantlets as explants described for some forage grasses (Ruredzo 1989). Collecting DNA-rich material such as leaves and root nodules can be done with little additional effort when specimens are collected for herbaria or gene banks. The material should be stored with a desiccant or immersed in a stabilizing buffer immediately after collecting to ensure successful subsequent DNA extraction. As such, this represents a simple long-term storage method (Adams 1997). However, it should be realized that DNA will only form a source for the introduction of individual germplasm collection management traits though application of methods in biotechnology. In addition, unlike seed, DNA is non-regenerable and stocks will be exhausted sooner or later. This means that storing DNA can never replace storage of living materials, whether as seed, *in vitro* tissue or cryopreserved material.

1.2.Conservation methods

It is now widely accepted that conservation can be done on-site (*in situ*) and off-site (*ex situ*). In this section these and other conservation approaches and methods will be briefly described.

1.2.1. *In situ* conservation

The CBD (UNEP 1992), covering both wild and domesticated species, uses a complex definition for *in situ* conservation: "the conservation of ecosystems and natural habitats and the maintenance and recovery of viable populations of species in their natural surroundings and, in the case of domesticates or cultivated species, in the surroundings where they have developed their distinctive properties." There may be substantial differences in approach for the conservation of wild species and domesticates. For example, for wild species conservation, the introgression of alien genes into populations of the target species would be avoided. In contrast, for crops, it has been argued that introgression of genes from wild species into crop populations is an evolutionary event and one advantage of *in situ* conservation and thus should be allowed to occur (Altieri and Merrick 1987).

With the conclusion of the CBD and Agenda 21 in 1992, and with the adoption of the GPA by the participating countries in the Fourth International Technical Conference on Plant Genetic Resources (FAO 1996), a significant impetus has been given to *in situ* conservation. In recent years on-farm conservation activities have become closely linked with development work, including the farmer empowerment (Jarvis and Hodgkin 2000).

Protected areas: Protected areas are widely regarded as instrumental for *in situ* conservation of wild relatives. Wild relatives of crops and domestic animals may occur beyond the influence of farming, in natural and semi-natural ecosystems and their conservation may well fit into the existing system of nature reserves. Currently the conservation of agrobiodiversity in protected areas is largely unplanned and this component of biodiversity is usually not specifically addressed. A feature of this form of conservation is that evolutionary processes continue to operate and that entire populations can undergo changes, and can become extinct. A disadvantage of protected area conservation is that the conserved material is not readily available for agricultural use. Also, with limited opportunity for management, little characterization and evaluation can be done on the germplasm, restricting its use as a genetic resource (Maxted, *et al* 1997b).

Conservation on-farm: Farmers worldwide have been practicing on farm conservation for as long as agriculture has existed, as a necessary part of crop production. For them, the most effective management practices have been those that combined highest yields with the greatest food security. Usually, these practices are based on within- and among-species diversity, surviving in areas that are not served by modern high-input agriculture. In addition to crops, wild and weedy species occur that are associated with farming. Suggestions have been made for intervention to boost the effectiveness of this age-old process. Jarvis *et al* (2000) provided detailed suggestions and procedures for the management of these resources on-farm in the framework of traditional farming systems, that allow for continued maintenance and evolution of traditional landraces and wild and weedy species that depend on traditional agricultural practices for their survival.

Potential advantages and disadvantages of conservation on-farm will need to be weighed for suitability for application to conservation, as well as for impact on farm livelihoods.

Home gardens: Home gardens are a reservoir of diversity for fruits, vegetables, ornamental plants and small domestic livestock. Proximity to the home allows detailed selection, for example, of colour variants of most plants and animals, as well as generation of the vast morphological variation that exists in many domesticated species. Several authors (Maxted *et al* 1997a, Damania 1996, and Engels 1995) list the conservation of plant genetic diversity in home gardens separately. As for on-farm conservation, the method is dynamic. A community of gardens may need to be included, as the intraspecific diversity within an individual garden is often limited, whereas the variation among gardens is often substantial (Engels, 2002b).

1.2.2. *Ex situ* conservation

Seed storage: Storing genetic diversity as seed is the best researched, most widely used and most convenient method of *ex situ* conservation. Much is known about the optimum treatment of the seed of most of the major food crops. For an early review, see Harrington (1970). Requirements for orthodox seeds include adequate drying, i.e. seed moisture contents as low as 3% for oily seeds and 5% or more for starchy seeds, appropriate storage temperature (-18°C is recommended for long-term storage), and careful production of quality seed to ensure the greatest longevity (Rao and Jackson 1996). Recent research shows that very low moisture contents could be sub-optimal and care is needed.

However, the seeds of many crop species, especially tropical shrubs and trees, will lose viability if dried (so-called 'recalcitrant' seeds). Seeds of some species can be dried to some extent but cannot survive low-temperature storage and are intermediate in storage characteristics. This category includes coffee, citrus species, rubber and others. In addition, seeds of wild relatives do not always behave similarly to the seed of domesticates, and optimal storage conditions have to be individually determined.

An IPGRI (International Plant Genetic Resource Institute) protocol to determine the precise seed storage characteristics of little researched species (Hong and Ellis 1996) and a compendium of available data on storage behaviour of approximately 7000 species, including references to individual species, is available (Hong and Ellis 1996, Engels *et al* 2001).

Most national gene banks now rely on cold storage facilities for seed maintenance. However, these depend on a reliable electricity supply, which can represent a problem in some countries. To overcome this problem, alternative approaches to low temperature storage have been developed, including the so-called 'ultra-dry seed' technology. Drying seeds to a moisture content as low as 1% (in the case of oily seeds) or approximately 3% (starchy seeds) and hermetic packaging allows storage for long periods at room temperature. Care must be taken to prevent over-drying of the seeds (Walters and Engels 1998).

Some gene banks have also experimented with storing seeds in liquid nitrogen. Besides the already mentioned danger of over drying the (orthodox) seeds, seed size is important for economic cryopreservation. Furthermore, it has been agreed that this approach might have advantages under circumstances where electricity supply is unreliable.

Pollen storage: The technique for pollen storage is comparable with that for seed storage, since pollen can be dried (less than 5% moisture content on a dry weight basis) and stored below 0°C. There is limited experience on the survival and fertilizing capacity of cryopreserved pollen more than five years old (Towill, 1985). Hoekstra (1995) using information on more than 1500 plant species failed to determine a clear correlation between the storability of pollen and of seed of the same species. Pollen might represent an interesting alternative for the long-term conservation of problematic species (IPGRI 1996). However, pollen has a relatively short life compared with seeds (although this varies significantly among species), and viability testing can be time-consuming and uneconomical. Pollen has, therefore, been used to a limited extent in germplasm conservation (Hoekstra 1995). Other disadvantages of pollen storage are the small amount produced by many species, the lack of transmission of organelle genomes via pollen, the loss of sex-linked genes in dioecious species, and the general inability to regenerate into plants (Hoekstra 1995). An advantage is that pests and diseases are rarely transferred by pollen (excepting some virus diseases). This allows safe movement and exchange of germplasm as pollen.

Field gene banks: Field banks are used for the conservation of clonal crops, where seed is recalcitrant, and for crops that rarely produce seed. The rule of thumb is to use the same propagation techniques as the farmer, for example not disrupting adapted clones through genetic segregation in a seed cycle. Many temperate and tropical fruit trees fulfill one or more of these conditions, as do many commodity crops such as cocoa, rubber, oil palm, coffee, banana and coconut as well as most root and tuber crops. An example of the scale of management of field gene banks is that oil palm genetic resources in Malaysia are planted at a density of 140 palms per hectare, and the collection from Nigeria alone occupies 200 ha. Since oil palm seed cannot be stored for more than two years, and pollen only for three years, a living collection, although expensive, is currently the only practicable conservation method. Similarly, the coffee gene bank in Jima, Ethiopia contains over 1600 accessions of coffee trees from the centre of diversity of the crop.

Management may be the same as used during routine farming, and cultivation methods can be adapted to local circumstances. Conserved material can be readily characterized and evaluated and then accessed for research and use. Some natural selection may take place within and between accessions, but management is designed to prevent it. Major constraints faced by field gene banks include costs and all the natural hazards of farming, including pests and diseases, drought, flood, cyclones etc. (Engelmann and Engels 2002).

***In vitro* conservation**: When a conservation method is susceptible to unavoidable hazards, as with field gene banks, an alternative, complementary method should also be used. *In vitro* conservation involves maintenance of explants in a sterile, pathogen-free environment and is widely used for the conservation and multiplication of species that produce recalcitrant seeds, or do not produce seeds (Engelmann 1997). Although research on *in vitro* techniques only started some 20 years ago the technique has been applied for multiplication, storage and, more recently, for collecting germplasm of more than 1000 species (Ashmore 1997).

Various *in vitro* conservation methods are used. For short- and medium-term storage the aim is to increase the intervals between subcultures by reducing growth. This is achieved by modifying the environmental conditions, including the culture medium, to realize so-called slow-growth conservation. The most widely applied technique is temperature reduction (varying from 0–5°C for cold tolerant species to 9–18°C for tropical species) that can be combined with a decrease in light intensity or storage in the dark (Engelmann 1997) and adjustment of the growth medium. Alternatives to standard slow-growth conservation include modification of the gaseous environment of cultures, desiccation and encapsulation of explants. The latter is termed synthetic seed where the idea is to use somatic embryos as true seeds. Embryos encapsulated in alginate gel can be stored after partial dehydration and sown directly in vivo (Janick *et al* 1993).

For small volumes, long-term storage is practicable through storage of cultures in cryopreservation at ultra-low temperature, usually by using liquid nitrogen (-196°C). At this temperature all cellular divisions and metabolic processes are virtually halted and, consequently, plant material can be stored without alteration or modification theoretically indefinitely (Engelmann 1997).

Botanical gardens and arboreta: Botanical gardens have played a historical role in the exchange and introduction of crop genetic resources. Usually botanical garden collections consist only of one or a few individuals per species (FAO, 1998), although in recent years there has been a tendency towards the establishment of conservation units, including seed banks (Laliberté 1997). Unfortunately, most botanical gardens have limited interest or expertise in crop genetic resources, although efforts are being made to change this (Heywood 1998).

DNA storage: This more recently developed technique is increasing in importance. DNA from the nuclei, mitochondria and chloroplasts is now routinely extracted and stored. For the purpose of analysis, DNA is often immobilized on nitrocellulose sheets where it can be probed, including with cloned genes. With the development of PCR specific oligonucleotides and genes can now be routinely amplified. DNA cloning technology has further facilitated efficient use of DNA sequences. These advances have led to the formation of an international network of DNA repositories for genomic DNA (Adams, 1997). The advantage of storing DNA is that it is efficient and simple and overcomes many physical limitations and constraints that characterize other forms of storage. The disadvantage lies in problems with subsequent gene isolation, cloning and transfer, but, most importantly, it does not allow the regeneration of live organisms (Maxted *et al* 1997a).

2. Complementarily of conservation strategies

Farming itself is the original method of conservation, linked directly with utilization. But farming is changing, rendering conservation of diversity at the farm superfluous given development of specialized crop breeding. Most farmers cannot afford and would not wish to be curators of living museums of agrobiodiversity (as suggested by Wilkes 1971). Fortunately, the wide spectrum of conservation methods can meet a wide range of conditions. With the range of genetic diversity included in conservation, security and accessibility can be balanced against feasibility and cost-efficiency. The choice of a single method of conservation will often not be enough: different and complementary methods of conservation have advantages and disadvantages. In making choices it is important to take a holistic view of the intended conservation effort and to place it in a wider context of current and potential future user groups, whenever applicable. It is also important to examine carefully the technical and human resources available as well as the administrative and political environment in which the conservation will be done in order to minimize problems (Engels 2002a).

In choosing alternative or complementary methods of conservation, the most obvious contrast is between *in situ* and *ex situ* approaches. The dynamic processes of *in situ* conservation could be combined with the usually more secure approach of *ex situ* conservation, and improve accessibility to the germplasm. As a result of disease pressure and natural selection, continuous adaptation is likely to occur, possibly enhancing the value of on farm populations as a source of variability for breeding for disease resistance. This potential for exploiting the evolutionary process during on-farm conservation was noted by Allard (1990) for disease resistance (of the barley-scald pathosystem). However, the rate of this adaptation is unknown, and methods of sampling or evaluation in the field have not yet been thoroughly developed to monitor this process (Maxted *et al* 1997a).

Many minor but locally important crops have been neglected by collectors and *ex situ* gene banks. For these crops and their wild relatives, *in situ* (including on-farm) conservation is appropriate. Notwithstanding the advantages of continuing evolution on farm, and the substantial diversity of material that can be conserved, there will be limited access to those resources, a lack of adequate characterization and evaluation, and the danger that farmers abandon the cultivation of traditional landraces under economic pressures. Careful monitoring will always be needed. Conservation through use *in situ* might run the risk of losing specific alleles or genotypes as a result of continuous adaptation and a backup system through *ex situ* conservation will be required. This was emphasized by Hammer *et al.* (1996) who found that 96.8% of the samples collected in Albania in 1941 were still intact in the Gatersleben gene bank in Germany, whereas a survey 50 years later in the same region in Albania showed genetic erosion of about 50%. The authors concluded that this "is an amazing result as the material had to survive the Second World War and two translocations".

The choice between conservation methods may be dictated by the biology of the species. For instance, if the cultivated species does not produce seeds (as for bananas) the choice includes on-farm conservation, maintenance in field gene banks, *in vitro* slow growth and cryopreservation (Sharrock and Engels 1997). Cassava and potato represent examples of extensively studied gene pools used to develop *in vitro* techniques, for which a broad range of conservation options are now available.

State of the Art in Egypt

Egypt is one of the earliest civilizations known to have adopted some form of nature conservation. Ancient Egyptians made rules concerning the use of wilderness areas, hunting and the treatment of wild animals. Those, considered sacred were protected. Recently, a unique combination of geographical, social, economic and ecological conditions have prompted governmental departments and non-governmental organizations (NGOs) in Egypt to take steps towards the conservation and sustainable use of natural resources long before the signing and ratification of the Convention on Biological Diversity (CBD) in 1992 and 1994, respectively. In 1979 the Ministry of Agriculture established the Egyptian Wildlife Service as the first national institution concerned with the formulation and implementation of policies pertaining to the protection of wildlife. In 1982, it was replaced with the Egyptian Environmental Affairs Agency (EEAA), which has recently become part of the Ministry of State for Environmental Affairs. As from 1994 the EEAA became the national institution concerned with the issues of conservation of biodiversity and the national obligation under the convention on biodiversity. EEAA established a National Biodiversity Unit (NBU) that set: (1) a national study (inventory) of the Egyptian Biodiversity, (2) a national biodiversity data bank (to be linked with a national biodiversity data network), (3) a national strategy for biodiversity conservation and a national plan of action. However, Egyptian activities in conservation of plant genetic resources can be summarized as fellow:

I. *In-Situ* conservation

A. Governmental Action

Long before the 13 provisions of article 8 of the CBD became effective in 1994, and in recognition of the significance of biodiversity conservation, Egypt has been active in the *in situ* conservation of wildlife, natural resources and natural habitats. This is clearly manifested in the declaration of 18 protected areas by Prime Ministerial Decrees since 1983 when Law 102 was promulgated by the People's Assembly. Now, The 24 protectorates are declared so far covering about 8% of the total area of the country. An extensive project is currently underway to discover additional environmental "hot spots", and it is intended to increase the nature reserves to cover 15% of the total area of Egypt by 2017 (Ibrahim 1995). They cover the following three main environmental categories: a. Wetland protectorates (the wetlands represent an environmental rarity in Egypt, since 96% of the area is an arid or semi-arid desert. Under such circumstances they are especially significant for all forms of life. This category includes a representative selection of 10 Egyptian wetlands). b. Desert protectorates (they include 5 protectorates), and c. Geological protectorates (only 3 protectorates of this category have been designated, Ibrahim 1995).

B. Non-Governmental Organizations (NGOs)

The Egyptian Government encourages and supports the establishment of various non-governmental organizations (NGOs) especially those working in the fields of the environment. This explains the relatively large number of such NGOs as can be found in the Directory of NGOs in the field of environment. Some of these NGOs are more active than others, but collectively they play an indispensable role in the *in situ* conservation of biodiversity and public awareness. The following is only a sample of the more prominent NGOs in Egypt: Tree Lovers Society, Cairo, The Civil Society for Environmental Protection ("Friends of the Environment Society"), Giza, The National Society for Environmental Protection, Qaliubia, The Central Society for Environmental Protection, Cairo, "Friends of the Environment" Society in Alexandria, The Society for the Protection of Nature, Cairo, The Society for the Protection of the Environment in Assiut, The Egyptian Society for Genetics, Giza, The Egyptian Botanical Society, Giza, The Egyptian Society of Plant Breeding, Giza, The Egyptian Society for Entomology, Cairo, The Egyptian Society for Zoology, Giza (National Biodiversity Unit 1997).

C. Farmers

The Egyptian farmers (Fallah) had very deep and rich experiences with biodiversity conservation since ancient Egyptian. Farmers in many isolated or semi-isolated villages on the eastern bank all along the river Nile in Upper Egypt as well as at some oases in the Egyptian deserts have many local varieties and landraces with very wide range of biodiversity, which represent a mine for useful gene pool.

II. *Ex-Situ* Conservation

With the generous help of UNEP an institutional survey of major referral collections of plants, animals and micro-organisms has been carried out by the National Biodiversity Unit (NBU) and resulted in the compilation of a comprehensive list of zoos, botanic gardens, herbaria, museums, mycological and entomological collections, and seed banks together with their facilities and unmet needs. These collections are spread across the country in universities, research centres and NGO's (National Biodiversity Unit 1997). They vary considerably in size, coverage and scientific and cultural significance. Here follows a list of some of these major collections in Egypt:

1. The **Botanic Gardens** at Orman (Giza), Qobba Palace (Cairo), Antoniadis (Alexandria), and the Botanic Island (in the River Nile, Aswan) together with the relatively small but highly significant collections of cultivators of date palm (at Senaniya near Damietta, Sohag, and N. Sinai), olive (in N. Sinai and along the shores of the Nile Delta), citrus (at Zagazig), and rice (at Kafr El- Sheikh).

2. The 6 comprehensive **entomological** collections housed at: (i) The Department of Entomology, Faculty of Science, Cairo University, (ii) The Department of Entomology, Faculty of Science, Ain Shams University, (iii) The Department of Plant Protection, Faculty of Agriculture, Al-Azhar University (better known as the Alveri collection), (iv) The Egyptian Entomological Society, (v) Institute of Plant Protection, Ministry of Agriculture, and (vi) The Agricultural Museum, Ministry of Agriculture.

3. The largest two **herbaria** in Egypt kept at the Botany Department, Faculty of Science, Cairo University (CAI) and the Agricultural Museum, Ministry of Agriculture (CAIM).

4. **Microbial** Genetic Resources. Culture collections are available at various institutions in Egypt. A Microbiological Resources Center (MIRCEN) was established in 1977 in Cairo with support from UNEP as one of the Microbiological Resources Centers network established under the auspices of UNESCO/ UNEP / ICRO, to serve various aspects of Applied and Environmental Microbiology in the Arab Region and North Africa.

III. New strategy for *ex-situ* conservation in Egypt

a. *Ex-Situ* conservation of plant genetic resources in Egypt (The Gene bank of Egypt).

In the past a number of institutions and individuals collected plant germplasm all over the country according to their need and in the absence of a national programme. Recently, a national programme for *Ex-Situ* conservation in Egypt has been developed. A new National Plant Genetic Resources Unit (The Gene bank of Egypt) is being established (National Biodiversity Unit 1997).

This National Gene Bank (NGB) "located in Agriculture Research Center, Giza" has been officially opened at October 2004 by the Minister of Agricultural and Land Reclamation. The large modern and well-equipped stores facilities provided best requirements for specimens storage. NGB will store a collection of samples from plants, livestock and agriculturally important microorganisms. This bank will be able to house 200,000 specimens and has already registered 12,000 samples from horticultural and field crops. The NGB will identify genetic resources — such as plant genes for tolerance to drought or salinity — that will be made available to public or private research programmes under a scheme that the NGB is drawing up. The gene bank will promote national and international cooperation on research into genetic resources by facilitating the exchange of specimens between scientists in different countries and institutions. Moreover, the NGB will also seek to protect intellectual property rights relating to Egyptian genetic resources (Prof. Mohamed Khalifa, NGB director, Personal communication).

There is a Plant Genetic Resources Section in the Field Crop Research Institute, Agricultural Research Center, Ministry of Agriculture and Land Reclamation. A total number of about 10,000 germplasm accessions are stored in 3 cold stores (63 m^3 cold store running at + 5°C, 79 m^3 cold store running at - 5°C and 124 m^3 cold store running at- 20°C). These conservation facilities are old and in poor working conditions. A Plant Genetic Resources Station, under the Desert Research Center, has been established in El Sheikh Zuwayed at the Northern Coast. Field collections of fruit species are maintained at this station (18 acres). Two cold stores [one running at -20°C and the other 50m^3- running at -4°C] and one seed drying unit were established since April 1998.

b. Using novel molecular marker techniques in biodiversity identification

At The International Conference of Genetic Engineering & its Applications, 8-11 April 2004, Sharm El-Sheikh, Egypt, many oral and poster presentations showed promising results for using modern molecular marker techniques (e.g. RFLP, AFLP. RAPD, ISSR) for identification of genetic resources of microorganisms, animals and plants in Egypt.

c. GPRI-Egypt:

The Genetic Resources Policy Initiative **(GRPI)** is a four-year project that aims to strengthen the capacity of developing countries to design comprehensive frameworks for genetic resources policy. Work is taking place with six pathfinder countries (Egypt, Ethiopia, Nepal, Peru, Vietnam and Zambia) and three sub-regions (Andean Community, West and Central Africa, and East Africa). The project anticipates expanding these partnerships during its lifetime. Activities are being conducted with financial support and technical guidance of The Netherlands Ministry of Foreign Affairs, BMZ/GTZ, IDRC, Rockefeller Foundation, CIDA and IPGRI. Administration is overseen jointly by IDRC (Canada) and IPGRI. The GRPI Global Coordination Office (GGCO) is located in IPGRI-SSA (Sub-Saharan Africa) in Nairobi, Kenya (http://www.grpi.org/).

Respect of **GPRI-Egypt,** A first "scoping" mission to Egypt took place in October, 2003. The Agricultural Research Center (ARC) and the Desert Research Center (DRC) jointly hosted the visit, the program consisted of individual interviews and group discussions with different stakeholders in Cairo, Giza, Nasr City, Moushtohor and Sheikh Zuweid (gene bank in North Sinai). In addition, presentations at different institutions, especially universities, targeted an audience of approximately 100 persons to raise awareness about GRPI was conducted (Estrella *et al.* 2003).

As a follow-up to this mission, two meetings of the preliminary task force were organized in Cairo in December 2003, to study the composition of this working group and the components of a work plan. The institutions that attended these meetings agreed that DRC would host the project with chairmanship provided by ARC.

GPRI-Egypt (http://www.grpi.org/egypt.php) was officially launched during the third meeting of the task force in Cairo, May 2004. The meeting concentrated on discussions of the immediate steps to be taken to implement the work plan. Organizing an awareness-raising workshop (held in

September 2004, one of us K. Z. Ahmed was one of the participants of this workshop) and implementing a policy survey with a combination of focus discussion groups, interviews and the commissioning of background/position papers were identified as priorities by the task force.

The task force has established three internal sub-groups ("mission sub-groups") to manage the activities indicated in the work plan. Each sub-group is preparing terms of reference for assignments in their field, as well as descriptions of the expected outputs from professionals to be integrated into GRPI-Egypt activities. The fourth and fifth meetings of the task force (Cairo, June and October 2004) analysed a list of representatives to be interviewed and a series of focus discussion groups to be organized. Survey sheets have been prepared with inputs from the task force members and the GGCO. A first focus discussion was organised in Nubaria (North West Desert Area) on November 4, 2004.

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بنوك الجينات و دراسة الحالة فى مصر

قاسم زكى أحمد و حسن زكى علام

مركز الهندسة الوراثية و التكنولوجيا الحيوية، كلية الزراعة، جامعة المنيا، المنيا

شهد العالم فى السنوات الأخيرة إهتماما متزايدا و ترحيبا كبيرا و وعيا مضطردا بالدور الحيوى الهام الذى يمكن أن تلعبه الموارد الوراثية فى مجالى الغذاء و الزراعة لتأمين الغذاء و مكافحة الفقر و التنمية المستدامة للبيئة. و أثمر هذا الإهتمام العالمى بمجهودات عظيمة للمحافظة على تلك الموارد و حسن إستغلالها على المستويين القومى و العالمى، و خاصة بإنشاء بنوك الجينات لتعظيم الإستفادة من تلك المجموعات من خلال الإنتخاب و برامج التربية، مما يساهم فى زيادة دخول المزارعين و الإنتاج الزراعى ليقابل الحاجة الملحة لتأمين الغذاء و التغذية، و حماية الموارد الطبيعية التى تعد أساس نظام الإنتاج الزراعى.

العمليات الروتينية ببنوك الجينات عادة تشمل جمع العينات الوراثية و معالجتها و إدارتها و تداولها (كإجراء الأبحاث عليها) و تخزينها، و تجديدها، وعمليات التقييم والتوثيق والنشر و التوزيع على المستعملين. للمحافظة على الموارد الوراثية عادة تتم إما فى نفس البيئة الطبيعية التى يعيش فيها الكائن الحى (*in situ*)، أو خارجها (*ex situ*). للمحافظة فى نفس الموقع (*in situ*) تتم غالبا للأنواع البرية و المنزرعة فى المحميات الطبيعية و فى المزرعة و فى الحدائق المنزلية. أما المحافظة على المصادر الوراثية خارج بيئتها الطبيعية (*ex situ*) يتركز أساسا لحفظ الأنواع المنزرعة و ذلك بحفظها كبذور، كحبوب لقاح، كخلايا و كأنسجة، أو كمادة وراثية (DNA) أو فى صورة نباتات كاملة فى حقول متخصصة أو فى الحدائق النباتية.

مصر إحدى الأمم السباقة فى حفظ التنوع الحيوى و حماية الطبيعة. حاليا بها نشاط واضح سواء فى القطاع الحكومى أو المنظمات غير الحكومية و كذا الفلاحون في الحماية للمصادر الوراثية سواء في مواقعها الأصلية كالمحميات الطبيعة، و أيضا فى العديد من الحدائق النباتية، والمعشبيات و بنوك الجينات الحافظة للبذور. و فى العام الماضى ٢٠٠٤م تم الإفتتاح الرسمى لبنك الجينات القومى، بمركز البحوث الزراعية بالجيزة. كذا تم البدء الرسمى لمشروع مبادرة السياسات فى مجال الموارد الوراثية ، بمساعدة دولية للقيام بحصر و تصنيف و تسجيل و حفظ و تداول الموارد الوراثية المصرية. فى هذا البحث المرجعى نتناول بالتفصيل ماهية بنوك الجينات مع بيان الموقف فى مصر حيال حفظ أصولها و مواردها الوراثية.

مجلد المؤتمر الرابع لتربية النبات-الإسماعيلية ٥ مارس ٢٠٠٥

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