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Botanic Gardens: Finding Solution for Genetic Resources Conservation and Global Environment Sustainability

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Abstract-The ex-situ methods of biodiversity conservation although a complex task to preserve a species away from its natural environment, can play a significant role to re-establish the genetic heritage in an appropriate environment. The changing global environment scenario and effort for conservation of rare and endangered species is a great challenge in front of green policymakers, and at this critical juncture botanic gardens can take an initiative in the collection of threatened plant species and reintroduce them back in their native habitats. The selection of plant species is an important and foremost step in establishing botanic gardens, as the rate of success is guided by certain criteria, including legal commitment and responsibilities, success percentage, preservation and storage, economy, degree of threat, local and regional socio-political issues and other limitations. The understanding and finding reasons that brings rarity to the plant species and application of effective scientific techniques of germplasm storage should be given focus under this conservation programme. Moreover, botanic garden as a center of education can bring awareness in the community and plays an important role in conservation of phyto-diversity.
Key words: botanic gardens, genetic resources conservation, environment sustainability

I. INTRODUCTION

Botanic gardens (BGs) are green treasure of nature and are centers of natural aesthetic beauty of taxonomic studies, general education, providing collections and management of plants in a scientific way and also helping in scientific research about plants. The Convention on Biological Diversity's provisions on access to genetic resources and benefit-sharing clearly states that botanic gardens acquire, use and exchange of plants for a range of scientific, conservation, economic and cultural purposes, which are affected by national laws and policies. The new Nagoya Protocol on access to genetic resources and benefit-sharing adds new requirements for compliance with national laws and providers' terms. Global socio-economic region and international involvement and a need for more effective communication with government authorities and within institutions along with capacity-building initiatives and practical tools, comply with new legislation, build trust and safeguard their role in conservation [1].

Worldwide about one third of all plant species is estimated to be threatened with extinction and plants are generally under-represented in conservation [2].According to the IUCN Red List of threatened plants 34,000 taxa are considered globally threatened with extinction. Currently, over 10,000 threatened species, approximately a third, are in botanic garden cultivation. The “Target 8” of *Global Strategy for Plant Conservation* (GSPC, 2011-2020), has decided to preserve at least 75% of threatened plant species in *ex situ* garden-collections, preferably in the countries of their origin, until 2020. These plants contribute to species recovery programmes and provide long-term backup collections.

Early botanic gardens established were probably built up with the object of growing plants of the neighborhood and those procured through collection or exchanged from distant lands. The aim was to bring together as many plants as possible and thus the ranking or status of the garden largely depended on the number of novelties it contained. The next stage in the evolution of botanic gardens was the study of systematic botany or taxonomy. Plants were arranged on the basis of their diagnostic characters and particular groups were grown together. Gradually these centers became places of study of the diversities and curiosities of plant kingdom. Botanic gardens thus became the centers of natural aesthetic beauty of taxonomic studies and general education.

Botanic gardens have collectively accumulated centuries of resources and expertise and can play a key role in plant conservation. BGs provide conservation for rare and endangered plants and also the center of expertise on horticulture and training thus are special target and focused places for plants. They play an important role in *ex situ* as well as in situ conservation. They maintain a wide range of species as living plants, in seed banks and tissue culture and according to an estimate there are probably over 80,000 species in cultivation in botanic gardens of the current estimate of 270,000 known plant species in the world. BGs also promote and

encourage botanical exploration in the tropics and they also helped found new gardens in the tropical regions to help cultivate newly discovered plant species. In earlier days tropical botanic gardens plays major role in the introduction, cultivation and distribution of both native and exotic crops of potential value and seedlings of valuable timber trees as well as providing guidance and advice to the local settlers on how to grow and maintain the crops and keep them free from diseases [3].

II. BOTANIC GARDENS AND BIODIVERSITY CONSERVATION

Botanic Gardens perform major functions of ecological imbalance and conservation of threatened plants and have served as main centers of conservation of plant resources from their extinction. Conservation of plant species often requires ex situ (off-site) cultivation of living collections and can better conserve the genetic diversity of the species by using the species biology to inform the collecting strategy; managing each population separately, collecting and maintaining multiple accessions and continuing the process over multiple years [4].

According to Hoban and Strand [5] the seed Collection from natural plant populations is a significant tool for conservation, ecological restoration, and assisted migration, understanding plant mating systems, and crop breeding and most of this collections rely on simple, broadly-applied techniques for minimum sample sizes, regardless of species' natural history, and are likely inadequate for obtaining sufficient genetic representation. BGs and arboreta play a vital role in the conservation of the rare and threatened relict tree species and provide an immediate insurance policy for the future species conservation and there is the need for re-evaluating the existing living ex situ collections of trees and more focused on threatened relict tree species [6]. The demographic and climatic global change will be a demand for novel plant germplasm of all kinds of ecoclimatic conditions that can face an unprecedented opportunity to regain their role as initiative centres of new germplasm, both of ornamentals as well as other economically important plants. Special emphasis should be given to broaden the plant introduction process, establishing closer cooperation with agricultural genebanks, agreement between botanic gardens and the agricultural sector on their respective responsibilities, controlling the quality and sampling of the accessions, proper evaluation of the introductions before they are disseminated, and to take full cognizance of policies to protect against the risks that new introductions might represent [7].

III. BOTANIC GARDEN AND ENVIRONMENTAL EDUCATION

Botanic gardens are ideal places of collections of reserves of biodiversity. They have the sheer diversity of plants including native, common, rare, endangered, endemic, exotic etc. thus representing the richness of the plant kingdom, their importance, morphology with their adaptations, economic, cultural and aesthetic uses and the threat and need to conserve the plants. BGs are innovative institutions that can help local people in many ways via the introduction of new plant species, creating friendly and secure environment, an improvement and beautification, preservation of rare plants, a continuous education and public awareness [8]. The beautiful scenery and rich diversity of plant species in botanical gardens attract visitors and thus serve as a base for educating people on biodiversity and their conservation. The collection of outdoor plant and landscape provide limited information and thus there is a need for a new tendency to set up visitor education centers (VECs) inside BGs [9].

The aim of environmental education is to increasing knowledge about biodiversity conservation, often based on the assumption that they may generate positive environmental attitudes [10]. Thus the botanic gardens along with governments agencies and non-governmental organizations have all been working in their various ways to promote environmental sustainability and reduce species and habitat loss [11]. The BGs are also associated with plant taxonomy, horticulture, and seed bank management and are fundamental to ecological restoration efforts, however few of the world's botanic gardens requires a reorientation of certain existing institutional strengths, such as plant-based research and knowledge transfer, widen research to include ecosystems as well as species, increase involvement in practical restoration projects and training practitioners, and serve as information hubs for data archiving and exchange [12]. Therefore botanic garden educators need to be aware of the background knowledge to understand about the environmental issues to plan, organize and implement different types of programmes for different target groups.

IV. BOTANIC GARDENS AND PLANT INVASIONS

Botanic gardens are a pathway for the introduction of invasive non-native plants and almost all of the world's worst invasive non-native plants occurred in one or more living collections (99%) and less than one-quarter of red-listed threatened species are cultivated. Although the risk posed by a single living collection is small, the probability of invasion increases with the number of

botanic gardens within a region. In South America and Asia the lack of preparedness is of particular concern as the patterns of introduction still remains a poor guide to determining future invasion risks [13]. The success of plant invasion depends on functional traits, range characteristics, residence time, phylogeny and before introduction it is to be taken into consideration that which alien plants is suitable for transition from naturalized to invasive as it help in conservation and has the potential to decrease the weed risk in the new environment [14].

Razanajatovo et al [15] observed that many animal-pollinated plant species that are introduced to non-native regions without their usual pollinators, some of these alien species managed to establish reproducing naturalized populations, which might negatively affect native plants and many naturalized alien species can readily attract native pollinators. According to phylogenetically corrected analyses the non-naturalized alien species received fewer flower visitors than both naturalized alien and native species and finally it may be conclude that successful naturalization of alien plants may be related to flower visitation. Thus there is a need of knowledge to know the factors that increases the probability of alien species becoming naturalized and subsequently invasive and the factors that distinguished invasive from noninvasive species were ornamental introduction, hermaphrodite flowers, pollination mode, being invasive elsewhere, onset of flowering season, moisture-indicator value, native range, and date of first record. The database with information on a combination of species traits and other variables is likely to produce the most accurate prediction of invasions [16].

V. RECENT DEVELOPMENTS IN EX SITU CONSERVATION STRATEGIES

Griffiths et al [17] gave special emphasis on ex situ conservation efforts such as botanical gardens, and seed banks to in situ conservation actions over the coming decades as the phylogenetic diversity of ex situ collections strengthen the capacity to respond to biodiversity loss and since 2000, the Millennium Seed Bank Partnership has banked seed from 14% of the world's plant species. The global strategy for plant conservation (GSPC) sets forth 16 targets to halt the current and continuing loss of plant diversity within a framework for actions at global, regional, national and local levels and Target 8 of the GSPC directs that at least 75 % of threatened plant species be present in *ex situ* collections by 2020. There is a need to identify and prioritize action and to analyze the gaps in *ex situ* collections and research related to biodiversity hotspots of threatened species [2]. The presence of endemic species is among the fundamental criteria for characterizing the biodiversity of a territory, and analyzing species richness, extinction level and distribution drivers is an important preliminary step to set conservation priorities and test environmental policies. The concept of adaptive management to develop strategies for the conservation of endemic floras including quantification of endemic plant diversity, assessment of the current IUCN knowledge, analyzing the spatial patterns of species distribution in relation to number of colonized habitats, preferential habitats, altitudinal range, and bedrock and assessment of Natura 2000 network to increase the overlap between endemic distributional areas and protected surface, should be given priority [18]. International agreements and policies play an increasingly prominent role in strategies to combat biodiversity loss and factors that influence the policy on institutions could improve the process of policy development and communication. The majority of gardens were aware of the Global Strategy for Plant Conservation (GSPC), older gardens in the global north, and younger global south gardens are most influenced by the GSPC. There are plans to develop a toolkit to help gardens better understand and implement the GSPC but there is need to communicate with each other and to feedback to policy formulators [19]. According to Newton [20] the efforts focusing on development of indicators for monitoring biodiversity loss, stimulated by development of the “2010 target” needs to consider Goodhart's Law, which states that once an indicator is made into a policy target, then it will lose the information content that qualifies it to play its role as an indicator, and is an significant tool for monitoring biodiversity and examine the IUCN Red List Index (RLI).

VI. BOTANIC GARDENS AND HUMAN WELL-BEINGS

Botanic gardens are a major force for the conservation and sustainable use of plant diversity worldwide, helping and managing plants in cultivation in the wild, promoting the cultivation and use of local, underutilized plants for improved nutrition and health and thus contributing to ecological and human well-being [21]. They inform people about the rational use of the earth's resources, biodiversity, and need to protect major ecosystems against climatic changes along with producing new generations of administrators and legislators who understand the environmental issues [22].

For years BGs in different countries were popular sources of fruit and ornamental trees and plays an important role in introduction of new resistant and tolerant forms of edible and ornamental plants. Botanic gardens and arboreta resources, including plant taxonomy, horticulture, and seed bank management, are fundamental to ecological restoration efforts, however few of the world's

botanic gardens are involved in the science or practice of restoration. There is a need of a reorientation of certain existing institutional strengths, such as plant-based research and knowledge transfer that would enable many more botanic gardens worldwide to provide effective science-based support to restoration efforts [12]. Botanical gardens, are the islands of serenity for the public helps in rescuing plant biodiversity, with various scope of research and gaining knowledge to people of all ages and instruction for plant science scholar, and are centers of both on-site and off-site preservation of plant species before they get vanished from their usual habitats [23]. The botanic garden plays a great role and creates a comfortable learning opportunities, processes and settings in managing environment and development and thus there is a need of garden based environmental and green developmental education program [24].

VII. PRIORITIES FOR EFFECTIVE PLANT COLLECTION AND CONSERVATION

Botanic gardens can play important roles in assisting in the development plans and programmes for the conservation of biological diversity and its sustainable use. They can provide expert advice, data, information, practical assistance and collaboration in the creation of such national plans. After their completion, botanic gardens can be amongst leading institutions involved in their implementation, and in any processes that evolve to revise and update such strategies and to monitor progress made in their implementation [25]. Some botanic gardens have started research on threatening processes and monitoring the impacts of global change, however there is an opportunity for them to have a role in linking biodiversity conservation and assessing benefits derived from ecosystem services [26]. International agreements and policies can play a significant role to combat biodiversity loss. Identifying factors determining the influence of a policy could improve the process of policy development and communication and under these conditions Global Strategy for Plant Conservation (GSPC) help gardens better understand and implement their strategies [19]. BGs collections are skewed towards horticultural robust and ornamental species and do not fully reflect priorities as defined by the Bern Convention. Recognizing the limitations of traditional botanic garden collections two core competencies, namely scientific horticulture and public display and interpretation should be utilized [27].

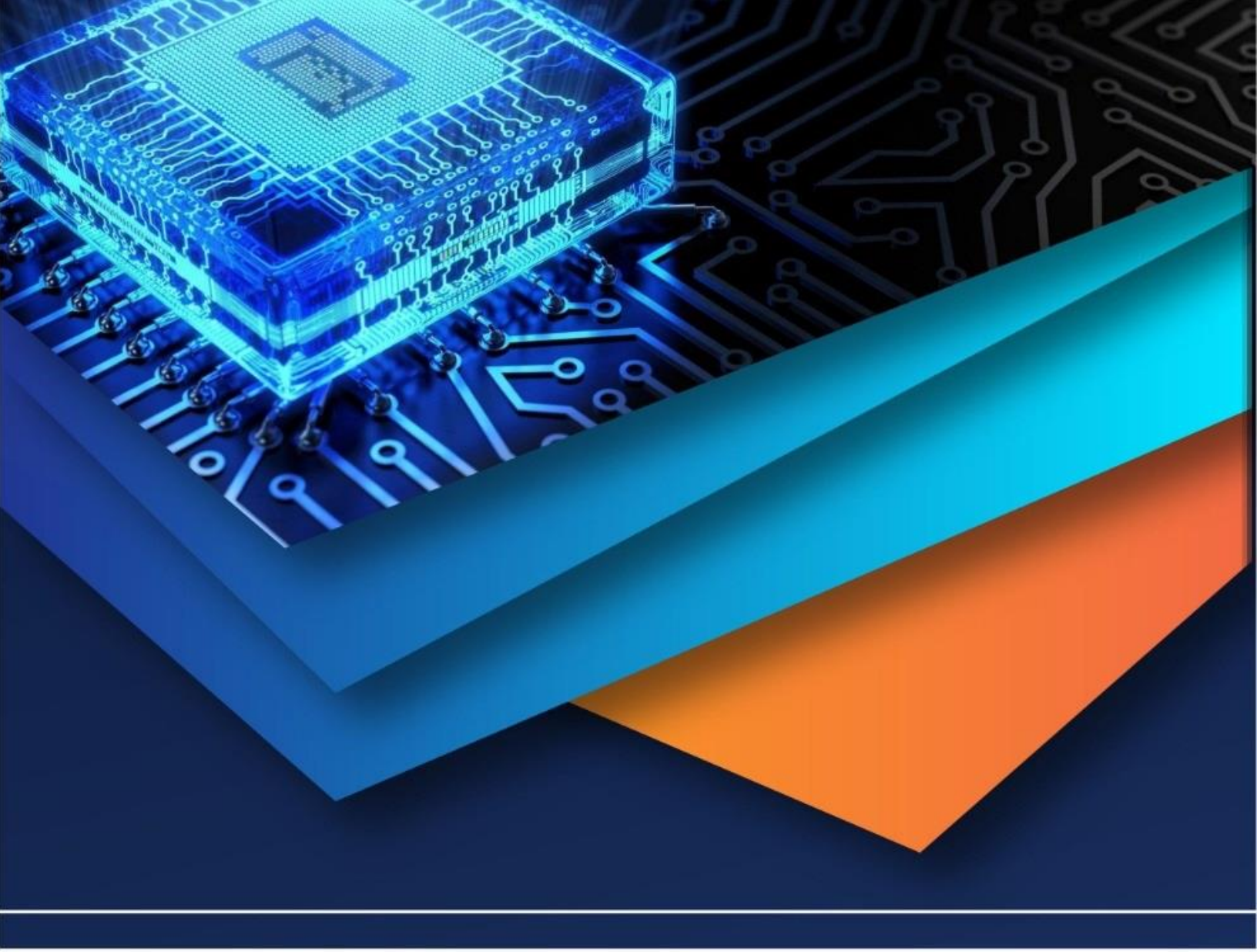
In the present scenario the aim of establishing new botanic gardens should be as botanical resource centers, supporting native plant conservation. In addition, many older existing botanic gardens are being redeveloped to take on new roles in botanical resource management. Enhancing the capacity of botanic gardens for conservation and education is a top priority in helping to ensure the maintenance of plant diversity. There has never been a better time for botanic gardens, when their importance and multiple roles are being increasingly recognized by governments and international agencies. Strengthening the global network of botanic gardens and linking it closely to others working to safeguard the biodiversity of our planet must be the most important and urgent task for botanic gardens [25].

The threats to biodiversity continue to increase and actions on the ground have remained inadequate therefore *ex situ* conservation can show leading role in biodiversity conservation. The loss of genetic resources is a matter of great concern, therefore greater emphasis was given to conservation of the plant wealth and as botanic garden is important centers close to nature and to learn about plant, they can play a vital role in environmental education and conservation.

REFERENCES

[1] Davis K., Smit M.F., Kidd M., Sharrock S., Allenstein P., “An access and benefit-sharing awareness survey for botanic gardens: Are they prepared for the Nagoya Protocol?”, South African Journal of Botany, 98:148–156, 2015.
[2] Cires E., Yannick D., Candela C., Paul G., Suzanne S., Douglas G., Sara O., Andrea K., Marie-Stéphanie S., “Gap analyses to support ex situ conservation of genetic diversity in Magnolia, a flagship group”, Biodiversity and Conservation, 22(3):567-590, 2013.
[3] Heywood V. H., “Botanic gardens and Taxonomy - their economic role”, Nelumbo, Bulletin Botanical Survey India, 25(1-4):134-147, 1983.
[4] Griffith M.P., Calonje M., Meerow A.W., Tut F., Kramer A.T., Hird A., Magellan T.M., Husby C.E., “Can a Botanic Garden Cycad Collection Capture the Genetic Diversity in a Wild Population?”, International Journal of Plant Sciences, 176(1):1-10, 2015.
[5] Hoban S., Strand A., “Ex situ seed collections will benefit from considering spatial sampling design and species’ reproductive biology”, Biological Conservation, 187:182-191, 2015.
[6] Christe C., Kozlowski G., Frey D., Fazan L., Bétrisey S., Pirintsos S., Gratzfeld J., Naciri, Y., “Do living ex situ collections capture the genetic variation of wild populations? A molecular analysis of two relict tree species, Zelkova abelica and Zelkova carpinifolia”, Biodiversity and Conservation, 23(12):2945-2959, 2014.
[7] Heywood V.H., “The role of botanic gardens as resource and introduction centres in the face of global change”, Biodiversity and Conservation, 20(2): 221-239, 2011.
[8] Kuzevanov V., Sizykh S., “Botanic Gardens Resources: Tangible and Intangible Aspects of Linking Biodiversity and Human Well-Being”, Hiroshima Peace Science, 28:113-134, 2006.

[9] He H., Chen J., "Educational and enjoyment benefits of visitor education centers at botanical gardens", Biological Conservation, 149:103–112, 2012.
[10] Williams S.J., Jones J.P.G., Gibbons J.N., Clubbe C., "Botanic gardens can positively influence visitors' environmental attitudes", Biodiversity and Conservation, 24(7):1609-1620, 2015.
[11] Blackmore S., Gibby M., Rae D., "Strengthening the scientific contribution of botanic gardens to the second phase of the Global Strategy for Plant Conservation", Botanical Journal of the Linnean Society, 166: 267–281, 2011.
[12] Hardwick K. A., Fiedler P., Lee L. C., Pavlik B., Hobbs R. J., Aronson J., Bidartondo M., Black E., Coates D., Daws M. I., Dixon K., Elliott S., Ewing K., Gann G., Gibbons D., Gratzfeld J., Hamilton M., Hardman D., Harris J., Holmes P. M., Jones M., Mabberley D., Mackenzie A., Magdalena C., Marrs R., Milliken W., Mills A., Lughadha E. N., Ramsay M., Smith P., Taylor N., Trivedi C., Way M., Whaley O., Hopper S. D., "The Role of Botanic Gardens in the Science and Practice of Ecological Restoration", Conservation Biology, 25: 265–275, 2011.
[13] Hulme P. E., "Resolving whether botanic gardens are on the road to conservation or a pathway for plant invasions", Conservation Biology, 29: 816–824, 2015.
[14] Gallagher R. V., Randall R. P., Leishman M. R., "Trait differences between naturalized and invasive plant species independent of residence time and phylogeny", Conservation Biology, 29: 360–369, 2015.
[15] Razanajatovo M., Föhr C., Fischer M., Prati D., Kleunen M.V., "Non-naturalized alien plants receive fewer flower visits than naturalized and native plants in a Swiss botanical garden", Biological Conservation, 182:109-116, 2015.
[16] Milbau A., Stout J. C., "Factors Associated with Alien Plants Transitioning from Casual, to Naturalized, to Invasive", Conservation Biology, 22:308–317, 2008.
[17] Griffiths K. E., Balding S. T., Dickie J. B., Lewis G. P., Pearce T. R., Grenyer R., "Maximizing the phylogenetic diversity of seed banks", Conservation Biology, 29:370–381, 2015.
[18] Bonanno G., "Adaptive management as a tool to improve the conservation of endemic floras: the case of Sicily, Malta and their satellite islands", Biodiversity and Conservation, 22(6):1317-1354, 2013.
[19] Williams S. J., Jones J.P.G., Clubbe C., Sharrock S., Gibbons J.N., "Why are some biodiversity policies implemented and others ignored? Lessons from the uptake of the Global Strategy for Plant Conservation by botanic gardens", Biodiversity and Conservation, 21(1):175-187, 2012.
[20] Newton A., C., "Implications of Goodhart's Law for monitoring global biodiversity loss", Conservation Letters, 4: 264–268, 2011.
[21] Sharrock S., "Botanic gardens—promoting the use of underutilized plants for improved nutrition and health", Acta Hortic (ISHS), 806:615–620, 2008.
[22] Bramwell D., "Botanical gardens and environmental education", In Julio D Rodrigo Perez (Ed.) Cultivating green awareness, Spain: Jardin Botanico Canario,15-18, 1993.
[23] Powledge F., "The Evolving Role of Botanical Gardens Hedges against extinction, showcases for botany?", BioScience, 61 (10): 743-749, 2011.
[24] Argaw T., "Opportunities of Botanical Garden in Environmental and Development Education to Support School Based Instruction in Ethiopia", Journal of Biology, Agriculture and Healthcare, 5(15):92-109, 2015.
[25] Wyse Jackson P., S., Sutherland L., A., "International Agenda for Botanic Gardens in Conservation", Botanic Gardens Conservation International, U.K., 2000.
[26] Donaldson J., S., "Botanic garden science for conservation and global change", Trends Plant Sci., 14(11):1–6, 2009.
[27] Maunder M., Higgens S., Culham A., "The effectiveness of botanic garden collections in supporting plant conservation: a European case study", Biodiversity and Conservation, 10(3):383-401, 2001.



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