

Opportunities and challenges

The dense network of health facilities under RNTCP and existing HMIS, the already in place case-management guidelines for asthma and COPD are the important assets that favour the development of PAL strategy. However, lack of political commitment, scarce resources like trained manpower and other inputs like drugs and equipment, poor smoking cessation services and weak referral and counter-referral system are the major challenges that need to be tackled during strategy development.

Conclusion

PAL provides a comprehensive package for a wide range of respiratory conditions, covering both technical and managerial aspects. A symptom-based systematic approach like PAL will help practitioners

as well as the health system to handle patients and also provide them with better care. PAL guides a clinician to interpret key signs and symptoms, diagnose and determine the degree of severity, provide adequate treatment and, if necessary, give proper referral advice. It also strengthens the health care delivery system and health resource management through better coordination and standardized procedures.

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Importance of seed banking and herbarium collections in biodiversity conservation and research: a new initiative in the United Arab Emirates

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In recent years, the demand for conservation of plant genetic resources has risen due to habitat loss and perceived climate change. It is speculated that under the current conditions of rapid climate change, a catastrophic loss of genetic diversity is likely to occur¹. Natural plant populations serve as repositories of genetic diversity. Seed collection is one of the most practical and effective ways for preservation of wild populations of native plants. It is evident that plant species are already endangered by habitat loss, and the additional threats posed by climate change make plant conservation even more challenging². Seed banking is one of the most widespread and valuable *ex situ* approaches to conserve and store seeds that could be a valuable source for habitat restoration and species conservation purposes. The seed banks have also been considered an increasingly important component of the international efforts to preserve plant biodiversity. Despite being regarded as an infertile

desert, the United Arab Emirates (UAE) hosts a unique fauna and flora that show remarkable adjustments to survive harsh environmental conditions with physiological, behavioural and morphological strategies³. Plants species found in the UAE are adapted to several environmental stresses, such as salinity and high temperature that can reach up to 50°C during summers. In the UAE, approximately 700 plant species have been recorded from diverse habitats^{4,5}. Many of the plants of the UAE that cannot tolerate the very harsh temperatures in summers, are present on the top of the high mountains. If the global warming process has already started, the temperatures would increase, even at the top of these mountains, and consequently many of these plants could become extinct. Therefore, seed banking is an important step towards safeguarding plant biodiversity in the region.

In 2009, the Sharjah Research Academy established the Sharjah Seed Bank

and Herbarium (SSBH) laboratory at the University of Sharjah, the first such formal laboratory in the history of the UAE. The SSBH laboratory aims to collect seeds and bank the entire flora of the UAE, with multiple populations sampled, as well as to build up comprehensive herbarium collections for the region. Field work to collect seeds and herbarium specimens has been underway since 2009, with a series of joint collection trips involving staff from the Royal Botanic Garden, Kew, UK. So far, more than 1000 vouchered seed collections have been made, representing more than 340 species⁶. Although total seed quantity is important, the genetic representativeness of the collection is a more important indicator of the value of a collection for recovery purposes. Keeping this in view, our seed collection strategy attempts to capture more genetic diversity of species throughout their geographic distribution. Seeds are collected using internationally accepted standards

so that the stored seed can be used effectively for conservation purposes. Once seeds have been collected, the basic sequence of events is to dry, clean and count them, and then package them for long-term frozen storage. Like the Kew seed bank, we store most of our seeds at -18°C , which can be easily achieved with standard home deep-freezers. Duplication at different locations is a safeguard against accidental loss of collections at one location. Therefore, some of our collections are duplicated for safe-keeping in the Millennium Seed Bank at Kew. To manage our collections, we have selected BRAHMS (Botanical Research and Herbarium Management System, <http://herbaria.plants.ox.ac.uk/bol/brahms/Software>), a free database program specifically for cataloguing and managing plant collections across the world. However, the development of herbarium database for our collection using BRAHMS is underway.

Herbaria are storehouses of irreplaceable knowledge and help catalogue biodiversity which makes it possible to compare specimens from different localities and therefore are considered key resources for plant classification and nomenclature. At SSBH, so far more than 1000 herbarium collections have been made from over 300 species to guide future collection efforts as well as add to the data on the flora of the UAE. Some of these plants are rare, threatened or poorly known and some are expected to be first-time records. During plant exploration trips, six species, namely *Echiochilon callianthum* (Boraginaceae), *Centaurium tenuiflorum* (Gentianaceae), *Boerhavia erecta* (Nyctaginaceae), *Limonium stocksii* (Plumbaginaceae), *Aristida mutabilis* (Poaceae) and *Chaenorhinum rubrifolium* (Scrophulariaceae) have been reported for the first time from the UAE. In addition, several collections remain unmatched with species known from the UAE and await determination, potentially representing more new records for the country. By taking the initiative to protect the national interest in plant cataloguing, mapping and conservation, we can safeguard our biodiversity before it is too late. Further, many important medicinal plants are found in the region and therefore research on medicinal plants needs more attention in the future. A complete list of medicinal plants will serve to complement past, present and future works on

traditional knowledge of medicinal plants in the UAE, which is still far from complete. Among other research priorities, there is an urgent need for comprehensive national databases on alien plant species. As plant invasions are considered as a major threat to biodiversity, herbarium records can be used more frequently for research and management of plant invasions in the UAE.

The SSBH intends to establish a plant molecular laboratory. We find it important to benefit from plant materials of all the native species that are collected in the seed bank and herbarium, where plant DNA can be used in different studies for the current and future generations. The major aims of the laboratory are to establish DNA barcoding as an identification tool for all plants of the UAE, establish a DNA bank for them and study plant genomes of native plants for identification and isolation of important genes, especially those that would help plants tolerate high salinity levels and temperature as well as drought conditions. Traditional taxonomists, who rely on fieldwork and morphological study as core aspects of their work, are few in number⁷. Consequently, DNA barcoding technique has the potential to be used for species identification; even if only small samples are available from the plant⁸. Adding the database of our proposed barcoding project to the now well-established Consortium for the Barcode of Life⁹ (CBOL, <http://barcoding.si.edu>), will help us link with larger global databases.

In the UAE, studies on seed germination requirements of species, types and levels of seed dormancy and effects of different environmental stresses on seed germination are mainly published through SSBH¹⁰⁻¹⁶. So far, these studies have reported the impact of several environmental factors such as light, temperature, salinity, storage conditions and maturation time on germination and seed dormancy of several desert plants. Besides these aspects, currently at SSBH ongoing research is focused to understand how to extend the survival periods under storage conditions, especially for recalcitrant seeds that do not survive drying and freezing during *ex situ* conservation. Research activities in this area are mainly intended to optimize the quality of the collections stored in the seed bank. Future work will study the relationships between plant traits and seed dispersal, as well as structure and dynamics of soil

seed banks for understanding how desert plants will interact and maintain biodiversity in the face of climate change.

Summarizing, in our efforts to conserve plants of the UAE, we are collecting seeds from wild plant populations and maintaining them in seed banks for research and long-term conservation purposes. So seed banking can be viewed as a conservation activity to safeguard against extinction of species in the wild. At SSBH, our banked seeds are being used to understand the biology and ecology of important species to determine the best way to germinate the seeds and to overcome the complicated dormancy mechanisms. Setting up such a seed bank and herbaria in other regions/countries will contribute in safeguarding biodiversity and strengthen the research activities in biological and conservation sciences. It will largely serve for research, conservation, restoration/rehabilitation programmes and educational purposes. Our next step in the SSBH is to build partnerships with other seed banks and herbaria in the Middle East. The target is to enhance the genetic diversity in our seed bank especially for species growing in different countries in the Middle East.

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