DRY WOODLANDS IN PAKISTAN'S PUNJAB PROVINCE

PILOTING RESTORATION OF UNIQUE YET VANISHING NATURAL ASSETS

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FINE DOCUMENTS AND POLICIES DO NOT MAKE CHANGE – PEOPLE DO.
The Pakistan National Conservation Strategy (1992)

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CONTENTS

Soan Valley, Punjab.

FOREWORD

As a nation that blends an incredible diversity in landscapes, ecosystems, plants and animals, but equally in people, cultures and customs, Pakistan combines all the vital ingredients for a prosperous and thriving state. Some of the earliest human civilisations have developed and resided here dating back several millennia. While the wealth of their vestiges represents yet another unique treasure of Pakistan, they are also testimony to the natural transience and impermanence of human society and the landscapes it shapes.

However, the speed and extent at which we have been changing our environment especially over the past hundred years, is breathtaking, and we are all too well-aware of the detrimental consequences that rapid, large-scale land conversions, overexploitation of natural resources and the introduction of exotic species have brought. But are we really? The immediacy of sustaining basic livelihood needs often leaves poverty-stricken communities with little choice or time to plump for a less invasive method of, or alternative to extracting a given natural resource – as much as they may be concerned by its dwindling magnitude or deteriorating quality. Equally, natural resource managers and even well-versed conservationists may not always be fully cognisant of the ecological and socio-economic values of certain habitats and the species they are made of.

Subtropical and tropical dry forests once covered large tracts of the land of Pakistan. Where they remain, these woodlands provide vital ecosystem services and goods including climate regulation and food – despite their relatively small diversity in woody plant species. Ironically, the latter may explain why Pakistan's dry forests have received limited attention by the scientific, botanical community and have remained for a long time without a spokesperson to highlight their values and needs for restoration and conservation. I feel therefore indebted to Profs. Amin Ulhaq Khan and Joachim Gratzfeld for offering this detailed account of an immensely commendable yet highly demanding endeavour in one of the world's hottest and driest places, driven by personal dedication and a successful institutional partnership. Aiming to bolster greater public awareness of Pakistan's dry forests and implement a pilot programme for their restoration, this collaboration between the Department of Botany, the Sustainable Development Study Centre and the Botanic Garden of Government College University, Lahore, and Botanic Gardens Conservation International (BGCI) is exemplary, not solely in terms of its thematic focus. In order to work towards its overall goal of enhancing natural regeneration of remnant dry woodlands, the firm participation of stakeholders from local communities, forest department authorities, academia and international conservation organisations, has been the main principle from the outset of this joint initiative.

In times when Pakistan sees itself incessantly confronted with challenging headlines, be it for political, religious or socio-economic reasons or a major natural hazard, it is these encouraging and innovative partnership ventures that need to be brought to the forefront of the attention of the media and the wider public. The botanic garden community especially has a fantastic pool of conservation stories, not only to tell but to build on and replicate as widely as possible. As it increasingly strives to look and act beyond its proverbial botanic garden wall to promote and integrate conservation approaches in specialised locations as well as in the wild, I would also like to congratulate the recently launched Ecological Restoration Alliance of Botanic Gardens. Coordinated by BGCI, the aim of the Alliance is to support and scale up the restoration of damaged, degraded and destroyed ecosystems around the world. Restoring the unique dry woodlands in Pakistan's Punjab province is just one example of this exceptional partnership that focuses on practical implementation, conveyed by the authors of this work so aptly by quoting a landmark in the history of Pakistan's environmental protection – the Pakistan National Conservation Strategy published in 1992: *Fine documents and policies do not make change – people do*, a basic truth but remaining relevant at all times.

Sher Alam Mahsud
Secretary Forestry, Wildlife and Fisheries Department
Government of Punjab

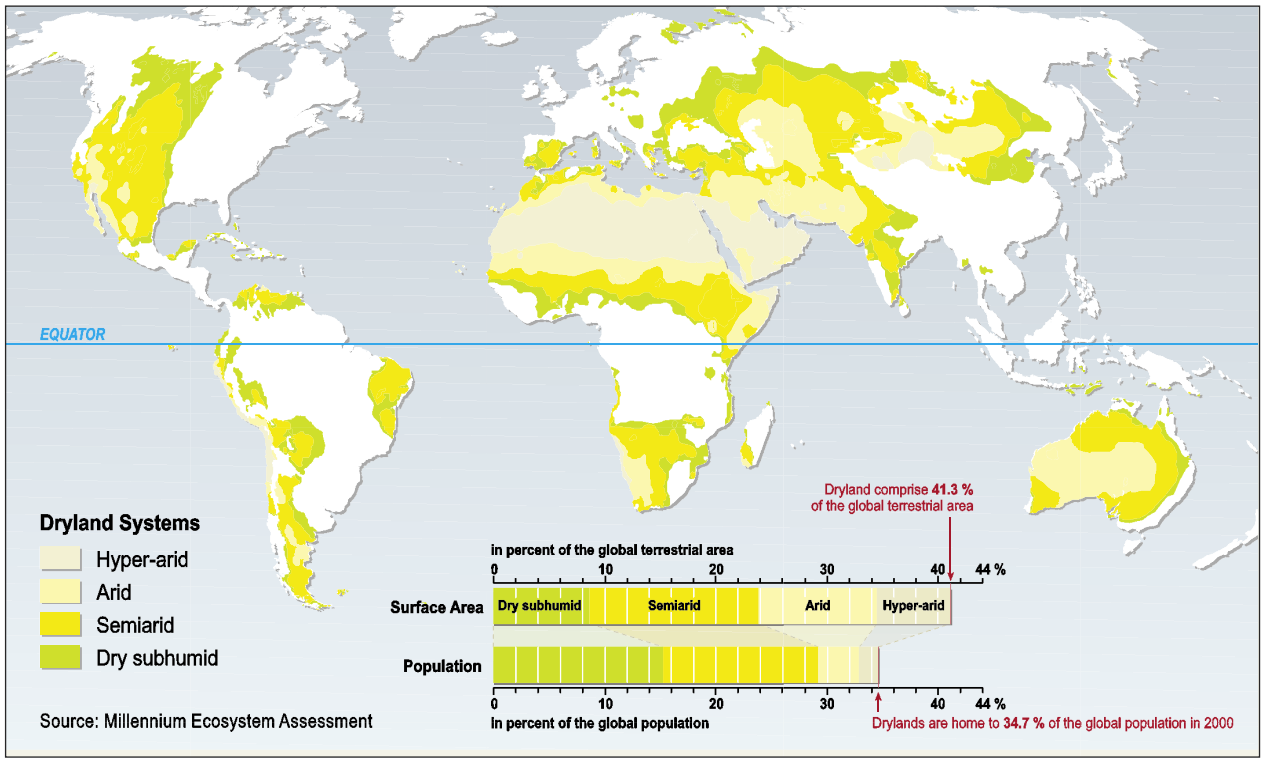
PART 1:
CONSERVING DRYLAND DIVERSITY – AN INTERNATIONAL CONCERN OF LOCAL URGENCY

1.1 DRYLANDS – A GLOBAL VIEW

Over 40 per cent of the Earth's terrestrial surface is dryland. A central feature that characterises drylands, as commonplace as it may sound, is limited soil moisture, the result of low rainfall and high evaporation. More formally, the level of aridity as expressed by the ratio of the mean annual precipitation to the mean annual potential evapotranspiration by the soil and plants in a given area – referred to as the *Aridity Index* – defines different dryland categories (UNESCO, 1979). Along a gradient of decreasing primary production and increasing aridity, these include *dry subhumid, semiarid, arid* or *hyperarid* zones, and support xerophytic wood- and scrublands, grasslands and deserts.

A unique biodiversity thrives in drylands, with plants and animals exhibiting an equally distinctive and varied adaptive capacity to extreme environmental conditions. Drylands include some 20 per cent of the major centres of global plant diversity and over 30 per cent of the designated endemic bird areas (Maestre *et al*., 2012).

Drylands are home to over a third of the human population, in spite of their extreme conditions for life. Millions of people directly rely on goods and services provided by dryland ecosystems to meet their daily livelihood needs.



Drylands of the World (Source: Millennium Ecosystem Assessment, 2005)

Reduction, or even loss in the biological and economic productivity of drylands have been triggered by rapid transformations resulting from large-scale human activities and climatic variations. To address and contribute solutions for the multiple forms of degradation of the world's drylands, the global community agreed on an international policy framework in 1992 – the United Nations Convention to Combat Desertification (UNCCD). This global treaty acts to raise awareness of dryland biodiversity and its values, and emphasises action to offset land degradation and promote sustainable development at the community level.

1.2 PAKISTAN – RICH IN DRYLANDS, SCARCE IN RESOURCES FOR CONSERVATION

1.2.1 AN UNEXPECTED WEALTH IN DRY WOODLANDS

By and large, Pakistan is a dryland country dominated by semiarid and arid climate zones. Spanning more than 1,500 km – from the peaks of over 8,600 m of K2 in the Karakorum range to the shores of the Arabian Sea – this huge spread also accounts for a progressive decrease in mean annual rainfall from the northern to the southernmost parts of the country. About 60 per cent of the total land cover receives less than 250 mm rainfall and some 25 per cent between 250-500 mm per year (Rasul *et al*., 2012).

Just five per cent of Pakistan's total land area of nearly 88 million ha is covered by natural forests (GoP, 2013). Their biodiversity, however, is remarkably varied, featuring alpine and subalpine scrub forest, temperate and subtropical coniferous and broadleaved forest, subtropical and tropical dry forest, as well as riverine and littoral forest. Most of Pakistan's forest cover is found in the northern parts of the country (Khyber Pakhtunkhwa, Northern Areas, Azad Jammu and Kashmir) with temperate coniferous and broadleaved forests representing the main share.

Dry forests form Pakistan's second most important woody vegetation type. They range from the temperate and subtropical sub-Himalayan hilly regions to the southern, tropical plains of the Indus in Punjab, Balochistan and Sindh. Generally of low plant species richness and high dominance of a particular woody taxon, these woodlands nevertheless represent a hallmark of Pakistan's biodiversity and provide a range of ecosystem goods and services. While numerous classification systems with varying nomenclature are in use to describe the country's dry forests, the main woody vegetation types at the centre of this work include:

Subtropical dry scrub forest

Tropical dry thorn forest (flood plain)

Tropical dry thorn forest (desert)

Tropical dry broadleaved forest with *Butea monosperma*

Map showing potential area of distribution of dry forest types within the colour-marked areas, based on factors related to climate, soil, water regime, etc.

Adapted from The New Oxford Atlas for Pakistan, Oxford University Press, Pakistan, 1998.

SUBTROPICAL DRY SCRUB FOREST

Occurring in Pakistan's montane areas up to 1,000 m above sea level, subtropical dry scrub forests are marked by a prolonged dry period with winter and spring precipitation in the northern, and a variable summer monsoon season in the southern parts of their geographical range. Although most of the scrub habit has been described as a sign of degradation resulting from heavy grazing, these woodlands exhibit an important botanical diversity. In Punjab province, the main woody species include *Acacia modesta, Olea ferruginea, Buxus papillosa, Maytenus royleana* and *Dodonaea viscosa*. Occasionally interspersed in these dry scrub- and woodlands, especially in more humid areas such as wadis, is *Nannorrhops ritchieana*, a unique palm tree of major socio-economic significance.

Habit of Subtropical dry scrub forest with *Acacia modesta* trees and shrub species including *Dodonaea viscosa, Buxus papillosa* and *Olea ferruginea*. Hayat-ul-Mir, district Khushab

Acacia modesta. Hayat-ul-Mir, district Khushab.
This plant is an important source of firewood. Gum collected from *A. modesta* is used as a sweetener and is said to restore vitality.

Olea ferruginea. Khura, district Khushab.
Decoctions made from branches and leaves of this wild olive are used for the treatment of toothaches and sore throats.

Dodonaea viscosa. Khabeki, district Khushab.
Generally avoided by grazing goats and other livestock, this pioneer species is frequently used in dryland restoration programmes given its fast and non-invasive growth.

Buxus papillosa. Hayat-ul-Mir, district Khushab.

Nannorrhops ritchieana. Hayat-ul-Mir, district Khushab.

A monotypic genus in the Arecaceae family, the distribution of this palm ranges from Pakistan through to Afghanistan, Iran and the Arabian Peninsula. It can either form almost pure stands on sandy or stony plains, or occur with other woody species on hills, and in or along wadis. Locally referred to as *mazri*, the leaves of this species have been used in the manufacture of a variety of household items, especially mats, baskets and cordage. Overexploitation and habitat loss have dramatically diminished *Nannorrhops ritchieana* populations across the country; surveys carried out in the 1990s recorded an annual production of raw mazri leaves of more than 37,000 tons (FAO, 1994). While synthetic materials have replaced the use of palm leaves in the production of commodities over the last few decades, natural populations are recovering only slowly and mostly renew by vegetative reproduction. Though fairly resistant to dry frost (Lackner, 2003), this charismatic plant is still largely underutilised in ornamental horticulture outside its natural range.

TROPICAL DRY THORN FOREST

Forming open woodlands with individual, conspicuous trees, to denser vegetation in areas with increased water availability, *Prosopis cineraria* and *Salvadora oleoides* are the key characteristic species of Pakistan's tropical dry thorn forest. Often found in association and establishing on a wide range of soils are *Capparis decidua*, *Ziziphus nummularia* and, in more humid zones, *Tamarix aphylla*. Towards the southernmost parts of Punjab and into Sindh, *Salvadora persica* gradually becomes more frequent than *S. oleoides* (Khan, 1994).

Prior to the development of Pakistan's extensive canal irrigation system in the eighteenth century, tropical dry thorn forest once represented the prevailing woodland type in the lower hills, sandy desert areas and flood plains of most parts of the Indus basin. Locally referred to as *rakhs* (Khan, 1994), these woodlands provided free grazing grounds, firewood, and other natural resources sought after by local communities. In Punjab province, it is estimated that these forests occupy less than two per cent of their former extent of 1,45 million ha recorded in the 1860s (Khan, 1994; 1996). Important areas with tropical desert thorn forest remain in the hyperarid regions of Thal and Cholistan (Punjab province), and Thar (Sindh province).

Habit of tropical flood plain thorn forest with *Salvadora oleoides* (centre) and *Tamarix aphylla* (right). Harappa, district Sahiwal.

Habit of tropical desert thorn forest with *Salvadora oleoides* (green) and *Prosopis cineraria*. Near Rakh Khairewala and Chaubara, district Layyah.

Prosopis cineraria. Near Rakh Khairewala and Chaubara, district Layyah.

Only a few mature specimens of *Prosopis cineraria* still thrive in the semiarid and arid zones of Punjab province. A nitrogen fixing plant, *P. cineraria* is highly valued for its soil fertility enhancing qualities. This, along with its generally mono-layered canopy structure and a very deep root system that does not compete for moisture with crops, makes the species much appreciated in dryland agroforestry. The seed pods are used as a vegetable as well as a fodder for camels, goats and sheep. The tree's wood is highly sought after in furniture manufacturing and the production of agricultural tool handles. As an important source of firewood, overexploitation has significantly contributed to the decline of natural populations.

Salvadora oleoides. Harappa, district Sahiwal.

A member of the Salvadoraceae family, this is a particularly emblematic species of the tropical thorn forest in Punjab province. By generating large amounts of organic leaf matter high in nutrient content, this plant makes a major contribution to soil formation, and therefore holds a central ecological role within the *rakh* woodlands (Khan, 1996). The species' extensive root system helps impede soil erosion, whilst the dense canopy of older trees acts as a windbreak. Offering shade and shelter, *Salvadora oleoides* populations provide a habitat and supply food for a wide range of native species of wildlife, including insects, birds, rodents and reptiles (Khan, 1991). Equally, *S. oleoides* performs significant socio-economic functions for the local communities living in drylands. The tree's edible fruit, locally referred to as *peelu*, has been a major alternative source of nutrition in periods of severe drought accompanied by crop failure (Khan, 1996). Traditionally, root- and branchlets of *S. oleoides* served as toothpicks and toothbrushes. More commonly known is toothpaste based on *Salvadora persica* extracts (Korejo *et al.*, 2010). Leaves are also used for wound healing and other medicinal purposes, while oil made from seed is a major ingredient in soap and candle making. Despite the species' various benefits, knowledge of their values has gradually been lost over time. Often branded as a refuge for vermin, these majestic trees have been indiscriminately cut and used as firewood in households and brick kiln factories. Furthermore, the tree's slow growth in reaching maturity has contributed to its unpopularity in reforestation (Khan, 1996).

Salvadora spp. -based toothpaste (above) and root- and branchlets used as a toothbrush (left).

Tamarix aphylla. Harappa, district Sahiwal.
Another dominant species of the tropical thorn forest, this fast growing, evergreen tree provides a range of ecological and socio-economic benefits. It is the most tolerant tree of waterlogged and saline soils in the *rakhs*, and, similarly to *Salvadora oleoides*, plays an important role in soil formation. Its bark and galls induced by insects are used for dyeing and tanning, as well as for medicinal purposes, e.g. in the treatment of skin diseases. Branches are also cut for basketry production. As with *S. oleoides, Tamarix aphylla* holds an underutilised horticultural potential, thriving under extreme ecological conditions and requiring minor tending attention.

Capparis decidua. Harappa, district Sahiwal.
Though by and large a shrub, *Capparis decidua* can also acquire the habit of a moderate tree following several decades of continued growth. The species withstands long periods of drought without damage, and is a key pioneer woody plant on sandy soils. Its hard and insect resistant wood is particularly sought after for firewood. *C. decidua* has a significant ornamental value presented by its peculiar growth habit and pink and red flowers that appear during the spring and monsoon seasons. Despite this potential the species is not commercially grown in nurseries or considered in reforestation schemes.

'Desert fruit', *Prosopis cineraria* (left), *Salvadora oleoides* (right), *Capparis decidua* (bottom).

TROPICAL DRY BROADLEAVED FOREST WITH *BUTEA MONOSPERMA*

Deciduous woodland stands with *Butea monosperma* (Leguminosae) in the northeast of Punjab province, near the border with India, have remained largely unexplored by the botanical community and forest authorities in Pakistan to this day. *B. monosperma* is found throughout the tropical dry areas of the Indian subcontinent in mixed forests. The scattered woodland patches in Punjab's Narowal district, however, are virtually all solely composed of *B. monosperma* as the dominating tree feature. Accompanied by *Murraya koenigii* (Rutaceae) and *Justicia adhatoda* (Acanthaceae) in the understorey, only few larger areas with *B. monosperma* remain. Small groves or single trees are occasionally encountered along rivers and roads, on arable fields and in graveyards. It is estimated that only 20 per cent of the original cover with *B. monosperma* forest remains (Khan, 2010).

Habit of tropical *Butea monosperma* forest. Kohlian, district Narowal.

Butea monosperma. Kohlian, district Narowal.

Multiple use values are associated with this species. The large, bright orange-red flowers are a favourite source of nectar for a variety of native birds and insects (Tandon et al., 2003). Interviews with representatives from local communities and forest authorities have revealed that up to the 1990s, the flowers of *B. monosperma* were still regularly harvested to produce a yellow-orange dye (Khan, 2010). While this tree appears to be no longer of major socio-economic significance in Pakistan, it is still widely exploited in India for various purposes. For instance, resin extracted from the bark is used as an astringent and seeds are ascribed contraceptive properties. But perhaps most importantly, *B. monosperma* is the host of the insect *Laccifer lacca* from which lac is obtained, used in the manufacture of furniture, boxes and other handicraft items.

Although this species has lost most of its traditional utilisation in Pakistan, and is predominately exploited as a source of firewood, 'nectar tasting' remains a popular leisure pursuit among children.

1.2.2 CONSERVATION CHALLENGES

As one of the very first countries to establish a national conservation strategy – The Pakistan National Conservation Strategy (NCS) (GoP and IUCN, 1992) – environmental concerns, and in particular the conservation and sustainable use of Pakistan's scarce forest resources, have been on the agenda of the government of Pakistan for a long time. The NCS highlighted the need to strengthen the capacity of the local government in sustainable natural resource management, especially by means of enhanced interagency collaboration from federal to provincial and local levels. As a party to the Convention on Biological Diversity (CBD), the country developed the Biodiversity Action Plan for Pakistan (GoP *et al*., 2000), which provides a detailed overview of the status of biological resources at the national level. Despite these strategic frameworks for conservation, loss of natural areas, including dry forests, remains a major concern for Pakistan, as highlighted in the periodical national review reports on the implementation progress of the CBD (GoP, 2009; 2014).

Left: The Pakistan National Conservation Strategy (1992)
Right: Biodiversity Action Plan for Pakistan (2000)

The livelihoods of two-thirds of Pakistan's rapidly growing population of over 184 million people, depend on goods and services provided by dryland natural resources, especially dry forests (GoP, 2006). These forests are a means of subsistence for a very large number of poor communities, mainly through agro-pastoral activities, and hold cultural and spiritual functions (GoP, 2009). The demand for forest goods, especially firewood – which remains the main source of household energy in rural areas of Pakistan – exceeds by far sustainable levels. This gap between need and supply, which is only partly met through imports of wood products (FAO, 2009), will continue to widen in the future.

Dromedaries loaded with *Dodonaea viscosa*, a source of firewood. Soan Valley, district Khushab.

An enormous irrigation system, expanded particularly in the eighteenth century, has significantly increased agricultural production, but also radically changed the natural landscape. Land brought under cultivation has nearly doubled over the past 50 years (Khan *et al*., 2012). Additionally, over 160,000 ha of forest land have been allocated over the years for numerous non-forest uses. The largest conversions in recent times were recorded for Sindh (110,024 ha), followed by Punjab (40,531 ha) (WWF, 2010).

Among all the countries in South Asia, Pakistan loses its already limited forest resources at the greatest pace (FAO, 2011). Forest cover is estimated to have diminished by some further two per cent during the first half decade of the new Millennium, although related statistics and data authenticity vary considerably among different organisations. All forest types in Pakistan are under acute pressure. As many woody species in dry forests are slow growing, recovery of degraded areas will take many decades.

Pakistan's tropical dry woodlands have experienced a particularly dramatic degradation in recent history. Loss in area cover over the past century is estimated to be in the order of more than 90 per cent, mainly stemming from conversion to agriculture and increased irrigation, plantation of non-native species, indiscriminate exploitation for the provision of fodder and firewood, exotic species invasions, mining and urbanisation (Khan, 1994). These actions also have a significant bearing on the physical, chemical and biological structure and composition of the generally thin dryland topsoils. As a result, numerous forms of soil degradation, including salinization, loss through wind erosion and compaction from vehicle movements, represent an enormous challenge for restoration (Gratzfeld, 2003).

Forestry authorities, local communities and, in particular, landless people, have continually been holding each other responsible for limited cooperation and growing habitat degradation. As highlighted in various studies, the many discrepancies relating to the forestry legal framework and its interpretation and non-observance at the local level, demonstrate that there is a wide gap between the *de jure* and the *de facto* situation (Steimann, 2004; FAO, 2006; Khan *et al*., 2013). This is expected to persist as a major challenge for ongoing forestry policy reform.

Only in recent history have Pakistan's dry forests come to the forefront of the attention of the scientific and conservation community, despite their major ecological and socio-economic importance. Growing interest is also shown by relevant government agencies and non-governmental organisations in applying pragmatic approaches to the management and restoration of dryland ecosystems (Shah, 2006). Various non-profit, civil society organisations have been established over the past two decades, working for forest conservation and development, and aiming to act as a bridge between government officials and local communities. On the whole, this has led to stronger environmental awareness and the start of practical restoration efforts.

Despite these encouraging advances, the need to build a shared sense of custodianship and tackle underlying causes of forest degradation and deforestation, remains as urgent as ever.

Alien invasive *Lantana camara* encroaching on *Butea monosperma* populations. Kohlian, district Narowal.

PART 2:
WORKING TOGETHER TO RESTORE – RECOVERY TRIALS OF DRY FOREST REMNANTS IN PAKISTAN'S PUNJAB PROVINCE

2.1 A UNIQUE PARTNERSHIP WITH AN AMBITIOUS AIM

The Department of Botany, Sustainable Development Study Centre and Botanic Garden of Government College University, Lahore, and BGCI, have been cooperating since 2009 to devise and implement a pilot action programme for dry forest conservation and restoration. By engaging stakeholders from local communities, forest department authorities, academia and international conservation organisations, this initiative offers insights into working collaboratively. Regular stakeholder consultations – a building block of this initiative – are critical to address and resolve issues related to land tenure and ownership, capacity building needs, as well as general methodological and site-specific technological challenges. The outcomes of this work serve also as a basis for future, larger-scale recovery schemes for dryland ecosystems, and provide experiences relevant to ongoing forestry policy reform in the country.

2.2 SPECIFIC OBJECTIVES

To address the overall goal of this initiative, three objectives were identified that drive the implementation of the programme of work:

- Trialling restoration techniques with a focus on native woody species in dry subtropical scrub forest, tropical flood plain and desert thorn forest, as well as tropical *Butea monosperma* populations.
- Working interdisciplinarily with local community and forestry department representatives to promote participative approaches to the restoration action.
- Popularising the conservation and use value of dry forests among users, by exploring the potential for new markets and products based on native dryland plant resources.

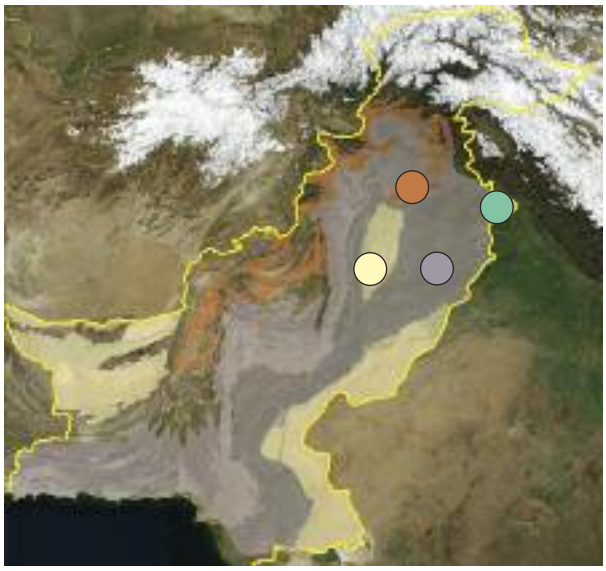
2.3 METHODS AND OVERVIEW OF MAIN ACTION

The determination of reference conditions for dry forest restoration, including natural plant species compositions, is based on a literature review and draws on research undertaken by Champion *et al*. (1965), Parker (1973), Robert (1991) and Khan (1991–to date). For the identification and prioritisation of demonstration sites and area size in the selected dry forest vegetation types, criteria were adopted to rate the degree of degradation, including zones with high levels of loss in plant cover, soil erosion, missing keystone species, and/or the score of damaged trees.

Following the prioritisation of demonstration sites and surveys of the vegetation, practical interventions carried out in all locations include i) demarcation and fencing of demonstration sites, ii) collection of plant propagation material from keystone woody species for cultivation and creation of a stock of seedlings for population reinforcement plantings, iii) removal of alien invasive species, iv) soil preparation to facilitate establishment of outplanted saplings, v) tending of seedlings, vi) monitoring and evaluation. This work was supported by a series of public outreach activities, the production of information materials, as well as periodic meetings and technical workshops with representatives from local communities and forestry authorities.

OVERVIEW OF DEMONSTRATION SITES

Project location and administrative entity	Hayat-ul-Mir Khushab district	Khabeki Khushab district	Khura Khushab district
Dry forest type	Subtropical scrub forest	Subtropical scrub forest	Subtropical scrub forest
Total plot area coverage (ha)	0.7	2.7	0.4
Land ownership	State (Dept. of Forestry)	State (Dept. of Forestry)	Communal
Key woody species	*Acacia modesta; Nannorrhops ritchieana; Buxus papillosa; Dodonaea viscosa*	*Acacia modesta; Olea ferruginea; Nannorrhops ritchieana; Buxus papillosa; Dodonaea viscosa*	*Acacia modesta; Olea ferruginea; Nannorrhops ritchieana; Buxus papillosa; Dodonaea viscosa*
Key drivers of change	Livestock grazing; invasive species	Livestock grazing; erosion	Livestock grazing; firewood collection



Project location and administrative entity	Kohlian Narowal district
Dry forest type	Tropical *Butea monosperma* populations
Total plot area coverage (ha)	1.5
Land ownership	State (Dept. of Forestry)
Key woody species	*Butea monosperma; Murraya koenigii*
Key drivers of change	Alien invasive species; firewood collection; fire

Project location and administrative entity	Rakh Khairewala Layyah district
Dry forest type	Tropical desert thorn forest
Total plot area coverage (ha)	0.05
Land ownership	State (Dept. of Forestry)
Key woody species	*Prosopis cineraria; Salvadora oleoides; Tamarix aphylla; Capparis decidua*
Key drivers of change	Firewood collection

Project location and administrative entity	Harappa Sahiwal district
Dry forest type	Tropical flood plain thorn forest
Total plot area coverage (ha)	5
Land ownership	State (Dept. of Forestry)
Key woody species	*Prosopis cineraria; Salvadora oleoides; Salvadora persica; Tamarix aphylla; Capparis decidua*
Key drivers of change	Salinization

PILOT RESTORATION WORK IN SUBTROPICAL SCRUB FOREST IN THE SOAN VALLEY (HAYAT-UL-MIR, KHABEKI AND KHURA), DISTRICT KHUSHAB

The Soan Valley, located in the heart of the Salt Range in northwest Punjab province between Jhelum and Indus Rivers in the east and west respectively, still holds important areas with subtropical dry scrub forest. However, in recent years, significant mining activity (coal, salt, silica and limestone) has been transforming the landscape of the valley. These actions are rapidly degrading and altering the scrub forest, exacerbated by indiscriminate firewood extraction, especially of *Acacia modesta* and *Olea ferruginea*, and encroaching populations of the alien invasive *Prosopis juliflora*.

In their initial stages of establishment, the saplings of *Acacia modesta* – which are particularly susceptible to browsing by rodents – and *Olea ferruginea* are protected with branches of *Dodonaea viscosa*. A regular planting pattern has been adopted to facilitate monitoring. Hayat-ul-Mir.

Unloading saplings of *Olea ferruginea* and *Acacia modesta* grown at the Botanic Garden of Government College University, Lahore. Hayat-ul-Mir.

Monitoring the growth condition of the saplings under the protective *Dodonaea viscosa* jacket. Hayat-ul-Mir.

Fencing is not always effective – grazing on *Acacia modesta*. Hayat-ul-Mir.

Seedlings establishment of *Acacia modesta* and *Olea ferruginea* four years following outplanting. Hayat-ul-Mir.

Monitoring growth rates. Khabeki.

Inspired by the pilot restoration work, the divisional forest officer for district Khushab, has established a nursery where the keystone species of this project are propagated. This has enabled the generation of a stock of several thousand saplings, which to a large extent have been included in various new restoration trials carried out by the provincial forestry department.

The population reinforcement plantings with native species have also sparked the interest of the Department of Agriculture. Its local representative has initiated restoration work of the degraded colonial orchard in Kinhati with native dryland trees. Located in an area of particular scenic beauty, the garden has tremendous potential as a base camp for ecotourism, and provides an excellent opportunity for public outreach to highlight the various services and goods provided by the dry forests.

PILOT RESTORATION WORK IN TROPICAL FLOOD PLAIN THORN FOREST AT HARAPPA, DISTRICT SAHIWAL

The archaeological site of Harappa with spectacular finds from the time of the Indus Valley Civilisation (5,500–3,900 BP), also hosts important remnants of tropical dry flood plain thorn forest. Visited by over 20,000 people every year, the combination of archaeological vestiges and remnants of natural vegetation, make this site an ideal field class room to learn more about the values of dry forests today and in the past. This location also offers a unique opportunity for interdisciplinary collaboration, with governmental agencies, academia, non-governmental organisations and local communities joining hands for the preservation of the country's cultural and natural heritage for future generations.

Palaeobotanical studies carried out in Harappa (e.g. Lancelotti, 2008) have revealed wood fragments of *Prosopis cineraria*, *Acacia* spp., *Salvadora* spp., *Capparis* spp., *Ziziphus* spp., *Tamarix* spp., *Dalbergia sissoo* and *Populus euphratica*. This indicates that many of the tree resources exploited in the past relate to species that still occur in the dry flood plain and desert thorn forests of present-day Pakistan.

Supply of seedlings for population reinforcement planting.

Salvadora oleoides (in the foreground), and *Prosopis cineraria* (in the background), planted in 2004 during a former project phase. Natural establishment of seedlings was mostly observed for *Salvadora oleoides*, especially under the canopy of larger, established trees. Increased regeneration via root budding and suckers from remnant species has also been recorded over the years.

Field course in restoration techniques for students of Government College University, Lahore.

PILOT RESTORATION WORK IN TROPICAL DESERT THORN FOREST AT RAKH KHAIREWALA, DISTRICT LAYYAH

Extending over an area of 2,500 ha, Rakh Khairewala is one of the few remaining locations in the Thal desert in northwest Punjab with major stands of tropical desert thorn forest. The landscape comprises a mosaic of fine sand dunes and plane areas with loamy soils. The woody vegetation is increasingly converted to agriculture, with wheat fields and pulses also occasionally cultivated on the dunes. In recent years, this has contributed to a major loss in habitat and plant populations of *rakh* keystone species, including the dune coloniser *Calligonum polygonoides, Prosopis cineraria* and *Salvadora oleoides*.

Dune restoration trial site with remnant populations of *Calligonum polygonoides*. Rakh Khairewala.

Saplings are watered twice a week following their planting in 2013.

Surveying growth rates of saplings.

Public outreach materials aimed at raising awareness of the value of dry forests, disseminated to local communities and schools during interviews and questionnaire surveys.

PILOT RESTORATION WORK IN TROPICAL DRY BROADLEAVED FOREST WITH *BUTEA MONOSPERMA* AT KOHLIAN, DISTRICT NAROWAL

Recent surveys suggest that *Butea monosperma* forests have declined by some 80 per cent over the last ten years, mainly due to intensified conversion to agricultural land and growing military operations in the border region (Khan, 2010). Shakargarh tehsil of Narowal district in the northeast of Pakistan, bordering India, is the country's administrative unit with the most remaining stands of *B. monosperma*. The pilot restoration site near the village of Kohlian is particularly affected by the invasive species of *Prosopis juliflora*, *Lantana camara* and *Parthenium hysterophorus*. In addition, loss of interest by local communities and forest authorities in the traditional uses of *B. monosperma* is further contributing to the degradation and shrinking of remnant populations.

Drivers of change to remnant *B. monosperma* (background): invasive *Prosopis juliflora* (middle) and livestock grazing.

Fenced pilot plot with remnant, coppiced *B. monosperma*.

Extracting seeds from *B. monosperma* pods.

Unloading *B. monosperma* saplings grown at the Botanic Garden of Government College University, Lahore.

Preparing saplings for outplanting.

Outplanting of saplings.

Local community members tending the saplings.

Discussing forest and project boundaries with local community and forestry department representatives.

Demonstrating planting methods.

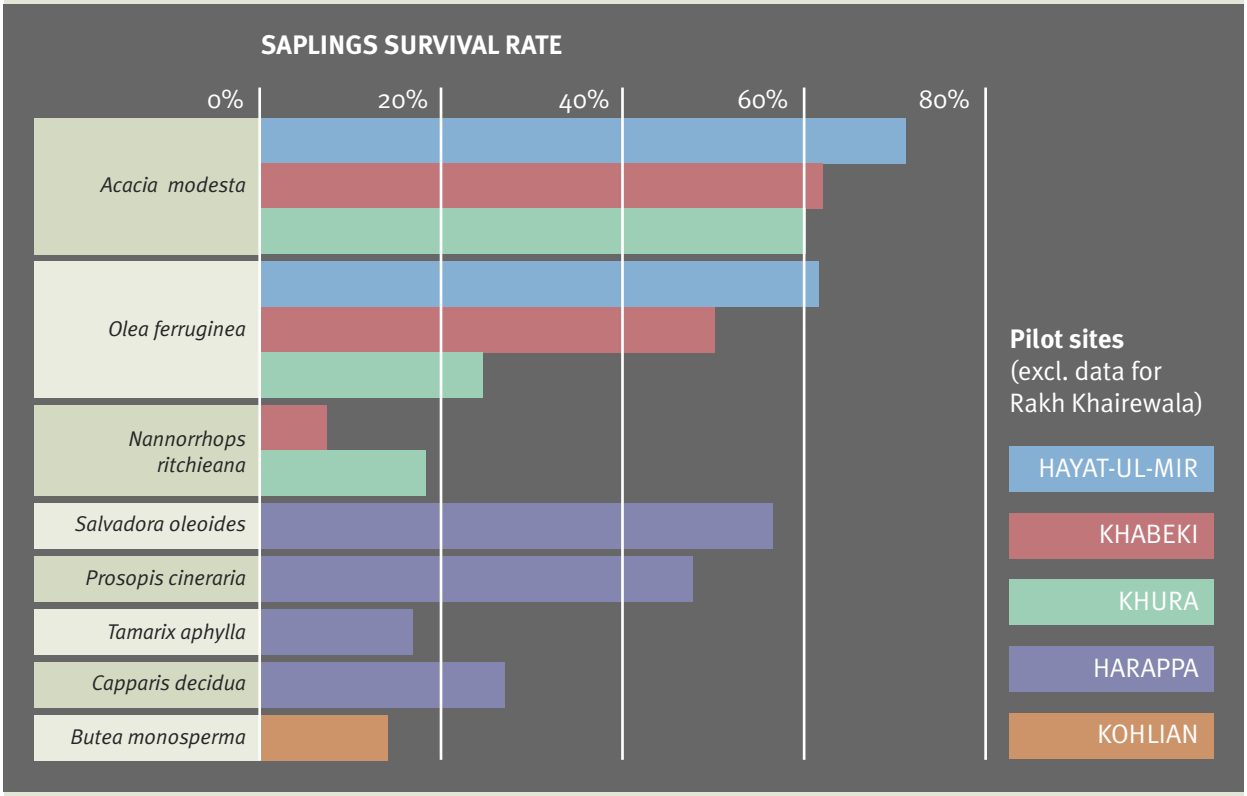
Initial planting efforts did not yield encouraging results due to lack of commitment to periodical care by the local community, severe grazing and fire. Absence of ownership of this work by the villagers was found to be closely related to the limited value attributed by the forestry authorities to the *Butea monosperma* remnants. To address this challenge, local schools were targeted to raise the profile of, and generate wider interest in the restoration work. With the enthusiastic engagement of a local school principal, the 'Butea Club' was founded, serving as a vehicle to instil a greater collective sense of ownership by school children in the restoration action. A series of activities were initiated involving the children in the planting and aftercare of the saplings, individually labelled with the name of the child responsible for the care. A nominal reward was offered to provide further incentives to water and look after the plants periodically.

2.4 ACHIEVEMENTS AND CHALLENGES

A novel initiative – both as regards its thematic focus and interdisciplinary partnership model – this venture has yielded numerous attainments and experiences valuable for the further development of restoration programmes for Pakistan's dry forests. Equally, the various technical and political challenges encountered offer important insights critical to a better understanding of how to tackle dryland restoration issues at the local level. In summary, achievements made and challenges experienced during the implementation of the project include:

ACHIEVEMENTS

- A first-time ever pilot scheme to trial restoration and compare methods within and among different subtropical and tropical woodland remnants in Punjab province;
- Over 10,000 saplings of eight woody target species raised locally as well as in *ex situ* nurseries at the Botanic Garden of Government College University, Lahore, and planted in ten demonstration plots covering an area of some ten hectares;
- With an overall 40 per cent seedling survival rate, reinforcement plantings accompanied by other conservation measures including fencing, elimination of invasive plants and basic soil remediation, have also facilitated natural regeneration via seed, root budding and suckers from remnant trees;

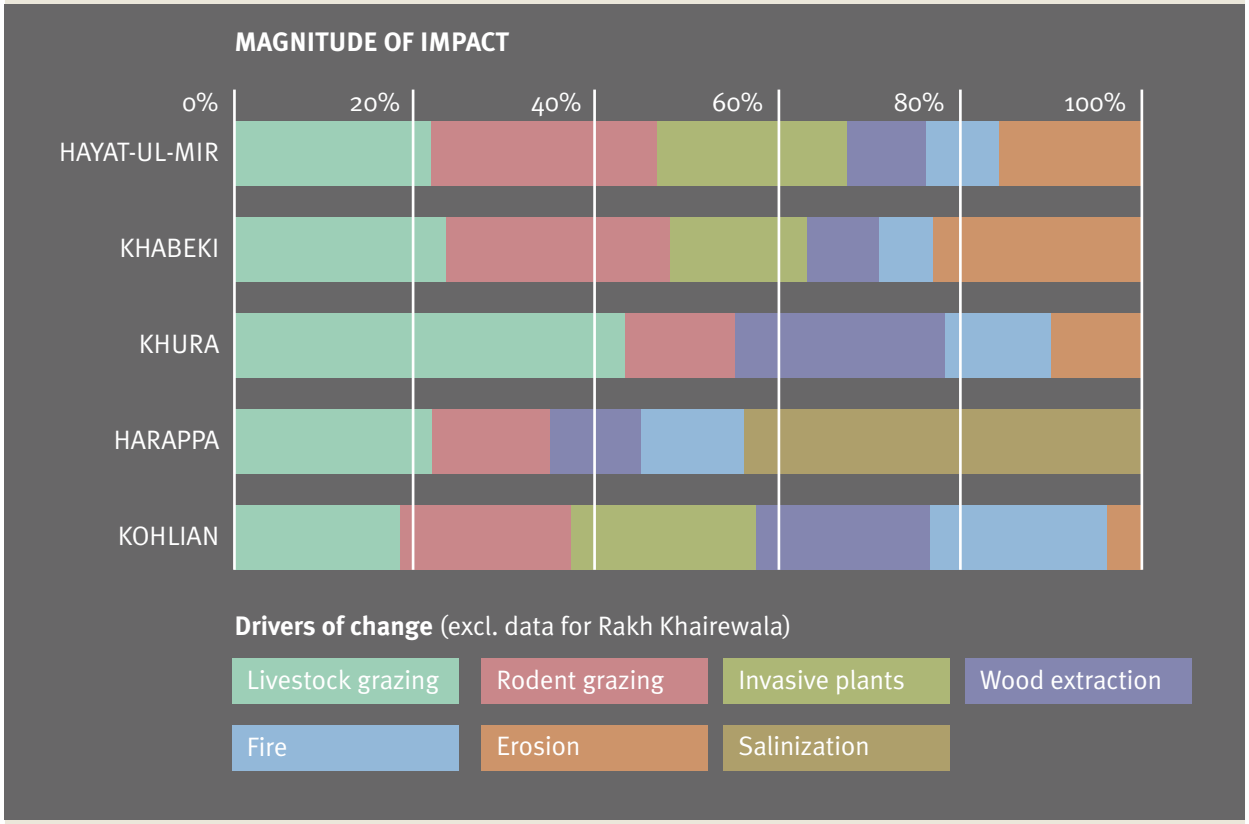


- Close collaboration and regular interaction with representatives from local communities and forestry departments helped considerably to consolidate ownership of the conservation measures and engagement in the restoration trials.

  This is exemplified by initiatives introduced by the local stakeholders of their own accord, including a school teacher founding the 'Butea Club' or a divisional forestry officer establishing a native plants section within the department's tree nursery.

CHALLENGES

- Institutionalisation of restoration programmes in the context of frequent changes in forestry personnel and other key stakeholders;
- Consideration of the genetic variation within and between populations to create restoration areas that are representative of the local gene pool diversity of the target species;
- Reduction in the mortality rate of outplanted saplings stemming from environmental hazards and human-induced causes such as severe drought, grazing, fire, removal of fences and cutting of mature trees on-site;



- Fencing as an immediate to medium term measure only, to lend credence to work undertaken within the enclosed area and protect restored areas and saplings from browsing and other pressures induced by wildlife and livestock.

  Yet, fencing is no guarantee for endorsement of the conservation work by all stakeholders in the long run, unless ambiguous land tenure arrangements are clarified and livelihood needs of local communities based on dryland natural resources are satisfied.

PART 3:
A FUTURE FOR PAKISTAN'S DRY WOODLANDS – HELP US TO EXPAND OUR RESTORATION EFFORTS

Despite growing international interest in dryland restoration in recent years, comparatively little conservation attention has been given to Pakistan's natural, dry forest remnants. Degradation and loss of ecosystem goods and services continue to have a negative bearing on the livelihoods of the communities living in these areas. Nevertheless, the number of encouraging restoration programmes is steadily rising. In order to maximise the benefits of the varied initiatives, capitalise on their experiences and replicate best practice, a much greater level of sharing of knowledge and expertise is required among relevant governmental agencies and non-governmental organisations.

Botanic gardens, as custodians of botanical knowledge and living plant resources, are key to successful conservation. Yet their role in the recovery of degraded ecosystems still remains in the early stages, both globally and particularly in Pakistan. To bring to bear this tremendous potential, a united force of botanic gardens is vital to promote the integration of *ex* and *in situ* conservation and habitat restoration. The Pakistan Botanic Gardens Network established in 2006 is a major step forward in providing a national platform to facilitate information exchange and coordination of programmes for the conservation and restoration of wild plant populations and the habitats they form.

Facilitating access to niche markets for eco-friendly dryland products harbours major income-generating opportunities for local people (Mortimore, 2009). As highlighted in this work, many of the woody plants in Pakistan's dry forests are of medicinal, cosmetic, ornamental or other socio-economic value, but few effective and sustainable markets for products from these and other dryland species exist to date. The development of value chains based on the principles of sustainable exploitation in the wild or cultivation, and fair and equitable sharing of the benefits arising from the use of the dryland plant resources, needs to be significantly scaled up. This will make a tremendous contribution to achieving restoration objectives, and will promote dry forest conservation and livelihoods improvement as two complementary endeavours.

Soan Valley, Punjab.

HOW CAN YOU SUPPORT THIS WORK?

Our efforts to promote, conserve and restore Pakistan's dry forests need to continue and expand. The awareness campaigns, capacity building and practical restoration trials undertaken to date, though limited in magnitude, present very promising steps. We rely on sustained financial and technical aid to scale up this work by:

- enhancing species recovery and habitat restoration expertise of local communities and authorities;
- increasing the size and number of restoration sites;
- strengthening *ex situ* conservation efforts by Pakistan's botanic gardens through genetically representative collections; and
- exploring the development of value chains for improved livelihoods of local people.

Public outreach campaigns to engage a steadily growing audience in support of our efforts form an integral part of this programme.

You can help the extension of this ambitious venture by making a donation and/or by becoming an institutional or individual member of the world's largest network for plant conservation – Botanic Gardens Conservation International (BGCI).

For more information about the various options and benefits of your support to BGCI, please visit:

http://www.bgci.org/joinin/donate/
http://www.bgci.org/joinin/members/
http://www.bgci.org/supporters/corporate/

or contact **info@bgci.org**

Engaging school children in the restoration work. Kohlian, district Narowal.

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Botanic Garden of Government College University, Lahore

BOTANIC GARDEN OF GOVERNMENT COLLEGE UNIVERSITY (BGGC)

The origins of the Botanic Garden of Government College University (BGGC) in the centre of Lahore date back to the 1860s, when agricultural land was converted into a park and named after the Viceroy of India of the time, John Lawrence. The Lawrence Garden was renamed Bagh-e-Jinnah (Jinnah Garden) in 1947. Managed today by the Department of Botany of Government College University, Lahore, BGGC covers an area of 2.8 hectares adjacent to the Jinnah Garden, and is host to a diverse range of plant collections representing some 600 native and exotic species. Besides being a major educational centre for botanical studies, BGGC is a green treasure in the bustling city of Lahore, offering a venue for relaxation and contemplation. BGGC also serves as the secretariat of the Pakistan Botanic Gardens Network.

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BOTANIC GARDENS CONSERVATION INTERNATIONAL (BGCI)

BGCI is the largest international network of botanic gardens and related institutions working collectively for plant conservation and environmental education. Its mission is to mobilize botanic gardens and engage partners in securing plant diversity for the well-being of people and the planet. Established in 1987, BGCI provides technical and policy guidance as well as regular up-to-date information through its newsletters, magazines, conferences and training courses, in addition to supporting numerous integrated conservation projects around the world. BGCI's databases include a directory of botanic gardens and an inventory of the plants held in botanic garden collections around the world, serving as a central resource for conservation planning and implementation.

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