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Combating Desertification Effects by Participatory Action and In-situ Conservation of Commiphora wightii: An Endangered Medicinal Shrub in Nagarparkar Hills of Tharparkar, Pakistan

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ABSTRACT
Participatory oriented actions were taken in district Tharparkar to combat desertification effects through conservation of Commiphora wightii, an endangered medicinal plant and protection of local biodiversity. Synergies of various stakeholders at different levels were integrated to strengthen local ecosystem conservation project in Nagarparkar area of district Tharparkar. Indigenous communities were actively involved in in-situ Commiphora wightii proliferation, plantation and awareness raising activities. In addition, local community groups played key role in wildlife protection measures. Optimistic results were achieved in conservation activities such as exemplary participation of green guards – group of native motivated individuals, developed a better relationship and coordination with public, private departments and organizations to promote sustainable use of local natural resources and plantation of 4250 Commiphora wightii (three and half months old) were carried out through vegetative cuttings at the selected natural rangeland sites in the study area.

INTRODUCTION
District Tharparkar is a desert area located 433 Km away from Karachi – capital city of Sindh province, in the south-eastern part of Pakistan, and spread over 19,638sq. Km. The area is attributed geographically beautiful landscape, rich flora and fauna, cultural and traditional diversities. For these qualities Tharparkar, the only fertile desert in the world is known as open air museum [1]. Arid zone ecology of Tharparkar is exclusive in its nature with distinct rangeland characteristics, and its landscape is among major ecosystems of Indus eco-regions in Pakistan which is now under environmental threat due to natural and anthropogenic reasons [2]. Pakistan is no exception from the rest of the world regarding loss of biodiversity. Deforestation, unplanned urbanization, population explosion, and unsustainable use of natural resources have exerted enormous pressure on plant biodiversity [3]. Regrettably, not much work has been carried out on conservation of endangered plant species of Pakistan [4]. Similarly, less work is undertaken for the conservation of natural resources and local biodiversity protection in Pakistan as well.

Nagarparkar, sub-district of Tharparkar, adjacent to the Indian border in the east-northern edge of Rann of Kutch, is exclusive terrain with flat land and hilly topography of Karoonjhar mountain range. This part of the district is rich in biodiversity including some internationally significant wild plant and animal species, the area is a wildlife sanctuary under the provincial law and part of Rann of Kutch Ramsar site as well [5]. However lack of awareness, poverty, changing pattern of land use, droughts and changing climatic conditions, scant rainfall, loopholes in the government regulations have provided exacerbated stresses to the wild plant species towards extinction. This problem is more desperate in some arid areas, particularly Nagarparkar town and surrounding villages of this area which is home to many plant species endemic to the region. Several of these plant species serve for fuel, fibre, food, timber, medicine and local agriculture is widely rely on this floral basis. Karoonjhar hills of the Nagarparkar have potential to grow various herbs and medicinal plants; many of them are yet to be explored from scientific community, some valuable plant species attract business sector for commercial...
purposes as well. Simultaneously, these plant species are highly significant to the indigenous communities from hundreds of years for their medicinal needs. Extinction of plant species in their wilderness would be an irreplaceable loss from conservation point of view and socio-economic and scientific losses as well. Native plant species are integral parts of the world-wide biodiversity, these plants play key function in our ecosystem where confronting with several risks i.e. habitat loss and degradation, introduction of alien species, pollution and diseases, over-exploitation and climate change [6-12].

Most of rural population in surrounding union councils and villages of Nagarparkar is economically disadvantaged and deprived from the basic needs of life. These communities largely depend on local natural resources for their survival due to rain-fed agriculture. These natural resources are facing continuous threats from different unsustainable human activities i.e. over-grazing, shifting cultivation, uncontrolled cropping, fuel wood, and various other activities causing loss of natural habitat [6]. Most of the local communities are rain-dependent and thus are nomadic in their life style; and keep on moving with their livestock to different areas within and out of their district which has negative implication on the flora [2]. Livestock mainly cows, goats and sheep are major livelihood source of these communities, however manifold growing number of the cattle requires more vegetation for food, resulting in serious threat to several native plant species, since equilibrium between carrying capacity of this rangeland and number of cattle is important. Driving forces responsible for these activities are, not limited, both physical and socio-economic in nature including lease policy of government for agriculture land, lack of environmental awareness, low literacy rate, growing demands of products in the market [6], dearth of ownership, political will and lack of commitment to the conservation of natural resources.

Commiphora wightii (Arnott) Bhandari (Burseraceae family) is threatened, slow growing, multi-branched with soft stem shrub (locally known as guglan or gugral) found in arid, rocky swathes of the Nagarparkar terrain (Fig. 2a). The oleo-gum mastic of C. wightii (locally called gugral gum), is stated in the classic Ayurvedic writings as an effective cure for bone fissures, arthritis, inflammation, obesity, cardiovascular disease, and lipid disorders [13,14]. The gum is taken out of the bark of the plant by resin tapping. A mature tapping shrub takes almost 10 years of growing period under the arid environmental conditions. Small cuts are applied by axe on the plant body during winter season to take out the gum resin (Fig. 2b). Overuse, slow growth and linked poor seed are main factors causing this plant species to be endangered [15]. Red Data list of IUCN declares gugral as Data Deficient since limited information is accessible about its conservation status [16].

Usually, indigenous people make a mixture of ass urine, garlic, asafetida and copper sulphate, using this traditional technique they dip the axe into this chemical mixture and then apply deep cuts on the whole plant body to extract optimum quantity of gum resin from guglan within short period of time. This unnatural method of tapping increases the amount of resin three to four fold against normal way of tapping, later plant becomes ill and subsequently unhealthy for extracting gum for the next couple of years and finally shrub might not survive because of lethal effect of copper sulphate [17]. Guglan forests are dying because of this unsustainable way of gum extraction, which increases gum productivity temporarily but kills the plant permanently within time of a few years.
Local communities play key role in in-situ conservation of local flora and fauna as these indigenous people have local wisdom about their ecosystem. Their fully involvement in programmes of biodiversity conservation and managing natural resources in a sustainable way would give encouraging and reduced cost conservation and management outcomes in several parts world-wide [6]. The presented study is a reflection of participatory efforts made by involving local communities and stakeholders to activate and raise awareness among local people of Tharparker, particularly Nagarparkar about the significance and sustainable use of *C. wightii* and conservation of local biodiversity. The main objective was to combat desertification effects with the participation of local stakeholders, by protecting rangelands of Nagarparkar including Karoonjhar biodiversity rich fragile habitat, from unsustainable exploitation of vegetative cover in the rangelands. A large scale *C. wightii* plantation was carried out on rangeland to conserve local ecology and secure livelihood opportunities for the poor communities.

**Actions:**

**Orientation to Stakeholders:**

In the beginning of October 2009, all the concerned stakeholders including local government officials of various departments, non-governmental organizations (NGOs), community-based organizations (CBOs), environmental journalists, politicians, social activists, civil and military officials, judiciary etc. of district Tharparker were approached and briefed about the main activities being implemented in the project area (Fig 1) for their understanding and to reinforce collaboration in order to gain support and integrate all these actors for necessary actions required to combat desertification by protecting local ecology. Inception workshops about conservation activities were conducted in all sub-districts of Tharparker. Project team paid several visits to 49 villages of two union councils (UCs) of Nagarparkar sub-district to on-board the local community and sensitised them for their effective participation in the conservation activities of *C. wightii* and protection of local biodiversity. This orientation approach turned out to be successful with the active participation from all relevant stakeholders and as a result, better consensus was developed among different stakeholders which later provided a very conducive environment in building momentum from biodiversity conservation point of view.

**Fig. 2(a):** A mature *Commiphora wightii* plant in Nagarparkar, Tharparkar; (b) Resin tapping from gugral plant

**Green Guards and Forest Vigilance Committees:**

Green Guards (GGs) were a typical part of *C. wightii* conservation activities. During preliminary interaction with indigenous community some motivated people from the villages were selected on voluntarily basis as GGs. Their role was to mobilize other people of their community to participate in conservation practices and pass awareness to other members. Later, these GGs were given knowledge through trainings about protection of local biodiversity and *C. wightii* plantation procedures. In order to integrate the efforts of GGs, a Central Green Council (CGC) headed by a president and a Cooperative of Indigenous People (CIP) headed by a village focal point were formed in each UC. In the CGC, each deh had a deh organizer and each UC had a UC organizer, whereas CIP had village focal points. All GGs were members of both CGC and CIP. The idea was to provide community a platform where they can meet and share their ideas with each other put synergies for their role in the conservation of natural resources and ecology of their area. These GGs were given a whistle, cap and a jacket with GG logo (Fig. 3).
District and Session courts of Tharparkar district was informed about illegal practice of gum extraction from *C.wightii*, poaching of wildlife and deforestation. Honourable court called a high profile meeting of all government departments to stop these activities in the district and made vigilance committees at district and sub-district level to oversee biodiversity issues and take appropriate timely measures. These formal vigilance committees triggered all government departments to pay attention and take actions for any illegal practice jeopardizing local ecology of the district.

**Field Surveys:**

To know prevailing density of *C.wightii* and health of the rangeland, field assessments were undertaken in the study area (Fig. 1). Information about *C.wightii* were collected in both UCs using questionnaire surveys, community discussions, dealers of gum resin and direct field observations. Moreover, Arid Zone Research Institute (AZRI), Umerkot district range department and Pakistan Agriculture Research Council (PARC) were contacted to obtain information about existing status of *C.wightii*. Next to that, feedback was obtained from trained GGs, shepherds, educated and older people of the community. This local knowledge helped in enumeration about the status of *C.wightii*.

**Awareness raising activities:**

Awareness raising among local communities is significant part for biodiversity conservation that helps in developing sense of ownership amongst local people and sustainable use of their natural resources. In this regard, several activities were undertaken in the study area and through print and electronic media as well to spread conservation messages to the rest of masses. These activities included training of 245 GGs, rakhibandhan event in the community (inspired from Chipko movement of India, local women tied rakhis to the trees meaning that, they considered trees as their brothers, a promise of protection), local FM radio messages, and establishment of 27 school environmental clubs for children. During these awareness sessions, local communities were given information about their dependency on natural ecology and its importance for conservation in order to continue getting benefits from local biodiversity in the long-run as their livelihood. GGs with local people of different age groups and were given knowledge for the future assessment of *C.wightii* and discouraging tapping of resin by applying chemical. These local people further disseminated environmental messages to their friends, relatives and other community members (Fig. 3).

**Vegetative propagation of *C.wightii* through stem cutting:**

Different suitable rangeland sites were identified in the study area with the support of local community and rangeland department for large scale propagation of *C.wightii*. Furthermore, a guglan nursery was developed with the support of GGs in the beginning of May 2010. Cuttings were taken from healthy and disease free branches of the plant. The basal parts of the cuttings were immersed in newly made 1500 mg/l aqueous solution of Indole-3-butyric acid solution for 5 seconds [18]. Under green-shaded (50% with green plastic mesh) nursery, these cuttings were shifted to plastic bags of 4 cm deep filled with manure and soil by ratio of 3:1. Nursery was covered with the plastic mesh to safeguard saplings from exposure of direct sunlight. Favourable growth time for *C.wightii* is rainy monsoon season; therefore 4250 plantlets, 3.5 months old (each with an approx. 30.5 cm height) were then planted to the identified rangeland sites between the months July and August 2010 with GGs and local people.
Consequences:
Orientation to Stakeholders:

All the stakeholders were kept informed from the inception about the conservation activities being undertaken in the area, this networking brought very good results, such as it drew attention of local, national [19, 20] and international media [21, 22, 23, 24, 25, 26, 27, 28] to highlight this issue which received governments’ consideration to prioritize biodiversity issue and take required measures for the conservation of C.wightii and local biodiversity. District judiciary took positive steps to halt illegal deforestation and poaching of wildlife in the district. Ombudsman from government department paid visits to Nagarparkar area to investigate illegal tapping of C.wightii and took deterring actions. Importantly, advisor to chief minister of Sindh province noticed the problem, paid visit to the area and forwarded this matter to the government for immediate action. Moreover, community exposure visit from WWF-Pakistan spread conservation message to their area of working.

Green Guards and Forest Vigilance Committees:

GGs participated proactively in all the conservation supportive activities in the Nagarparkar area. GGs used their local knowledge and traditional way of conservation, such as they took community members in confidence and made check points at different locations to monitor illegal hunting and cutting of trees, they used given whistles to alert each other, they divided area into different sectors by mutual agreement and did patrolling wearing cap and jacket with GG logo, which made them distinguished among other community members. During various occasion, network of GGs saved migratory birds and local wildlife such as Demoiselle Crane (Anthropoides virgo), Houbara Bustard (Chlamydotis undulata), Blue bull (Boselaphus tragocamelusare), Indian Peafowl (Pavo cristatus) and Chinkara from poaching and timely informed concerned government departments. Later, it was noticed that other young people from different villages wanted to be GG due to inspirational role of GGs. Formation of vigilance committees ordered by District and Session court influenced conservation efforts positively overall the district, government departments such as wildlife, forest, revenue, police, rangers, local persons from NGOs and media were members of these vigilance committees. These committees conducted regular meetings, discussed and identified biodiversity loss threats in the district, in some cases legal actions were also taken by the local police. Support from district government, local community and efforts of GGs checked unsustainable tapping significantly during the year 2010. In addition, GGs proved themselves agents for community managed rangelands, and indigenous communities realized the importance of their nexus with their natural rangelands, they considered rotational grazing, planting and protecting existing vegetation to maintain healthy rangelands for nature and their future.

Field surveys results:

Survey results revealed, UC Pethapur and Nagarparkar of sub-district Nagarparkar are ‘hotspots’ for C. wightii, however it was also found that C. wightii population exists in Muhrano and Manjthiunion councils of sub-district Mithi, Jhermryo and Diplo union councils of sub-district Diplo, and Kanteyo union council of sub-district Chacharo in district Tharparkar and some parts of adjacent district Badin as well. It was concluded that C. wightii is being wiped out intensively. During discussions with GGs and local community members of older age, they maintained that few decades ago they couldn’t walk through the C. wightii forests while grazing their goats on the Karoonjhar hills. It was obvious; drastically reduction in the population of C. wightii is the result of deploying poor labourers by some influential people to extract gum resin for commercial purposes using unsustainable way. Labours were given small size axes, and ethephon (2-chloroethyl phosphoric acid, a synthetic chemical releases ethylene) to extract higher amount of gum. This short-term method of tapping is unsustainable way. Labours were given small size axes, and ethephon (2-chloroethyl phosphoric acid, a synthetic chemical releases ethylene) to extract higher amount of gum. This short-term method of tapping is unsustainable way. Labours were given small size axes, and ethephon (2-chloroethyl phosphoric acid, a synthetic chemical releases ethylene) to extract higher amount of gum. This short-term method of tapping is unsustainable way.

Awareness raising activities:

Overall impacts of training to GGs, orientation workshops to stakeholders, local FM radio programmes, rakhibandhan event, and awareness sessions among local communities remained optimistic. All these activities considerably raised awareness level of indigenous people about conservation of C.wightii and created a sense of ownership about sustainable use of natural resources and their protection. GGs reinforced centuries old traditional panchayat (village council) system in their villages which is now fading away due to changing pattern of rural society. This panchayat system is like a unity system of villagers; they discuss and try to solve their problems. Loss of local biodiversity is equal to loss of their livelihood means; GGs held regular meetings with their villagers by involving children, women and man of all age groups and conveyed conservations messages. Villagers were observed planting C.wightii plants around their houses and some schools as fencing walls. Moreover, locals supported in stopping poaching of wildlife incidents around Karoonjhar hilly areas and actively participated in large scale C.wightii plantation activities in order to restore this plant species in the natural habitat (Figure 4).
Vegetative propagation of C. wightii and relocation:

During first phase, stem-cuttings were placed in the soil and manure filled plastic bags, nursery observations showed that within a time period of 20 days stem-cuttings started sprouting under favourable climatic conditions. Increasing rate of budding and growth was noticed in the plant saplings when stem cutting acquired diameter from 0.6 to 0.8 mm. After, 20 to 30 days roots growth was observed in the stem-cuttings, same results were achieved by [6]. Later, GGs and local community were involved in shifting these plantlets to the identified plantation sites around Karoonjhar hills (Fig 4).

Fig. 4: Commiphora wightii plantation activities with GGs and indigenous villagers in Karoonjhar hilly areas

Conclusions:

Community-based approach is significant as well as successful for local biodiversity conservation programmes as discussed in this paper. A participatory effort from all stakeholders by understanding local environmental and socio-economic dynamics of the area and integrating it in conservation aspects is integral for the success. Local wisdom is important to be cohesive with scientific knowledge to produce innovative natural resources conservation approaches and embed them in various tiers of planning. Poor rural communities are largely dependent on their local natural resources for livelihood; therefore health of local ecosystem must not be comprised by short-term benefits and loopholes in the governance systems must be overcome at different levels of management to protect natural resource base.

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