

# The Use of Trees and Shrubs in Spate Irrigation Areas

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Practical Note Spate Irrigation



Flood-Based Livelihoods  
Network Foundation

## Introduction

In spate irrigation, water is either diverted from normally dry river beds (wadi's) when the river is in spate or moisture is captured by the direct rain fall is used for crop cultivation. The flood water in the riverbed after rains is then diverted to the fields. This may be done by free intakes, by diversion spurs or by bunds, that are built across the river bed. The flood water – typically lasting a few hours or a few days – is channelled through a network of primary, secondary and sometimes tertiary flood channels. Command areas may range from anything between a few hectares to over 25,000 hectares. Spate irrigation occurs in areas as varied as South Asia, the Middle East, West Africa, North Africa, the Horn of Africa, Central Asia and Latin America. Spate irrigation is typically found in arid and semi-arid regions, where highlands border plains. It uses seasonal floods for irrigation – but as the floods differ from year to year the area served by it fluctuates widely. Ephemeral rivers are often unexpectedly rich depositories of vegetation. Spates collect seeds from a large part of catchments and deposit them in the river bed and flood irrigated fields. The moist, and often organic-rich layers of silt forming spate irrigated fields, provide a favorable environment for wild trees, plants and mushrooms to germinate and develop. Logs and branches, often carried over considerable distance by spate flows, may add to this process by lodging against trees growing in or along the river channel and field banks, creating small blockages, trapping organic material, and further supporting vegetative growth (Jacobsen et al., 1995)

Vegetation sometimes helps in raising the river beds. When trees, such as Tamarix, colonize the

bed of spate rivers and earthen water canals, flows are slowed down, sediment settles and bed levels rise. In many rivers prone to degradation, as in wadi Tuban and wadi Siham in Yemen, as well as in Korakan River in Balochistan, a ban on cutting vegetation along the wadi bed has been put in place by the spate irrigation farmers. In other areas, farmers have actively planted Tamarix saplings. In Balochistan several projects have planted different trees and shrubs including Tamarix along the banks and inside the rivers for multipurpose functions. This was done on a participatory basis on the request of local farmers and villagers. Not only does vegetation withstand normal floods, but regeneration is possible from regrowth when damage occurs during exceptional floods. Sediments deposit in front, over and behind the vegetative barrier. Sedimentation of coarse material, during high and medium floods and of silt mixed with vegetative debris at low flows, eventually forms a solid natural protective structure. The distribution of natural vegetation in wadis is, however, limited to sites of low- speed flow, where seeds are deposited and covered with enough sediment to obtain germination. In sites characterized by swift currents, vegetation establishment can only be obtained by planting cuttings deep and offering protection against scouring.

In many spate irrigation systems, the risk of sand accumulation is ever present. One reason why spate irrigation faces the threat of sand deposit is that agricultural land stretches increasingly into marginal areas, with little accessibility to spate flows and poor (sandy) soil textures in the agricultural lands that are close to the river. Another explanation may be related to the practice of rainfed agriculture in the sand dune areas. In

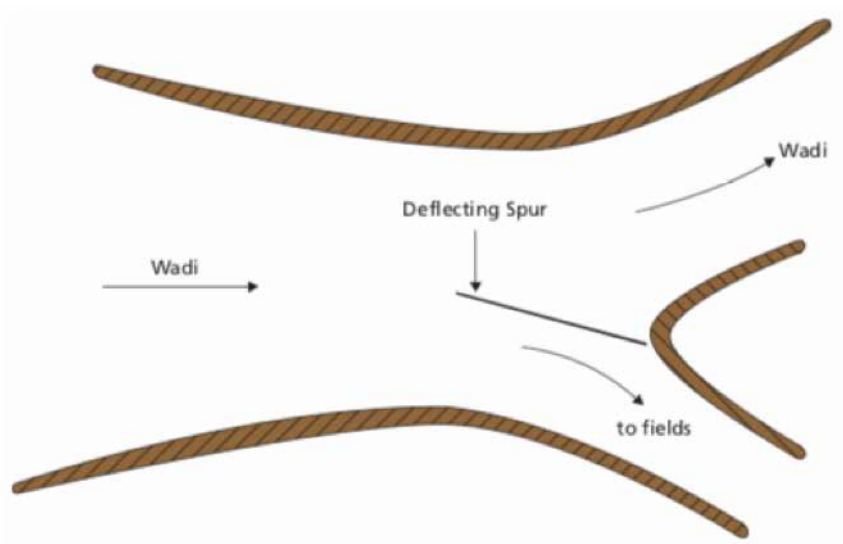


Figure 1: A spur intake diverting water from a small sandy-bed spate river. The spur is located at the outside of a bend where it intercepts the low-flow channel. It is constructed from tree trunks driven into the wadi bed, sealed woven branches, brushwood and sand from the river bed.

some places, when there is adequate rainfall for rainfed agriculture, farmers tend to uproot natural vegetation and crop marginal, sandy land. Animals graze the area after the harvesting of millet and, as a result, the sand dunes are stripped of natural vegetation and regeneration becomes slow and difficult (Scholte et al., 1991). The rehabilitation of sand dune areas requires the engagement of farmers in planting native trees and dwarf shrubs. In the Tihama (Yemen), a dwarf shrub (*Dipterygium glaucum*) and two tuft grasses (*Panicum turdudum* and *Odysseum mucronatum*) form the vegetation cover that will eventually stabilize the sand dunes (El-Hassan, 1999). Management of the rehabilitated land is crucial and cultivation and grazing should be limited, if not prevented. This can only be done with the full participation of local populations.

Agroforestry offers multiple advantages and trees are well adapted to the uncertainty associated with spate irrigation. In particular, growing nitrogen-fixing trees like acacia species can help to improve soil fertility. The wood can be used as fuel as there is a high demand for fuelwood in the area to replace cow dung, that can then be used as a fertilizer, leading to better yields. Trees can be used as a source of fodder and provide crops with some shelter. Iqbal (1990) and Kowsar (2005) have proposed an alternative mixed system of raising trees, agricultural crops and livestock simultaneously in spate-irrigated areas in Pakistan and Tesfai (2001) refers to the potential for growing trees along field bunds. The production of wood and fodder and terrain stabilization all benefit from systematic efforts towards agroforestry in spate-irrigated areas. Agroforestry can be managed in several ways, including allowing natural vegetation to grow in the command area actively protecting natural vegetation. In addition, planting of indigenous tree species will help stabilize bunds and river courses and provide fuelwood and fodder. There is



Figure 2: Collection of shrubs for the repair of flood diversions spurs in Eritrea

considerable variation between spate systems with respect to the degree of natural vegetation that occurs. The spate systems in the Tihama in Yemen are largely devoid of natural vegetation, while there is a great diversity of wild vegetation in those of Ethiopia, Pakistan and Sudan. In extreme cases, there are spate irrigation systems where natural vegetation grows out of control.

Trees and shrubs in spate irrigation areas are the backbone of the spate agricultural farming system. Many trees and shrubs are multipurpose and used for among others shading, timber, fodder, fencing, fuel wood, edible fruits and medicinal uses. The outputs of these trees and shrubs provide income on top of the income of farming for many farmers and their families and often serve as a reserve fund. In case of drought and other harsh climate conditions, their crops might die but the trees and shrubs will survive. On top of that, many trees and shrubs (Pipal, Date Palm, Cedar, Kandi, etc.) are symbols of religion and praised in poetry and literature (shrubs and trees are gifts of nature and the source of livelihood in arid areas). This Practical Note describes some of the most important and most promising trees and shrubs in spate irrigated areas and their different uses. Most of these trees and shrubs are common and traditional in spate irrigation areas in Pakistan, Yemen (Tihama) and Ethiopia (Tigray).

### Trees and shrubs and its uses/benefits

The table below gives an overview of all trees and shrubs discussed in this practical note, its resilience and its main uses and benefits.



The Selam tree is said to be the most important and dominant tree in spate irrigation systems in Yemen and Ethiopia. It has an estimated land coverage of over 22,000 ha. The Selam tree is very resilient to drought and grows well in areas with rainfall less than 150 mm/year. It is moderately tolerant to salinity and has a high generation capacity. This tree has an average height of 3 to 5 meters without a dominant stem but with thorns of approximately 8 cm. Its life span is 10 to 15 years. The Selam tree

Name of tree/shrub			Resilience		Use												
Local	Scientific	Drought tolerance	Salt tolerance	Fodder	Firewood	Timber	Edible fruits	Fencing	Sand dune stabilization	Honey	Medicinal	Charcoal	Handi crafts	Branches for spate diversion	Bird nesting	Shading	Root used
Selam	Acacia Eherenbergiana	+	+/-	x	x	x		x		x		x					
Sedr/Elb/Argh/Jujube	Zizyphus Spina-christi	-	-	x	x	x	x	x		x	x					x	
Ber/Berry	Zizyphus Mauritiana	+		x	x	x	x	x		x							
Arack	Silvadora Persica	+					x		x								x
Jaal/Jaar/Pilo	Silvadora Oides	+					x		x		x			x	x		x
Haleg/Bedena/Lalo	Balanites Aegyptica	-	+/-	x		x	x		x								
Date Palm/Nakhil	Hyphaene Thebaica	-	+/-			x	x			x			x				
Dome	Cocos Nucifera	+/-	+				x						x				
Athel/Frash/Gaz/Lai	Tamarix	+	+/-	x	x	x		x	x		x		x	x	x	x	
Daber	Debora Glabra	-	-		x												
Jand/Kandi	Prosopis Cineraria/Spicegera	+		x	x	x		x									
Karita/Karir	Capparis Decidua	+		x	x	x	x	x	x	x	x						
Kikar/Babool	Accacia Nilotica	+		x	x	x		x							x		
Mesquite	Prosopis Juliflora	+		x	x	x				x		x	x				

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Local	Scientific	Drought tolerance	Salt tolerance	Fodder	Firewood	Timber	Edible fruits	Fencing	Sand dune stabilization	Honey	Medicinal	Charcoal	Handi crafts	Branches for spate diversion	Bird nesting	Shading	Root used
Paneer	Withania Coagulens	+			x						x						
Boi/Bui	Aerva Javanica	+	+	x	x									x			
Lana/Laani	Suaeda	+		x	x				x			x					
	Fruticosa/Haloxylon Salicornicum																
Phog	Calligonun Polygonoides			x	x				x			x					
sinwaar	Rhazia Stricta			x	x				x		x						
Ak	Calotropis Procera	+		x	x						x						
Plantain	Plantago Ovata										x						
Wanza/Gambil	Cordia Africana					x	x			x							
Sisal	Agave Sisalana	+						x					x				
Poinsettia	Euphorbia Abyssinica					x		x		x							
Mangrove/Shura	Avicennia Marina		+	x											x		
Mutundu	Croton Macrostachyus															x	





Figure 3: left: flower of Selam, middle: honey of Selam, right: charcoal of Selam

has many benefits. Its flowers are very loved by bees which produce high quality honey. It is said to be one of the best honeys used in many local dishes and can be sold for 30USD/liter. Besides its flowers, its leaves and thorns are also beneficial. They are very good fodder for goats and rich in proteins so effective in goat fattening. The branches are used for fencing, its stem and branches for fuel wood and timber and the tree itself for shading. The wood of the Selam tree is produces very good charcoal that lights quick and stays lit for a long time. It is sold in Yemen for about 5USD per sack of 20 kg. Besides using charcoal for cooking, it can also be used to extract Keteran (fluid). Keteran can be used as a cure for animals (mostly goat, sheep and camels) for skin diseases. One old nomadic father in Yemen said the following about the Selam tree: “Iza Labu Sheger Selam, Labu Alnob, Labu Alasel, Labu alkenem, Labu Alakel”. Which means: if there is no Selam Tree, there are no bees, there is no honey, there are no goats, there is no food. The practice of planting this tree has been promoted in the flood water spreading systems in Iran. They attracted a population of sheep and cattle, providing a larger supply of organic fertilizer through animal manure. This, in turn, has attracted the dung beetle, whose burrowing action has loosened the soil and increased the infiltration rates of flood water (Kowsar, 2005).



This tree is very common in spate irrigation areas in Yemen and Ethiopia and has many different local names (Sedr, Elb, Argh, Jujube, etc.). Besides the Selam, it is said to be the most important tree in spate irrigation areas in Yemen because of its many beneficial uses. It has an estimated land coverage of about 10,000 ha in Yemen. In the Shabwah Governorate in Yemen, each household has between 25 and 50 species of Zizyphus trees. It doesn't grow as well in spate areas as the Selam tree but better in highland areas since it is more sensitive to drought. It requires 20 to 30 degrees and 300 to 400 mm of rainfall a year to grow well. On top of that, this tree is sensitive to salinity and can only tolerate  $EC < 0.7$  dS/m. Its average height is 5 to 10 meters and has a life span of 20 to 25 years. Its thorns are 1 to 2 cm long so smaller than the thorns of the Selam tree. Like the Selam tree,



Figure 4: left: honey of Sedr, middle and right: fruit of Sedr



Figure 5: left: camel feeding from Sadr leaves, right: bed made of Sadr wood

its flowers are loved by bees that produce good quality honey that can be sold for the same price (30 USD/liter). The *Zizyphus* produces fruits (called Tihama apple in Yemen) that have a mild sugary taste and is a common supplementary food. On top of that, it is believed to cure kidney problems after boiling, filtering the juice and drinking at least 1 liter a day. Its leaves and branches are favorite feed for camels. On top of that, its leaves can be dried, grind and mixed with water to form a thick green fluid that is used as a shampoo to wash hair. Its stem is very strong and resistant to termite species which makes it very suitable for timber. Its timber is used for making beds, farming tools like ploughs, spades and hoe handles and fishing boats. In Ethiopia, the tree is grafted and its branches are used for fencing. In Pakistan there are quite large orchards of Sadr tree in Multan in Punjab and Tharpakar in Sindh. The grafted trees produce huge quantity of edible fruits that is seasonally available throughout Pakistan. Many households in the temporal region of the country grow this tree and graft it to get improved fruits and have shade to escape the sun in summer days.



The Ber/Berry is wild tree and very common in spate irrigation areas in Pakistan, Yemen, Mauritania, Somalia and Eritrea. In Pakistan, it is also called the 'Miracle Tree' since it can survive during extreme draught conditions and has many beneficial uses. Its height can reach up to 10 meters. There is one variety with a thick trunk which makes its wood very suitable for timber. Its timber is mainly used for construction, roofing material, agricultural tools and furniture. During the flowering stage, bees come for honey collection. Its honey



Figure 6: Fruits of Ber





Figure 7: left: fencing by using thorned branches, right: Ber branches/leaves used as goat fodder

is the most expensive in Pakistan and it does not freeze/become hard. The Ber also produces fruits that are widely used and sold for about 1USD/kg in Pakistan. Its leaves are excellent as goat fodder. There is another variety that has thorns and more a shape of a bush. This variety is mainly used as fodder for goats and its branches with thorns are also used for field fencing and afterwards as firewood. Local varieties can be easily grafted for improved varieties. Some farmers in Pakistan also sell its branches to goat herders who feed its leaves to the animal in March and April. It sheds the leaves in peak summer months in spate irrigated areas as the moisture to the tree is available only by means of rains and subsequent floods. Rural people in Pakistan's spate irrigated areas do not like to sell the trees to timber merchants but prefer to feed it to their domestic animals, particularly the goats.



**Arack**

*Silvadora Persica*

The Arack tree is an endangered species in Yemen with a land coverage of less than 3,000 ha. The tree is easy to uproot and its habitat is being constantly encroached by agricultural fields. The Arack tree is resilient to drought and does well with rainfall less than 150 mm/year. It has a slow regeneration, no dominant stem and a life span of 10 to 15 years.



Figure 8: top: green unripe fruits, middle: red ripe fruits, bottom: Arack used for sand dune stabilization



Its height is 4 to 6 meters and the Arack tree has no thorns. It is one of the only trees which has roots that can be used. They are used as natural tooth brush and raw material for tooth paste that is exported to Saudi Arabia. It also produces fruits that are green when unripe and reddish when ripe. They have a hot/spicy taste and are a supplement to almost every dish in Yemen. The tree itself is very effective in stopping sand dunes.



The Jaal is another Silvadora tree which is more common in Pakistan also called Jaar or Pilo. It can be mostly found in sandy and desert areas. It is highly resistant to drought and can has a height of 3 to 7 meters. This tree has a large and thick canopy and is slow growing. It is the multi-purpose tree of arid areas. Just like the Arack, it is useful for sand dune stabilization and soil conservation

and its thin branches are used as tooth brush and also have medicinal value. One brush is sold for about 10USD cents in Pakistan. The tree is trimmed carefully to get these brush sticks periodically. The branches of the Jaal are used to divert water during spate flow and its fruits are liked as snack. On top of that, the tree is a good abode for birds and wildlife since it is easy to hide in it.



The Haleg tree is native to mountainous areas in Yemen and also called Bedena or Lalo. It grows best with 20 to 30 degrees Celsius and a rainfall of 300 to 400 mm/year. But it has proven to also grow with a temperature above 35 degrees and 100-200 mm of rainfall a year. In these drier areas, it is a very good sand dune defense. The Haleg tree has a moderate regeneration ability and is moderately tolerant to salinity. It has a life span of 20 to 25 years and can grow up to 5-20 m high with a dominant and strong stem and thorns of 5 to 8 cm long. The Haleg tree has many benefits. Its stem is very strong and heavy and the best wood for traditional beds, traditional house poles and fishing boats. The typical Yemeni highland village huts are made with poles of the Haleg tree. Its leaves and branches are good camel feed and its small egg-shaped fruits are supplementary feed for children with a high protein content.



Figure 9: Jaal branches sold as tooth brush



Figure 10: left: traditional Yemen highland house made of Haleg timber, middle: thorns of Haleg, right: Haleg used for sand dune stabilization



The Date Palm (also called Nakhal) grows usually in humid and water rich areas. It is moderately tolerant to salinity and can survive an EC upto 2 dS/m. Its height is 20 to 30 meters with a life span of 40 to 60 years. The tree is moderately sensitive to drought. In order to have good fruits, irrigation from September to March is needed of about 30-50 liters with an interval of 3 to 4 weeks. If there is not irrigation for 5 to 6 weeks, its fruits will become small and less fluidy and if not irrigated for more than 8 weeks, there will be no fruits at all. When irrigated well, fruits start setting in April to August and irrigation can stop. The population of Date Palms has declined significantly in Yemen from approximately 5 million trees in 1970 to 2 million trees in 2005. This is partly related to a lowering groundwater table from 5 meters to more than 40 meters.

The most common and well-known use of the Date Palm are its fruits (dates). It is commonly eaten during the Ramadan. The fruits are harvested, spread and dried. Traditionally it is spread under the sun on thatched sheets made of sisal or dates palm leaves. To avert the effects of rains and sand storms, they are dried in temporary huts made of transparent plastic sheets. The good and bad fruits are manually separated or they are already known by the farmer who already know the variety of tree in the farm. The bad fruits are used as fodder for cattle, goats, sheep and camels. The good fruits dry naturally with air in about 7 days. There is also an improved way where a nylon covered case with various separation compartments is used to select the good fruits. Windows are used for fresh air entry and a small motor is used to suck moisture out of the dates. This drying process only takes 3 days. There is another way of drying the dates that makes it possible to produce honey (in Yemen). It is a long, detailed process: the good fruits are put in sacks that are put on top of each other in a small windowless dark brick-walled room with a temperature higher than 40 degrees. In this state, the fruits are squeezed and start dripping. The fluid/honey drips on the concrete floor, through a hole into a pipe and finally into a container with a cloth filter on top. The 170 to 200 sacks stay packed in the room for about 3 months. The honey is collected in jerrycans, divided in 0.75l bottles and sold for about 5 USD per bottle. The local name for the Date Palm honey is Debs or Kitara



Figure 11: Fruit of the date palm



Figure 12: left: house made of date palm stem and leaves, left: basket made of date palm leaves





Figure 13: process of drying dates, from top-left to bottom-right: drying under the sun on thatched sheets made of sisal or date palm leaves; bad fruits that are separated from good fruits and used as livestock fodder; fruits dried in a temporary hut using a motor to suck moisture out of the dates; various separation compartments to select the good fruits



Figure 14: making honey out of dates, from top-left to bottom right: good fruits put in sacks on top of each other in a room with high temperature; entrance of room; fluid drips into hole, into pipe into a container with cloth filter on top; honey is divided into bottles



(Tihama word for slow continuous drops). The wood of the Date Palm is used for construction of village houses and its leaves/branches are used to make baskets thatched sheets used domestically in local areas. Date Palm is a major source of livelihood for thousands of people in Pakistan and the tree should be protected against wild cutting by unskilled hand-crafters. Panjgur, Kech and Turbat in Balochistan, Ranipur and Sukkur in Sindh Pakistan are major regions producing many varieties of dates, packaging and selling it on local markets. The dry dates are available across the country throughout year.

Some of the local farmer in Balochistan produces its (sheera) a liquid paste from the low variety of date and eat with butter as celebrity food in winter months.



**Dome**  
Cocos Nucifera

Like the Date Palm, the Dome tree is also a coastal tree which is tolerant to salinity and can stand an EC higher than 2.5 dS/m. It has a poor regeneration capacity and is moderately tolerant to drought. It has a dominant stem and can grow up to 30 meters high. Its land coverage also reduced significantly in Yemen from 2 million trees in 1970 to 0.5 million in 2005. The tree is relentlessly cut for various hand craft materials. Also, the tree is dependent on groundwater which has become scarcer; the water table lowered from 2 to 5 meters in 1970 to more than 35 meters in 2005.



Figure 15: handicrafts made of Dome tree leaves

The tree has many different beneficial uses of which the most common one the coconut. The inside is eaten raw and the interior layer is a hard shell used by children for a swirling ball game. Its juice is very sweet and drunk naturally or used in dishes. The leaves of the Dome tree are used for various handicrafts like shopping baskets, prayer mats, bed sheets and sun protection huts. In Yemen, Khel is made from the Dome tree. A cut is made at the juncture between stem and leaves and a container is tied just below the cut to collect continuously ripping thin liquid. Yeast is added to the liquid and kept for 40 days for fermentation. It turns into a strong alcohol with a taste of vinegar. It is diluted with an equal volume of water and usually sold in small bottles of 0.3l that are sold for 5USD per bottle. Khel is used as salad dressing or for in soups.



**Athel**  
Tamarix

The Tamarix tree is common in both Yemen and Pakistan. In Yemen it is called Athel and in Pakistan it is named Frash, Gaz or Lai. The Tamarix is resilient to drought and grows with less than 150 mm of rainfall a year and temperatures higher than 35 degrees Celsius. It is moderate tolerant to salinity and has a poor regeneration capacity. The tree has a dominant stem and is usually between 5 and 15 meters high with a life span of 15 to 25 years. In Yemen it is commonly used for fencing agricultural areas and traditional hut roofs. In spate irrigation systems in Pakistan, this tree is used for more purposes. In Pakistan different varieties grown that vary in height, bushiness and deciduousness. One variety produces natural sugar called shangruff or Shaklo which is used as medicine. There is another variety that becomes hollow at an old age and is used by birds for nesting. The branches of the Tamarix are commonly used to divert spate water into fields. They are not thorny and also very suitable for firewood sold at about 50USD per ton. The green branches are used as fodder for camels. There is one variety that grows in rivers



and has thing, straight long branches that are used to make baskets, mats, handles for agricultural tools and roof thatches. The timber of the Tamarix is light weight and used to make local Pakistani beds (Charpai), other furniture, house construction material and agricultural tools. Its leaves are mixed

with mud for construction reinforcement and also used to clean utensils. Its bark is used in the dying industry (carpet wool) and together with its seeds used in the tanning industry. The tree in its whole is good for sand dune stabilization and shade for humans and animals.

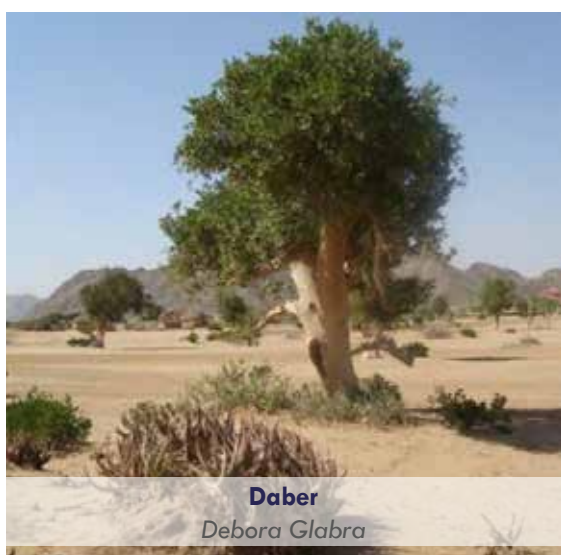


Figure 16: top-left: branches of Athel for roof thatching, other: baskets and beds made out of Athel branches



Figure 17: from top-left to bottom-right: Athel tree used for shade; timber used for poles; Athel tree used for sand dune stabilization; Athel tree used for bird nesting





The Daber is a tree which is relatively sensitive to drought and needs 300 to 450 mm of rainfall a year and a temperature lower than 30 degrees Celsius. It is sensitive to salinity and has a very slow regeneration capacity. Its height is 10 to 15 meters, it has a dominant stem and its lifespan is 50 to 70 years. This makes it one of the oldest trees in spate irrigation areas in Yemen and has a high historical value. Farmers have the tradition to drill a hole inside the tree to store farm implements and farmers lunch. Its old and dry branches are a good source of firewood.



The Jand tree can be found in spate irrigation systems in Pakistan and is also called Kandi. It is a religious tree among indigenous tribes of the Thar Desert. It is very drought resistant and can grow up to a height of 20 meters. It is leguminous in nature thus helps to increase soil fertility. There are different varieties both tree and bush like. Timber is used as main beam in roofs or agricultural tools. Its pods are used for goat and sheep fodder. Branches are trimmed seasonally and its green part is used as fodder and the remaining dry part is used for firewood (often used in local brick kilns) and field fencing since it has thorns.



Figure 18: left: whole in tree used to store farm implements and farmers lunch, right: branches of Daber sold as firewood



Figure 19: left: Jand used in a local brick kiln in Pakistan, right: Timber from the Jand tree





Figure 20: left: fruits of the Karita, right: flowers of the Karita



The Karita (also called Karir) is very common in spate irrigation areas in Pakistan and can be found in all four provinces including coastal zones but mainly in dry areas since it is very drought resistant. It can reach up to 4 meters and is usually in a bush shape but occasionally grows as a tree. The canopy is very thick. Its wood has a bitter taste thus not attacked by ants and liked for construction material like beams and roofing. Camels like the canopy as fodder. Its branches are used for firewood mostly in brick kilns. The branches of the thorny variety are also used for fencing. Karita has flowers that appear in March that are liked by honey bees. It produces fruit that are matured around May/June. In early stage the fruits are used to make pickles. Its fresh red and small flowers are used to cook as a vegetable in many areas of Pakistan. Because of the thick canopy, the tree is liked by wildlife to hide inside and it is useful against wind erosion serving as a windbreak around spate irrigation fields. Also, several grasses and plant species grow under it for protection against eating/cutting.

The Kikar tree (also called Babool) is a predominant tree in spate irrigation areas in Pakistan that can be found in all provinces but can be mainly seen in lowlands and coastal areas. It is drought resistant but can also survive in wet areas, when watered it grows very fast. The tree is leguminous in nature, can grow up to 18 meters high and has many different varieties, both bush and tree types. Some varieties are thornier than others. The less thorny varieties are liked by birds for nesting. The Branches of the Kikar tree are usually trimmed every year during winter season and used as goat, sheep and camel fodder. Dry branches are used as firewood (usually in brick kilns) and the thorny branches for fencing of spate irrigation fields. Its wood is used for many purposes: beams for house/hut construction, agricultural tools, furniture and planks. Medium poles are also used in the mining industry to support mine tunnels. The Kikar tree grows flowers that come out in August/September that are liked by bees and its pods that appear during spring are eaten by goats and sheep. The tree also produces gum that is used for sweets and other confectionary items. Also its twigs are used as tooth brush which is thrown away after one time use as it gets dried quickly. Its thorn is considered dangerous for humans and animals because it can pinch in bear feet. The large trees provide shelter against the scorching heat of summer months both to human and animals. Many households grow it in the home compound to have shade in summers.



Figure 21: from top-left to bottom-right: branches of Kikar used for goat fodder; pods of the Kikar; wood of Kokar; Local hut made of Kikar wood and dried branches



**Mesquite**  
*Prosopis Juliflora*

*Prosopis Juliflora*, also known as mesquite, is a woody stemmed, thorny, evergreen shrub or small tree that is common in spate irrigation systems in Eritrea, Ethiopia, Kenya, Pakistan, Somalia, Sudan and Yemen. Especially in areas where livestock is grazing, *Prosopis Juliflora* spreads rapidly via seedpods clinging to animal skin. It germinates easily and once settled in an area it is difficult to get rid of and it takes over natural vegetation. *Prosopis Juliflora* invades land and encroaches on river beds and canal beds blocking them and in turn shifts drainage patterns uncontrollably. Its thorns are poisonous and livestock can become ill when exclusively fed with pods of *Prosopis juliflora*. But this shrub also has a lot of benefits and is one of the most versatile shrubs in spate irrigation areas. Its wood is hard, durable and resistant to pest attacks and weathering when mature which makes it very suitable for furniture making, housing

and flooring and decoration material. Its wood is used as firewood since it burns slow and has good heating properties. Charcoal is produced of it which can provide a small-scale producer an income of 1900USD/year. This charcoal can in turn be used as bio-char to rehabilitate acidic degraded land, improve soil properties and increase yields. *Prosopis* is also used for bio-fuel since its sugars can be converted into ethanol. Also, its biomass can be used to produce power. On top of that, its wooden residues can be chipped and used as mulching or processed into wooden pulp which is the primary raw material for paper production. Its pods are eaten by livestock (as long as it is <50% of its total diet) and when dried, milled and mixed it becomes highly nutritious flour to be used to e.g. make bread or porridge. When *Prosopis* blossoms, it produces a high amount of pollen that can be transformed into good quality honey. The shrub also exudates gum that can be used in the food-cosmetic industry.

In the spate irrigation systems of the Gash and Tokar in the Sudan, there has been a severe invasion of mesquite since the 1990s. The species were introduced as part of dune stabilization programmes, but soon got out of hand. The aggressive spread of the mesquite in the Gash and Tokar spate systems in the Sudan is largely the result of poor field and marginal land management arrangements, related to the absence of permanent land ownership in these systems. The mesquite is a



prime source of income for landless families, who use it to produce charcoal. Under the new Gash Livelihoods Project, the eradication of mesquite is now foreseen in combination with land titling. This will need due consideration of mesquite’s economic importance as the primary source of cash income, particularly for the landless, and its river bank stabilization effects. The project will identify suitable alternative non-invasive tree species for establishment on public lands and women’s group woodlots in the area. Such tree species will include nitrogen-fixing trees as well other trees with extensive root systems.



Paneer is a shrub that is very common in spate irrigation areas in Pakistan, mostly on sandy and loamy sandy soils. The shrub is highly drought resistant and can grow up to 2 meters high. It has a big coverage and thick canopy so birds like to hide inside. Its dead branches are used for firewood and its flowers are liked by bees. The fruit and seeds are used in different local medicines at household level in daily life. Its seeds are also sold on local markets and exported abroad for the herbal medicine industry. The seed is also kept in almost every household to prepare local cheese.



Figure 22: chipping of the wooden residues of the Mesquite



Figure 23: left to right: stairs, art, table and sculptures made of Mesquite wood



Figure 24: Making, packing and loading of charcoal made out of Mesquite





Figure 25: from top-left to bottom-right: Pods of the Mesquite collected; pods weighted; pods milled and mixed; mesquite pod flour



Figure 26: left: pods of the paneer, right: seeds of the paneer



**Boi**

*Aerva Javanica*

Boi is common in spate irrigation areas in Pakistan that have sandy soils including for the coastal

zone. The shrub is highly drought resistant and can withstand high temperatures. It can grow up to 2.5 meters high and has thin light weight stem and branches. Its wood is good firewood used on household level and in brick and pottery kilns. Boi produces a cotton like flower used to fill pillows/ quilts and other bedding items. Its branches are good fodder for camels, donkeys, cattle sheep and goats and is available during drought periods. The branches are also used to divert spate water to the field when dry. At flowering stage, the shrub is liked by bees.



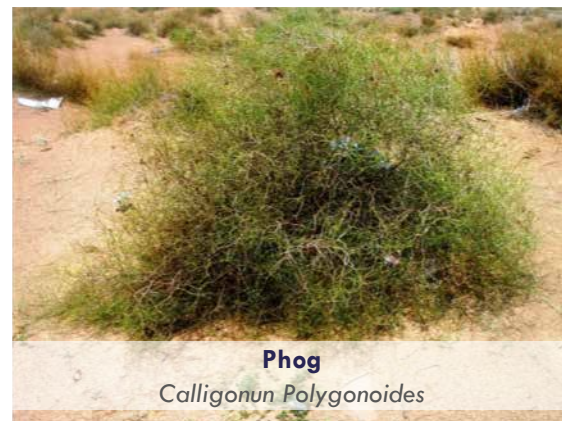


Figure 27: Dried branches of the Boi



Lana (also called Laani) is a shrub that is common in all four provinces of Pakistan with various heights up to 1 meter depending upon different factors such as water availability. It is a slow growing bush but highly drought resistant. In many spate irrigation areas, it is the main fodder for camels. Its branches are also used as firewood on household

level and in brick kilns. The Lana is under threat since commercial exploiters uproot the plant to be used in brick kilns on commercial level. There is one specific variety that is used to produce charcoal mainly used in local blacksmiths fire ovens. Another variety is used to make local organic soap. Since the shrub has no thorns, it is used to make huts. On top of that, the Lana shrub is good for sand dune stabilization. It is currently an endangered species in Pakistan and is vanishing quickly.



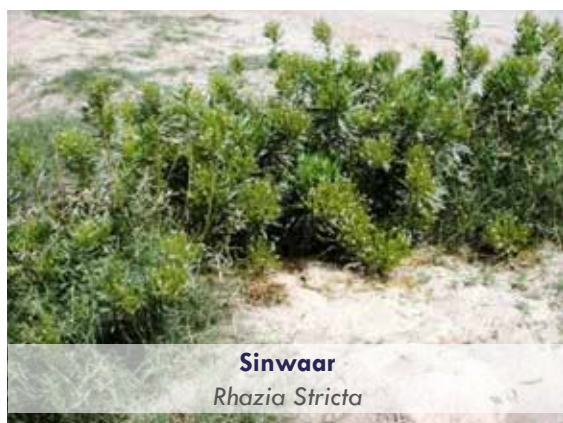
Phog is a famous shrub in arid regions of Pakistan and mostly grows on sandy areas. It can reach up to 3 meters high. It has light weight wood which is very suitable for household firewood and brick kilns. Also, charcoal is made from its wood. Besides that, its green branches and leaves are used as fodder for camels, goats and sheep. Phog is also a good sand stabilizer. Phog is also an endangered shrub specie that is disappearing in many parts of Pakistan.



Figure 28: from top-left to bottom-right: Lana charcoal used in a local blacksmith in Pakistan; Lana charcoal; dried Lana branches; Lana used for sand dune stabilization



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Sinwaar is wild shrub and commonly found in sand dunes and sandy soils throughout spate irrigation areas. The shrub can reach up to only 0.75 meters high. Its branches are sometimes use for firewood at household level. Its dry leaves are eaten by goats, sheep and camels and has medicinal value and thus used in herbal medicines. The Sinwaar is also a good shrub for sand dune stabilization.



Calotropis procera can be found in spate areas in different countries mainly in Pakistan, Ethiopia and Kenya. It. can reach up to 3 meters and in rare cases even grows as a tree. Its dry leaves are used as fodder for goat and sheep and is not liked by other animals. It has either white or purple flowers. Its inside flesh contains toxic milk which can lead to blindness when in contact with the eye. Also, the plants takes up quite water which inhibits the growth of other plants and in turn makes land barer. However it also has advantages. Its leaves have medicanal value. Its large nature of leaves can be warmed and pressed on the breasts of nursing mothers to reduce swelling and its root infusion is a remedy for coughs and snake bites. In addition, the calotrhopis is a source of high quality cotton. Its branches can be used for firewood. Its branches are hollow inside and are used in Pakistan for sisha equipment.



Figure 29: Sinwaar in different areas, also used for sand dune stabilization



Figure 30: Cotton of the Ak





Figure 31: left: Sisha equipment made of Ak branches, right: purple flowers of the Ak



**Plantain**  
*Plantago Ovata*

The plantain is a very small shrub found on loamy and sandy soils in spate irrigation areas. It grows well in February after the winter rains of December/January and harvested in April. The male seed is more coars than the female and needs more water. It is usually found in depressions where moisture is available, without moisture it will not survive. The female plants grow better on soils having good draining qualities and slopes. In Pakistan, its seeds and shoots/bulbs are harvested and grinded in local stone flouring machines. This serves as a local herbal medicine which is bought by dealers and sold in national and international markets for a local price level of 6USD/kg. It is a good source of income for women in local areas who collect on average 15 to 20 kg/year.



**Sisal**  
*Agave Sisalana*

The sisal is mainly used for fiber and rope making. But also, for live fencing established by cutting. In Tanzania it is monocropped while in Pakistan it is planted in marginal areas. In Mexico it produced on big scale for tequila production. Cores/roots are packed on top of each other in a hot oven. The liquid that comes out of it is distilled.



**Poinsettia**  
*Euphorbia Abyssinica*

The Poinsettia is very common in Ethiopia and Kenya where it grows in midlands. It is used for fencing, produces honey and construction wood to make doors.



**Wanza**  
*Cordia Africana*

Wanza (also called Gambil), is common in spate irrigation areas in Ethiopia. Its wood is strong and used for house construction and making of furniture (Beds, chairs) and cupboards. Its yellow fruits are edible and its flowers attract bees.



The Mangrove (also called Shura) is common at the Red Sea Shores. It is very tolerant to salinity and can withstand an EC of over 4 dS/m. It has a high regeneration capacity, no dominant stem and a maximum plant height of one meter. Camels love to eat the leaves of the Mangrove and it is also a good habitat for migrant birds. This shrub is also common in the coastal area of Thatha and Badin in Sindh Pakistan where many non-profit organizations are trying to restore its vegetation. It provides shelter to the fish and good environment for fish hatchery in natural conditions.



This tree is common in spate irrigation areas in Ethiopia where it is mainly used for shade. It needs pruning over the cropping seasons to avoid bird attack.



Figure 32: Camels feeding from Mangrove

## Conclusion

Trees and shrubs in spate irrigation areas have many different uses and considerably contribute to the livelihoods of the people living in these areas. In some areas, more uses are discovered/known than in other areas. Sharing good practices among farmers in the same area and in different areas and countries is important to promote the uses of trees and shrubs in spate irrigation areas. Cutting of trees in spate irrigation areas should be reduced. The clearing of land of trees and shrubs close to spate-irrigated areas is primarily associated with the traditional construction of diversion bunds and the collection of wood for fuel. The construction of brushwood spurs and weirs in traditional spate irrigation requires large numbers of trees and branches. In Eritrea, the intensive use of acacia trees seriously threatens the long-term sustainability of spate irrigation in the Eastern Lowlands. For example, it has been reported that more than 28 000 trees are required annually to build water diversion structures to irrigate the 3000 ha of land under flood-based farming systems of Sheeb in Eritrea. Farmers estimate that it now takes ten times longer to gather the acacia shrubs needed to maintain their system than in the past. Similarly, in the border area of the Sudan with Eritrea, brushwood flood-spreading structures were traditionally built from branch palm (Niemeijer, 1993). This tree has now largely disappeared from the area and the steep decline in water spreading is associated with its loss. In several parts of Ethiopia natural vegetation has become scarce and the sorghum roots are excavated and used in place of brushwood for flood diversions, with further negative consequences on soil fertility and erosion. Thus, options to reduce the unsustainable use of local trees and shrubs, through the construction of more permanent diversion structures, should be highly promoted. Also, local tree cutting bans should be put in place to protect trees in common lands. A combination of local water harvesting and planting high-value tree crops could turn areas with low outputs and income generation into high-value areas. One important aspect of this is improving the marketing of non-wood forestry products like honey and medicinal products. These significantly add to the income of farmers without threatening the number of trees.



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## Colofon

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