Conservation and Sustainable Use of Genetic Resources
of Priority Food Tree Species in sub-Saharan Africa

SAFORGEN

Ziziphus mauritiana

Ber

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Ber plantation for fruit production

Common name	Scientific name	Synonyms	Family
Ber, Indian jujube, Indian plum, Indian cherry, Indian date (English) Jujubier (French)	*Ziziphus mauritiana* Lam.	*Ziziphus jujuba* (L.) *Lam.*, *Z. jujuba* (L.) Gaertn. (including var. *stenocarpa Kuntze*), *Z. tomentosa Poir* ., *Z. rotundata* D.C., *Z. aucheri Boiss*., *Z. insularis Smith*, *Z. sororia Roem*. and *Schult*., *Z. orthacantha* DC.	Rhamnaceae

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This leaflet highlights the nutritional and socio-economic potential of ber and provides information to assist those working with the species. The focus is on conserving genetic diversity and promoting sustainable use of ber. The leaflet presents a synthesis of current knowledge about the species. The recommendations provided should be regarded as a starting point, to be further developed according to local or regional conditions. These guidelines will be updated as new information becomes available.

Socio-cultural group	Country	Vernacular name
Tigrinya	Ethiopia	Abateri, gaba-artgie, gewa-ortigi
Kiswahili	Kenya, Tanzania	Mkunazi
Boran	Kenya	Kwkurrah
Turkana	Kenya	Ekalati
Luo	Kenya	Olongo
Pokot	Kenya	Tolumuro
Chewa	Malawi	Masao
Yao	Malawi	Msondoka
Wolof	West Africa – Sahel	Sédeem, sideem, deem, dim
Fulbe	West Africa – Sahel	Jaabé, jaabi, tabi, n'giobi
Serer	West Africa – Sahel	Ngit, ngic, gic, ingnic, ngel
Jola-Fonyi	West Africa – Sahel	Bu sédem, tôbôro
Bambara	West Africa – Sahel	Ntomono
Mandinka	West Africa – Sahel	Tômônon
Hausa	West Africa – Sahel	Magaria
Hassanya	West Africa – Sahel	Sider, sidar, neggaie, nabagaya
Mooré	West Africa – Sahel	Bagende, magunuga, mugulanga
Tamachek	West Africa – Sahel	Ajzen
Gourmanché	West Africa – Sahel	Batenluongu, bu sakonhionabu, inakpayuani, nan janlwane
Karamajong	Uganda	Esilang
Nyanja	Zambia	Masau
Tonga	Zambia	Musawce
Bemba	Zambia	Akasongole
Shona, Tangu	Zimbabwe	Musawu, masua, yanja

Geographical distribution

Ber is widely distributed throughout the warm subtropics and tropics of South Asia and Africa. It is found in the arid to semi-arid zones of all Sahelian countries in West Africa, and of East and southern Africa (Sudan and Kenya to Mozambique and Angola).

Importance and use

Ber is preserved in farmers' fields primarily because of its nourishing fruit. A survey in Burkina

Fruits from domesticated trees and from wild trees

Faso, Mali, Niger and Senegal revealed that this species is among the ten species most valued by farmers. However, the small size of the fruit of the local cultivar and its sensitivity to parasite attacks limit its cultivation.

The main product from ber is the fruit pulp which is consumed fresh or dry and also made into a juice. In addition, leaves are used for fodder and the leaves, roots and bark are used for medicinal purposes. The wood is used for handles, kitchen utensils, firewood and charcoal.

Increasingly it is planted together with other tree and shrub species as live fences to protect

Uses	Part of plant
Food and drink	Fruit
Fodder	Leaves, branches, fruits
Live fence, erosion control	Whole tree
Fuel wood/charcoal	Trunk, branches
Medicines	Leaves, roots, bark, fruits, seeds
Handles, kitchen utensils	Wood


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Fruits for sale in a local market

crops or vegetables from browsing by animals in the dry season. It is also appropriate for planting along contour lines for erosion control. In addition, ber is among the most popular species used in agroforestry systems for the protection and improvement of soils, especially in the Sahelian zone of Africa.

Socio-economic value

Ber is an important fruit in sub-Saharan Africa contributing to food security and household income.

In Africa, ber trees are not grown on a commercial scale in most of the producing countries and fruits are collected from trees growing in home gardens and in the wild. In West Africa, trade of ber fruits is still limited to local markets and managed by rural communities. In SADC countries, this trade is well organized. In Zimbabwe, a study has shown that producers and traders of ber fruits have been able to capture better prices by cleaning and packaging the fruits in plastic bags. In countries such as Botswana, Malawi or Zimbabwe, there are companies specialized in trade of wild fruits and ber is among the best selling ones.

Ecology and biology

Ber is most abundant in savannah parklands in semi-arid lowlands with an annual rainfall up to 800 mm and maximum temperatures up to 45°C. It is a drought tolerant species but also cultivated in higher rainfall areas. It grows on a wide range of sites but prefers free-draining soils, though it tolerates short-term water logging. Outside its native area, ber can become a problem, forming dense thickets, hampering livestock production and reducing pasture production.


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Ber fruit development

Reproductive biology

Ber flowers are both male and female. There is a high rate of abortion, especially for young trees. Ber is largely out-crossing. Some trees release pollen in the morning while others release it in the afternoon, thus favouring cross-pollination. Under controlled pollination, fruit set is greater with cross-pollination than with self-pollination. Observations at Samanko, Mali, show that ber is mainly pollinated by insects, including bees, butterflies and beetles.

Phenology

Ber sheds its leaves and becomes dormant during hot, dry periods. In the Sahel it sheds its leaves in March–April. The trees produce new leaves in June and July and fruits mature in December to January.

Related species

Three *Ziziphus* species apart from ber are found widely in sub-Saharan Africa:

- *Z. abyssinica* in scattered tree grassland at 400–2200 m above sea level, from Senegal to Ethiopia and south to Zimbabwe and Mozambique.
- *Z. mucronata* in open woodland at 0–200 m above sea level, from Mauritania and Senegal to Somalia and south to South Africa and Madagascar.
- *Z. spina-christi* in semi-arid areas at 0–1300 m above sea level, from Mauritania and Senegal to Cameroon and in the Horn of Africa and North Africa.

Morphological traits and their variation

Ber is highly variable in size and form, ranging from a spreading shrub to an erect small or medium-sized tree. Height varies from 3-16 m. Branches and twigs may or may not have spines and leaf size and shape also varies. The flowers have an acrid smell and form small clusters. The plum-like fruits are variously coloured and smooth-skinned, and from improved varieties, may be 5 cm long by 3 cm in diameter. The number of flowers varies significantly among trees and is highly correlated with fruit set and ripe fruit number, thus indicating that the number of flowers can be used as a reliable criterion for indirect selection of superior genotypes of ber.

Genetic knowledge

There are very few published studies of ber genetic variation in Africa. Provenance/progeny trials have been established mainly by the World Agroforestry Centre, in collaboration with the FAO and other partners in Burkina Faso, Mali and Senegal during the last decade. Although the provenances trials include low numbers of provenances and most were planted only in one location, preliminary results indicate high genetic variation in growth and morphological characteristics. Early results from provenance trials in Mali and Senegal indicated significant differences in growth and biomass production among provenances. Fruit production is just beginning in these trials, but early results suggest that provenances vary. Similar results have been found in India.

Local practices

Traditionally, local rural communities do not distinguish variations within the species. It is believed that the trees, mainly once managed in live fences, can habour snakes and rats. Rural farmers rank it as one of the most preferred fruit tree species and the local populations are managed in the wild. However, farmers are more interested in Indian and Thai varieties that produce larger and tastier fruits than African varieties. These are mostly managed in fruit orchards.

Threats

Ber is not considered to be threatened. However, deforestation, climate change, bush fires and changes in land use practices are reducing the frequency of the species across the Sahel.

Conservation status

In addition to the collection of local sources, mentioned in the previous section, the World Agroforestry Centre has varieties from India and Thailand, and has established a genebank in Samanko, Mali, which now contains over 60 clonal accessions, including more than 40 Sahelian selections. Such materials are conserved *ex situ* as mother plants for vegetative cuttings, and for on-going and future breeding programmes. These are active collections that support the national and regional ber improvement schemes, rather than static collections for a long-term conservation in gene banks.

Ex situ emphasis has been on live genebanking but ber can also be conserved as seed. The seeds are orthodox and should be stored at low moisture content (7-10%) in air-tight containers. At room temperature the seed can be expected to store for at least one year. In cold storage at 5ºC, the seed will retain high viability for several years. Seed is stored temporarily for use in planting and improvement programmes at several Tree Seed Centres in Africa including Burkina Faso, Mali, Malawi, Niger, Senegal, Tanzania, and Togo.

It is not known whether ber occurs in any conservation areas that receive effective protection.

Management and improvement

Although the potential of ber is evident in the Sahel, farmers face a number of constraints to cultivation, including the limited productivity of local accessions, limited water availability, infertile soils, threats from pests and diseases, lack of improved germplasm and/or lack of access to the improved germplasm, limited knowledge regarding fruit tree management, and natural resources policies that often prevent farmers from managing trees on their farms.

In the West African Sahel, local ber accessions commonly produce about 5-8 kg of fruit per tree at three years of age, without irrigation or fertilizer, compared with 20-50 kg per tree for improved varieties from India and elsewhere. With irrigation and improved management fruit yields of 80-200 kg per tree are achievable.

However, the introduced varieties often have pest and disease problems; for example, Indian varieties of ber are attacked by fruit borers, fruit flies and leaf and fruit eaters. The variegated grasshopper (*Zonocerus variegatus* L.) is one of the major pests, and limits cultivation of most improved varieties in sub-Saharan Africa. The fresh fruit of improved varieties also deteriorates very rapidly after harvest, making transport to the markets difficult. As a result, farmers continue to grow local varieties even though they have lower production potential.

Selection and domestication

Improved cultivars are being produced in China, India and Thailand. The World Agroforestry Centre is also running a selection programme using accessions from Africa, India and Thailand. The aim is to develop improved accessions which combine the heavy fruiting virtues of the Asian varieties with the pest-tolerance and local adaptation of local accessions. In Burkina Faso, introduced cultivars have performed better under irrigation and application of rock phosphate than the local cultivar. Results of the World Agroforestry Centre's crossing trials between introduced and local cultivars show evidence of significant divergence between the Asian and African populations. Some of the crosses had very low fruit set probably because of a degree of incompatibility between various accessions from India or Thailand crossed with the Sahelian local sources.

A programme for the improvement and domestication of ber has been initiated in Senegal to optimize the use of the ber in the agroforestry systems of West Africa's arid zone. This programme focuses on introducing and adapting improved varieties of Indian origin to the Sahelian zone. These varieties derive from a genetic improvement programme established in India over a century ago. However, when applied in Senegal, the vegetative propagation methods developed in India, including stem cutting and grafting, resulted in low success rates, unsuitable for large-scale use. Consequently, *in vitro* culture was tested as a means of mass propagation for this species. This was justified by the success of micropropagation in species which do not react well to traditional horticultural propagation techniques. The outcome of this research is the achievement of successful establishment of over 80% of the micrografts.

In another improvement programme more than 150 'plus trees' have been selected by farmers and

researchers in parts of Burkina Faso, Guinea, Mali, Niger and Senegal since 2004 and have been established in genebanks and regeneration plots. Plus trees were selected based on the following criteria: tree vigour, early and high fruit set, sweet fruits, resistance to pests and disease, small seeds, large and round fruits, relatively long shelf life, fewer thorns, large canopy with many branches for greater fruit production.

More collections are planned in the future by the World Agroforestry Centre and its partners to ensure that the breeding population has a broad genetic base.

The selection of plus trees and their clonal development may be faster and have a greater impact than conventional breeding. However, it is very important to ensure that genetic diversity is not severely reduced in the process. This is particularly important for on-farm breeding populations, because farmers tend to select very few trees/clones to establish orchards.

The following is a breeding strategy suitable for ber in the Sahel allowing a broad genetic base:

- Establish and analyze provenance/progeny trials that include provenances and progeny from candidate plus trees. The trials should include seedlings from promising trees throughout the range of the species and be replicated in the range of environments where ber would be grown in the Sahel. Replications should be established not only on experimental stations, but also on farms and the programme should involve the participation of farmers in the evaluation of the variation.
- Select the most promising trees from the progeny trials. Selection criteria include fruit-quality characteristics as determined by market demand and rural preferences; yield and phenology of production (i.e. extend production period); water-use efficiency and drought tolerance; resistance to pests and diseases, and other criteria considered important by rural communities.
- Carry out population improvement by grafting scions from the best trees in progeny tests to establish orchards (different trees will likely be best in different areas), and use controlled pollination to produce progeny for the next round of progeny testing. The orchards will serve as sources of cuttings for mass propagation as rooted cuttings and for breeding for continued improvement.

Propagation from seed

Ber is usually propagated from seed. Natural regeneration is very abundant, but ber seedlings can also be raised in tree nurseries. The seed coat is hard and should be cracked or partially removed before planting. The seed is then sown without any further treatment.

Seed should be planted in a good growing medium (made of equal parts of sand, silt or clay and organic manure) either in seedbed at a spacing of 30 x 30 cm or in pots or polythene bags. Seedlings should be transplanted to the field during the rainy season to aid establishment. On well-prepared soils, seed can also be sown directly into the ground, preferably during the rainy season. After the seedlings have developed a strong taproot, i.e. 7–12 months after sowing, they can be thinned to a required number of trees, at a correct spacing.

Vegetative propagation

Several methods of vegetative propagation are available, including cuttings, grafting and air

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Controlled pollination



Grafting ber

layering (marcotting). Top grafting is the most popular technique for propagating this species in the Sahel because it is quick, easy and effective (success rate up to 95%). In the Sahel, T (shield) budding during the active growth period from June to September is 85% successful. Buds should be inserted as close as possible to the ground to minimise the area for emergence of sprouts from the rootstock.

Management

Planted trees need careful tending for best results. Plants should be established in holes of 40 x 40 x 40 cm filled with top soil and about 1.5 kg of farm manure. Holes should be prepared one month before planting. Tree spacing varies from 5 x 5 m (i.e. 400 stems per hectare) up to more than 10 x 10 m (i.e. about 100 stems per hectare) depending on climatic conditions and tree characteristics.

Young trees should be watered at least once a week during the first year with 20–30 litres of water per tree. This can be gradually decreased as the trees become well established.

In the Sahel, farmers are encouraged to apply organic manure and rock phosphate fertilizers to boost production. Ber trees can be pruned to a height of 1.2–1.5 m to facilitate management and harvesting. This can be done by cutting (pollarding) the main stem above the first 2–5 secondary branches to allow the development of lateral branches that will bear the fruits. In the Sahel, pruning is done during the dry season.

Crops can be grown under young ber trees until the trees occupy entirely the space provided.

Guidelines for conservation and use

Ber is not threatened in the Sahel. Natural populations are plentiful and smallholder farmers preserve the species on-farm. Therefore, the best means of preserving the species is *in situ*, including on farm and in the forests in the natural ecosystems in which it occurs.

Research needs

- Conduct molecular analyses to determine the likely origin of the species and identify centres of diversity to guide conservation activities
- Determine the number of viable populations in protected natural areas such as national parks
- Identify seed handling methods to enhance potential for *ex situ* conservation
- Determine genetic variation in drought tolerance, tree growth and fruit production, and location of important sources of variation
- Identify pollinator species, investigate effective pollen flow and determine threats to pollinator species
- Investigate effectiveness of seed dispersal and degree of dependence on fauna that are rare or threatened
- Determine effective population sizes in semi-natural farmland populations and minimum viable populations for conservation and long-term sustainable use. ■

Ziziphus mauritiana **Ber**

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This leaflet was produced by members of the SAFORGEN Food Tree Species Working Group. The objective of the working group is to encourage collaboration among experts and researchers in order to promote sustainable use and conservation of the valuable food tree species of sub-Saharan Africa.

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