

*Lawsonia inermis* (henna). Henna leaves are used for cosmetics. A drought tolerant line was introduced from India and is used as live fences since it is not palatable to ruminants.



Women farmers use some of the harvested okra for home consumption.

### Vegetables

Two traditional leafy vegetables are planted in the BDL system: *Senna obtusifolia* and Roselle (*Hibiscus sabdariffa*). In a recent survey of leafy vegetables in Niger, *Senna obtusifolia* came second (after moringa) and Roselle came fourth in preferences by the rural population.

Okra (*Albemoschus esculentus*) is a very important component of the diet of Africans. ICRISAT/ AVRDC has identified a short duration cultivar from the Birnie N'koni area that is most suitable for production in the zai holes of the BDL. Unlike the case with cereals and legumes, okra seeds are balanced in both tryptophane and in sulfur-containing amino acids.

### Conclusion

The BDL is an innovative production system of horticulture crops that provides solutions to a range of critical constraints affecting the livelihood of the rural population of the Sudano Sahel. Because of its simplicity and its many positive attributes the potential for its mass-adoption is very high.

# Bioreclamation of Degraded Lands

## Improved soil fertility, harvested rainwater, and a successful tree-crop system



## About ICRISAT



The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) is a non-profit, non-political organization that does innovative agricultural research and capacity building for sustainable development with a wide array of partners across the globe. ICRISAT's mission is to help empower 644 million poor people to overcome hunger, poverty and a degraded environment in the dry tropics through better agriculture. ICRISAT belongs to the Alliance of Centers of the Consultative Group on International Agricultural Research (CGIAR).

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Science with a human face

## Introduction

The Sahel, south of the Sahara in northwestern Africa, has a very hostile environment. Air temperatures are always high and the intense monsoon rains cause significant soil erosion. The prevalent acid sandy soil is very poor in nutrients and has very low organic carbon content. In these harsh conditions, 60 million poor people need to live and grow food.

More than 50% of the Sahelian soil is degraded. Most of these degraded lands are crusted lateritic soils. The soil is undergoing a continuous process of erosion, mostly by wind but also by water. Between 70 to 90% of the population live off rain fed agriculture, but drought results in crop failure in two out of five years.

The lack of nutritional balance in the daily diets of rural Africa is becoming a matter of concern to the international community. In dry West Africa between 13-15% of children are suffering from acute malnutrition.

The Bioreclamation of Degraded Lands (BDL) system developed by ICRISAT provides solutions to these constraints. The BDL is an integrated system aimed at increasing food production and income of poor farmers (chiefly women) through the utilization of degraded lands for production of rain fed fruit trees and vegetables.

## The BDL Method

Degraded lands are scarified to break down the surface crust. Micro-catchments (called demi-lunes)



A single tree is planted in each demi-lune (half-moon structure).



Manure is placed in the zaï pits, which are dug between the demi-lunes.

are built to catch and store runoff rainwater. The demi-lune is usually 2 x 3 m in size, but size can vary if necessary. The harvested water is stored in the soil for long periods and is utilized by a tree planted in the 40 x 80 cm ridge left in the center of the open side of the demi-lune to avoid waterlogging.

Demi-lunes are usually spaced at 5 x 10 m. The area between the demi-lunes is occupied by planting pits known as "zaï" holes, which are holes 20 x 20 x 20 cm deep dug in the laterite. About 250 g of compost or manure is placed in the bottom of the zaï hole and is covered with a 5 cm layer of soil. Traditional vegetables are planted in the zaï holes that are usually spaced at 0.5 x 1.0 m. The zaï also collects runoff water. The deeply placed compost in the hole results in extensive root growth allowing the plant to exploit both water and nutrients. In addition, trenches are dug every 20 m down the slope to further harvest runoff water.

## Empowering the women

Women are denied the right to own cropland in the Sahel, but a village chief can allot degraded lands to women. The women form associations that are legally registered. The association leases each of its members a plot of land in the BDL ranging from 100-300 m<sup>2</sup> in size. In a 200 m<sup>2</sup> plot there are two Pomme du Sahel trees and two Moringa stenopetala trees intercropped with traditional vegetables.

## Crops for the BDL

Trees are a major component of the BDL. They are much more resilient to droughts and can cope better with dry spells than annual crops. The most suitable vegetable crops are okra and Roselle

ICRISAT established a BDL experimental field in 2006 using the water-harvesting technologies and



An ICRISAT scientific officer supervises the harvesting of a roselle crop in Niamey, Niger.

trees and vegetables. The trees are still young and only now are starting to bear fruit. However yield data for the traditional vegetables is available. *Senna obtusifolia* can produce a yield of 1,500 fresh leaves per hectare. The calyx yield of Roselle is 450 kg/ha and the fresh yield of okra fruit is 1,000 kg/ha. The estimated annual value of tree and vegetable products can amount to US\$ 1,200/ha.

## Tree Species

The two trees selected for the BDL are described below:

*Ziziphus mauritiana* is a small tree native to the Sahel but with a wide range of distribution all the way to Thailand. India domesticated this tree. The fruit resembles a small apple in shape that prompted us to call it the Apple of the Sahel, or Pomme du Sahel in French. A mature rain fed tree can give a yield of up to 20 kg of fruit. Pomme du Sahel has ten times the concentration of Vitamin C as compared to an apple. It is rich in iron, calcium and phosphorus and in essential amino acids.

*Moringa stenopetala* originates in Ethiopia and Kenya. The tree yields large quantities of leaves that are consumed as a vegetable. Its relative, *Moringa oleifera* (moringa or horseradish tree, commonly called drumstick) from India is well known in Sahelian countries. Moringa is one of the most nutritious vegetables known – the green leaves and immature pods and seeds are consumed. It has seven times the Vitamin C of oranges, four times the Vitamin A in carrots, four times the calcium of milk, double the protein of milk and three times the potassium of bananas. The leaves have a very high concentration of anti-oxidants. In the Sahel, *M. oleifera* requires supplementary irrigation but *M. stenopetala* can grow in demi-lunes without supplementary irrigation.

In addition, the following trees are under investigation:

*Tamarindus indica*. The tamarind is native to dry Africa and South and Southeast Asia. The fruit (pod) is usually sour. ICRISAT is testing four varieties of Sweet Tamarind obtained from USDA-Florida.

*Sclerocarya birrea* sub-species Caffra. Sclerocarya (marula) is a drought tolerant tree native to Africa's drylands. The sub-species "Caffra" that grows in southern Africa is a very robust tree. The fruit of Sclerocarya are used for juice, wine and liquor production. The kernels are used as tasty nuts. The oil extracted from the kernels is used in cosmetics. Ben Gurion University scientists together with a local NGO selected in Botswana three lines of high yielding trees with large fruit. These were successfully grafted in Niger on the local Sclerocarya birrea and are growing well in the degraded land.

*Acacia senegal*. This Sahelian tree produces the well-known gum Arabic. ICRISAT selected high yielding *A. senegal* trees from a Sudanese provenance (giving about 1 kg gum per tree) and grafted these on local *A. senegal*.

*Boswellia papyrifera*. This is the Frankincense tree from dry Ethiopia.

*Acacia tumida*. A fast growing Australian species producing a high biomass on marginal lands of the Sahel. Used mostly for wood but its seeds can be used as chicken feed



A Pomme du Sahel tree (*Ziziphus mauritiana*) can produce up to 20 kg of the small apple-like fruit in a season.