

Food and Agriculture Organization of the United Nations



Pastoral and Environmental Network in the Horn of Africa

# MANAGING AND UTILISING PROSOPIS TREES A MANUAL TO SUPPORT RURAL COMMUNITIES TO "MAKE PROSOPIS MAKE MONEY"

# Managing and utilising prosopis trees

# A manual to support rural communities to *"make prosopis make money"*

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The Pastoral and Environmental Network in the Horn of Africa (PENHA) is a nongovernmental organisation, registered as a charity in the UK with its head office in London.

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# 1. Introducing basic concepts

## The potential of prosopis

## Traditional uses

In Argentina, Chile, Peru, Mexico and the USA where prosopis trees are native and have always been there, native people learnt how to make the most of what the trees produced. The pods were a vital staple food from at least 5000 years ago and remained so until the arrival of modern agriculture and cheap cereals, are still a valuable source of animal fodder, and the wood was essential source of fuel and construction timber.

Indigenous peoples throughout the Americas used to collect and store pods in large baskets raised off the ground for later use. These were especially important during droughts when there was little other available food. Sun-dried pods were ground into flour using stone mills, and mixed with maize or other grain flour to make bread, cakes, or a rich gruel. Pods were boiled into a sweet molasses-like syrup for mixing into refreshing drinks. Traditional home-made foods made from prosopis pod flour are still sold in markets in the Americas to this day. But as news of its taste and health food uses is spreading, there is also an increase in the international trade of high quality prosopis pod flour.

As well as being a main source of firewood, wood was also used for all products that wood could be used for, for tool handles, domestic items, and even for making shovels, as well as for posts and poles. Larger branches and trunks were used for door and window frames, roof beams and in all aspects of rustic construction.

The common name of prosopis in the Quechua language in Peru literally means 'the tree', and the main month when trees fruit in the southwestern USA was named after prosopis in some Amerindian languages –indicating the importance of prosopis to indigenous American peoples.

## The value of tree products

Prosopis pods (or 'beans') are made up of small, hard seeds each in their own fibrous capsule, surrounded by a sweet pulp with a golden yellow skin when ripe. When milled, the resulting flour contains 10–20% protein (mostly from the seeds) and 30–60% carbohydrate mostly in the pulp, of which more than half can be sugar, with acceptable levels of minerals and amino acids. In nutritional terms, this makes prosopis pod flour comparable or superior to that from most cereals (like maize, millet, sorghum or maize), with no anti-nutritional factors detected.

	Whole milled prosopis pod flour	Refined wheat flour
Protein (g/100g)	16	9
Sugars (g/100g)	13	2
Energy (kcal/100g)	361	338
Carbohydrates (g/100g)	69	72
Phosphorus (mg/100g)	218	45
Fibre (g/100g)	48	3
Fat (g/100g)	2	1

Source, and for full nutritional analysis including amino acid profile:

Pasiecznik NM, Choge SK, Trenchard EJ, Harris PJC. 2012. Improving food security in famine-prone areas using invasive and underutilised prosopis trees. Food Chain 2(2): 197-206.

Prosopis wood has a high energy value when burnt and produces excellent charcoal, and is often the used fuel wood where it is common, straighter branches were used for fence posts, and poles and larger trunks were used in rustic construction. They were soaked in water for several days or left to 'cook' around fires to kill insects that would otherwise eat the yellow sapwood, although the reddish heartwood is very hard and resistant to decay. It was also used to make door and window frames, rustic furniture, and various agricultural and kitchen tools.

The reddish heart wood is very hard and durable, and large logs are sawn into timber in the Americas, that supply hundreds of factories that produce high quality furniture and flooring.

Honey from prosopis flowers is also of the highest quality, gum resin is equivalent to commercial gum Arabic, and tree extracts contain tannin and are used in traditional medicines, amongst many other uses.

## Social and environmental benefits

Some prosopis trees in South America are also more than a thousand years old, and very large trees held an important place in local culture, as well as for the shade they offer and as places to meet. Prosopis grow quickly and offers shade and shelter in hot dry deserts where few other trees can survive. It is often found as a street tree, and as a shade tree around houses. It can be planted in rows as windbreaks or shelterbelts to protect crops from drying winds, and protect houses, roads and canals from blowing sand. This reduces erosion, helped further by its roots which bind soil and can stabilise sand dunes. Prosopis trees are also in the legume or bean family of plants, so as well as producing nutritious 'beans', they improve soil fertility by fixing nitrogen.

## Making money from prosopis wood – 4 easy steps

Making charcoal is simple, prosopis is everywhere, and the economic benefits are enormous. All it takes is a little knowledge, a charcoal pit or mound, a market, and some time...



Cut

Cut down trees, and dig up all seedlings. All roots, and branches thicker than your thumb can make charcoal, but thicker branches and stumps are better. Longer straighter lengths could also be used or sold as fence posts or construction poles, and maybe for better prices.



## Clear

Tree stumps will quickly grow back, so dealing with them is an important part of the process. Stumps of smaller shrubs must be removed or burnt. Pile and burn all branches, otherwise this leaves a thorny hazard for everyone for years to come.

## Load



Some people use charcoal pits and cover them with metal roof sheets. Others build large mounds and cover them with soil. Smaller twigs will be needed to start the 'burn', and put stumps and larger branches in the middle, and light. Keep an eye on it every day.



## Sack

Once the 'burn' is finished, and which be only a few days in small pits or 10-12 days in large mound, the 'burn' is extinguished and it is left for a few days to cool. Then empty the pit or uncover the mound, and load into sacks.

## Making money from prosopis pods - 4 easy steps

Processing prosopis pods into animal feed is simple, they are everywhere, and the economic benefits are enormous. All it takes is a little knowledge, a mill, a market, and some time...



## Collect

Collect only clean, undamaged, golden-yellow beans, best if picked directly from trees. Garden rakes are useful for 'pulling' beans into heaps. Then fill buckets or sacks by hand – but make sure there are <u>no</u> soil or stones as they will reduce the quality of the flour.



# Dry

Dry beans in the sun before storing or milling. Spread them out on plastic sheet, rooftops or on concrete floors - but <u>not</u> on the ground, as they can get infected and make animals sick. Once dry, beans can be stored for more than a year in covered sheds, if needed.

## Mill



Mill only clean and 'snap-dry' beans, and better to mill in the afternoon especially in coastal areas. If there is any (morning) moisture in the beans, milling machines will quickly 'clog up'. Once milled, put the flour straight into sacks, weigh and seal/sew the bags closed.



## Mix

Mix the flour with other fodder before giving to your animals. Animals, like people, cannot live on only one single food, and prosopis is sweet, so too much will damage animals' teeth. Mix no more than half prosopis flour with cut grass or any other available fodder.

# 2. Managing prosopis

## **Reducing risks of introduction**

## Preventing new invasions

This manual focuses on how to manage areas already invaded, but it is also important to reduce the risks of prosopis invading new areas, or re-invading cleared areas. Once prosopis has invaded, it can form dense thickets in less than ten years. Prevention involves stopping (or reducing the chance of) prosopis entering an area where it does not already exist. First is to limit the chance of 'intentional introduction' by people bringing in seeds, pods or seedlings to plant. Prosopis are regulated 'noxious weeds' in some countries where the introduction of seeds and plants in outlawed. Second is to reduce the risk of accidental introduction, most commonly from livestock coming from areas where prosopis already grows and introducing seeds still in their stomachs. In some countries, livestock moving into a 'clean' (prosopis-free) area are kept in a holding ground (quarantine) for a week so any seeds will have been excreted. At the community level, coordinated education and raising awareness are the most effective prevention strategies.

## Awareness-raising and early detection

People must be made aware of the dangers of prosopis invasion. Public education about the consequences of their actions/inactions will ensure their support for strategies to prevent prosopis introduction, and to effectively control existing invasions. This can be done through special meetings and training sessions, posters, fliers, newspapers, radio and television.

All invasions start with a few initial trees, often from seeds brought in by water or livestock. As such, they tend to be found around well, along watercourses, riverbanks, irrigation canals, roadsides or paths, or scattered in the landscape. These first isolated trees must be removed, but this requires regular monitoring and responding rapidly before they flower and fruit.

Prosopis invasions can cover tens, hundreds and even thousands of hectares, and experience from around the world has shown that eradication is not possible once it has reached this stage, because so many seeds become stored in the soil and which can survive for very years before germinating. It is much less work to get rid of small isolated trees and pockets, and total eradication may even be possible at this stage. Communities can be asked to report and uproot any prosopis they see, especially in high-risk areas such as along roads, wadis, around wells and where animals are corralled for the night.

## Hand tools and maintenance

## Common hand tools

**Axes**. Traditional short handled axes are commonly used, also machetes in some countries. Short handled axes of European design have also been introduced and are appreciated. Long handled 'felling axes' are also very useful, but are not always available.

**Mattocks**. For cutting smaller trees, a sharp mattock is very effective, also useful for digging up the stumps of larger trees, or if too difficult to remove, then for digging a hole around them, so a fire can be started around the base below ground level.

**Rakes**. These reduce the handling of thorny branches significantly and so reduce the risk of scratches. They are also useful for pushing or pulling branches during cutting, clearing ground around pruned trees, and gathering cut material into piles for burning. Rakes are also useful for pulling fallen pods from beneath low drooping branches.

**Gloves**. Strong work gloves are recommended. Experience from other countries suggests that welding gloves are the most resistant, but even these may last only a few months of daily use.



**Saws**. Carpentry saws can be used, but bowsaws are preferred for this sort of work. They are especially useful for cutting medium sized and large branches.

Loppers. These are useful for smaller branches up to diameters of 2-3 cm (thumb width).

## Keeping tools sharp

As with all tools, the sharper they are, the easier and quicker they cut. And this is especially true with the hard wood of prosopis trees. And this is not limited to axes, saws and loppers. It is very important that the cutting edge of mattocks are also kept sharp, in order that the roots of small trees can be cut with ease below ground level, often with a single swing. As mattocks are also used for digging, it is useful if they are sharpened with a file at least every week, or even each day.

## Managing trees and thickets

## Introduction

Four types of management interventions are used to control prosopis - manual, mechanical, chemical and biological. In this manual, only manual control is considered. Other publications describe the use of tractors, herbicides and seed-feeding insects, but these high-investment options are mostly limited to developed countries (e.g. Australia, South Africa and USA). Fire has also been used as seedlings are fire sensitive, but thick bark makes older trees resistant.

## A summary

Total clearance

- Using a sharp mattock, cut all small trees and seedings below ground level.
- Using bowsaws or axes, cut all branches of all trees just above the ground.
- Using rakes, pull cut material to one side and separate wood for poles, firewood or charcoal.
- Uproot all stumps, or dig around and start a fire around the stump below ground level.
- Pile all small and thorny branches and burn, preferable over larger tree stumps.

## Thinning and pruning

- Start by thinning out thickets, first removing all lower branches, seedlings and smaller trees.
- Select the trees to be retained and pruned, about 5-10 metres apart depending on the site.
- Remove all other trees, uprooting or burning all stumps below ground level.
- For trees to be pruned, identify the straightest and most upright stem(s), 3-4 maximum.
- Cut all other branches as the base, and remove side branches to head height.
- Sort wood for poles, firewood or charcoal and pile up the remainder for burning.

To make the most of the material to be cut and removed from the site, support should be offered that can facilitate initiation of partnerships between the local community groups wishing to manage prosopis and dealers and industries using prosopis wood, charcoal or pods for animal feeds. If the area is large and communal, communities will need to prepare a long term plan to allow for regular harvesting and equitable sharing of benefits. The business opportunities provided by exploiting these new 'free' resources will sustainable improve local livelihoods and lead to a long-term strategy for prosopis management.

## Thinning

To begin to manage thickets, the first stage is often to improve access, by either cutting all trees in broad strips or 'roads' into an area, or by thinning, the selective removal of trees and lower branches to create a more open stand. The area can then either be cleared in blocks or further thinned until the preferred tree density is achieved. Wide spacing allows more light to reach the ground and reduces competition so grasses and other plants will begin to return. Sort larger branches for poles, firewood or charcoal, with all other branches and twigs piled up and burnt.

First, mark the boundaries of the selected area for intervention. All cut branches should be pulled to one side or other after cutting to allow space to work. Cut as close to the ground as practical. Axes or machetes may be what is available and what workers are accustomed to, but bowsaws or other hand saws tend to be more effective. Stumps will then need uprooting or killed (see next section).



## Stump killing

When trees are cut above the ground, the stumps will resprout vigorously and quickly produce many very thorny young stems. The resulting bush can even become less desirable than the cut tree it replaces, so it is essential that stumps are removed or killed. With seedlings and small trees, the plant will be killed by cutting the root several centimetres below ground level with a sharp mattock, or by using an axe to cut roots and pulling up the stump.



This small plant was cut just above ground level and resprouted. Cut below the ground it will not regrow

For larger stumps, the soil is dug out from around the base to a depth of at least 30 cm and all the exposed roots are severed. Stumps contain a lot of dense heartwood that makes excellent charcoal, so if they can be removed, they can make money...

With the stumps of larger trees, severing of the roots may not be possible, but the lower it can be cut, the better. Some trees cut at ground level will not regrow, but many will, so it is better to ensure that stump is killed to prevent regrowth, by burning using strong fire. Begin by removing the soil around the stump to expose all the major roots. One method from Kenya involves replacing the spaces with manure to cover the stump, and which burns slowly and easily kills the stumps. But as all small branches and thorny twigs need burning anyway, they also be killed by lighting fires of this material over the larger stumps, and when burnt down, moving the hot embers into holes surrounding other roots.



For larger stumps, a fire is lit around the base below ground level before more branches are piled on top



Well cleared land with all branches burned



Poorly clearly land, with stumps resprouting vigorously

## Pruning

Pruning to a single stem, or singling, produces an erect tree with a clear, well-defined trunk. Pulling all pruned branches away from the tree to make space, as soon as they are cut. A rake can be useful to reduce handing of thorny branches. Pruning increases total wood production, increases the final yield of the main trunk, improves accessibility within the thicket. Pruning increases the annual diameter growth of the main trunk by between two and four times as it concentrates nutrients to the few remaining stems. Importantly, pruned trees allow more light to reach the ground surface, and pruned trees are also much more efficient in their use of water in the soil. Grass and other herbaceous plants always grow much better under pruned trees.



## Follow up

A few months after clearing an area, it should be revisited for 'follow up'. Uproot any stumps that were not killed or uprooted first time round along with any newly emerged seedlings. Also, cut off any side/coppice shoots from the bases of pruned trees. It is more effective to carry out follow-up practices as frequently as possible, or at least twice every year. Different communities have their own systems for managing and sharing common property resources, to be explored, and activated in areas where they are no longer active.

## 3. Processing prosopis products

## Pods for animal feed

Pastoral communities often complain about damage to animals' teeth by eating prosopis. This occurs when they feed on a diet almost exclusively made up of whole pods and for extended periods. The high sugar content encourages bacterial activity, causing tooth decay and they will eventually fall out. In addition, prosopis pods have sharp tips that can prick the stomach lining. The seeds also pass through the stomach undamaged, increasing the spread of prosopis as an invasive weed, but in addition, the seeds are rich in protein which is not used by the animals. But all of these issues are solved in one go, when pods are milled into flour. Also, for long term control of prosopis invasions in pastoral areas, it is best to collect and mill prosopis pods to destroy as many seeds as possible so fewer new trees will appear.

In its native Americas, prosopis is a valuable feed resource for livestock production, and it can become so where introduced into Africa and Asia, especially where feed scarcity and drought are common. But, it will only be used if new knowledge and markets are introduced, as the opening to a recent conference paper outlined.

## Harvesting and drying

The following procedures apply for collection and processing of pods for production of animal feeds and human food. First, harvest pods when ripe and golden yellow, either from the trees or the ground below, into sacks. Leave any green unripe pods, or those that are damaged, discoloured or even slighted rotten. Transport pods sacks to the storage facility, and on arrival, spread them out to dry and grade them based on their physical appearance.



Dry the collected pods for 2-3 sunny days immediately after collection. Pods should be dried on concrete floors/slabs, plastic sheeting, on tin roofs or roofing sheets. Do not dry pods directly on soil, as this increases the risk of fungal infection by aflotoxins which can cause health problems. Spread pods as thinly as possible, at most 5 cm deep, and mix or turn them periodically to ensure uniformity of drying. Sort pods into grades during or after drying.

## Storing and milling

Store in a clean storage facility protected from rain, or any moisture. The storage floor should be raised to avoid termite attacks or floods. Destroy discarded pods by burning. During the dry season however, pods can be safely stored on rooftops.

Pods should only be milled or ground when they are completely dry. The 'rule of thumb' is that they should snap cleanly when bent. The sugary pods are 'hydroscopic', meaning that they readily absorb atmospheric moisture, like a sponge, so even previously dried pods can become moist again, especially in coastal areas or when humidity is high. If so, they should be sun-dried again before milling. Milling is best carried out on hot sunny days and only starting when any morning dew has evaporated.

Traditionally in the Americas, pods were ground using various types of stone mills, but the most efficient means of processing prosopis pods in large quantities is with a hammer mill. Many different types have used around the world, tractor powered or using petrol or diesel engines. Using fixed diesel-powered mills like that below, about 100 kg of prosopis pod flour could be produced per hour and the mill could run for eight hours a day. Optimally, 125 kg per hour was possible, or 1 tonne of pod flour per day.



Note that with any hammermill, it is essential that the hole size in the grill must be small enough to ensure than all the seeds are broken up, and no larger than 3 mm.



Inside a hammermill, and comparing two grills: that on the left will mill all prosopis seeds, the other will not

## Mixed animal feeds

Survival rations for livestock can be made up with 50% prosopis flour, but most feed mixes use in the order of 25% prosopis. In considering what could be mixed with prosopis pod flour, it is useful to first list all the available feeds in the locality with an assured supply for the period when they will be needed most. These may include grass, hay, other fodder plants, plant leaves, crop residues (maize, millet, sorghum, beans, bananas, wheat, barley, etc.) food residues (fish meal, bone meal, dates, etc) and sea weeds among a wide range of other products.

A livestock expert can indicate the nutritional content of available ingredients and suggest the relative quantities that could be mixed for different livestock (sheep, goats, cattle, camels, poultry, etc.) and for different purposes (during lactation, fattening, etc.). Whether pure pod flour or ready-mixed feeds are to be traded, first understand the market, potential buyers, acceptable prices and the supply requirements.

A company in Brazil established in 2006 processes only prosopis pods, and makes mixed feeds for livestock, horses, domestic animals and even fish. The main factory has the capacity to produce 3000 tonnes of prosopis pod flour per year, with an annual turnover of US\$ 6 million.



A factory in Brazil producing 100% prosopis animal feed as well as mixed rations (Credit: Alessandro Davi)

## Checklist for hammermill operation

The following summary is provided to cooperatives in receipt of hammermills supplied by the PENHA Prosopis Management and Utilization Project, Somaliland, but much of the information is applicable for all small petrol-powered mils.

## **Basic safety**

- Accidents when using or if near the hammermill can SERIOUSLY INJURE or even KILL.
- Make sure that everyone who operates the machine understands all the safety instructions.
- Know how to STOP THE ENGINE quickly (using the red ON/OFF switch on the inside of the engine).



- Do NOT put hands near the drive belt or in the feed intake when the mill is running.
- Make sure no children or animals are allowed near.
- Do not operate the mill inside a closed building – carbon monoxide exhaust fumes can kill.
  - The exhaust and engine get very HOT. Do not touch, and do not run near flammable objects.

## Knowing your hammermill

The hammermill is powered by a 6.5 HP, 200 cc petrol engine. Identify all the different parts before using, referring to the 'Gasoline Engine Owner's Manual' for more information.

## Front view



Red on/off switch (with red wire) on the front of the recoil starter

## Side view



Fuel on/off, choke and throttle under the air filter and fuel tank

Back view



Exhaust (gets hot!), air filter, with oil cap/dipstick at the bottom

And take the time to identify the different parts of the mill unit, including the **drive belt**, **mill cover**, **mill blades**, **grill**, **grease nipples**, **feed intake** and **output shoot**.

## Before you start

Grease the axles



Open the mill cover and apply grease using the grease gun provided to the both nipples on either end of the axle.

## Change the grill



For milling prosopis pods (maize, wheat or other cereals), replace the largehole grill with the fine grill (with 1 mm holes)

Fill with engine oil



Fill the reservoir with about 0.5 litres of 10W/30 engine oil, but check using the dipstick on the inside of the cap to be certain.

## Daily maintenance

- > Take a few minutes to do a pre-operation check before EVERY use to avoid damage.
- Make sure the mill is level and the red starter switch is in the OFF position.

## Engine

- 1. Check for leaks there should be no fuel or oil underneath the engine or on the ground.
- 2. Clean wipe with a cloth, especially around the exhaust and starter cord.
- 3. Check oil remove dipstick and check. Add oil if needed.
- 4. Check fuel open fuel filler cap and fill. Always start with a full fuel tank.
- 5. Check air filter remove, tap, blow and replace If very dirty, rinse in water, dry and replace.
- 6. Make sure all shields and covers are secure, and tighten nuts as needed.

## Mill

- 1. Clean out open the mill cover, clear out any contents and ensure that the grill is secure.
- 2. Grease axles Pump grease into the mill axles using the grease gun until grease oozes out.
- 3. Check drive belt Run fingers around the belt, ensuring it is tight and there are no cracks.

## Starting the engine

- 1. Turn the red starter button to the ON position.
- 2. Move the fuel lever fully to the right, to ON.
- 3. Move the choke lever to the left to CLOSED Move the throttle lever to about one third of the way from the 'tortoise' to the 'hare'
- 4. Pull the starting cord sharply. Release slowly, not let it 'snap back'.
- 5. When the engine is running, open the choke (move fully to the right) and adjust the throttle accordingly.

[Note: when the engine is hot, start with the choke OPEN].

## Monthly maintenance

Change the oil, check the spark plug and clean the air filter with warm soapy water. Ask a mechanic to check the fuel filter, the idle speed and valve clearance.

## Human food

Although the use of prosopis pods for making human food is widely practiced in the Americas where the trees are native, they are not eaten where it was introduced. The negative perception that prosopis has received in many of these countries has partly contributed to the lack of interest to its use as a food. Many communities consider it as only good for livestock, and although children sometimes suck the whole pods, adults do not consider it as good to eat. All these views are linked to the lack of knowledge on the nutritional content of the pods, that is equivalent or even better that most of the common staple cereals, and that the pods do not contain anti-nutritional factors.

For making human food, only the best prosopis pods should be used. Use pods collected directly from trees as pods that have been on the ground can become infected with microscopic fungi called aflotoxins that are harmful to human health. These are the same type of fungi that are also found on poorly stored beans, cereals and other agricultural products, and following such simple procedures can greatly reduce the risk of infection.

Keep the resulting flour in clean air tight packets and in a cool, dry storage facility. Sieve the prosopis pod flour to the finest size possible and mix this with wheat, maize or other flour at ratio of at most one-to-four (20%). Mix thoroughly and use the mixed flour in place of pure flour to bake any foods as desired such as bread, biscuits, flat bread, pancakes, cakes, etc.



Pure prosopis flour from Argentina available by mail order on the international market

## Wood for charcoal

The demand for firewood and charcoal in dry areas has caused massive deforestation, increasing desertification and environmental degradation. This was one reason why prosopis was introduced and widely planted, and it could supply much more under better management. In any case, the harvesting and sale of 'free' prosopis firewood from communal land is often a vital source of income for the very poorest people in such areas. But converting firewood to charcoal increases its value considerably.

Charcoal production has been the most popular, widely accepted and most profitable activity carried out by many communities engaged in prosopis management in many developing countries. In Kenya for example, a community managing about 300 square kilometres of prosopis forest in Baringo County are earning over US\$1.2 million annually (or US\$100,000 every month) only from the sale of prosopis charcoal. No initial capital is required beyond the basic tools and perhaps a metal sheet or chimney, and traditional production methods have helped to make the trade extremely attractive to pastoral communities.

## Pits and earth kilns

Charcoal pits are commonly used for making charcoal. These can be of varying sizes, but often between 1 m and 2 m wide, long and deep. When full and 'fired', pits are covered with metal roofing sheets. These can be efficient assuming that they are well stacked, but when working across a landscape, some prefer to use earth mounds, constructed where a lot of wood has been cut. The ground should be flat, or cut into a slope, and not in wadis as rains could wash the whole mound away.



The yield of traditional earth mounds is around 15–20%, i.e. 250-300 kg of cut wood is needed to produce each 50 kg sack of charcoal. However, improved earth 'kilns' that use metal chimneys can increase efficiency leading to higher yields. Wood should be left to dry for a few weeks at least – never burn fresh-cut wood as it contains too much moisture when 'green'. Pack the stack as tightly as possible, mixing different sized pieces to fill gaps and maximize heat transfer. Cover the stack first with a thick (2-3 cm) layer of grass, leaves or whatever can be found, so that the soil in the top layer can't 'fall through'. The soils layer should be at least 15 cm thick so that it completely excludes air from entering.

## Improved kilns

There are many ways to increase the efficiency of wood conversation from 15-20% using traditional methods to 25-30%. Each of these, however, requires investment in chimneys and inlet pipes at least, or complete metal kilns. The Casamance kiln is a modified earth kiln that gives higher yields (26-30%) that uses a single chimney and four air inlets. Portable metal kilns are efficient and attain a wood recovery rate of about 30%. A standard design of drum kiln (below) uses three detachable but interlocking compartments, a conical cover with lid, four chimneys and a frame at the centre to facilitate firing from the top. Another uses old 200 litre oil drums to make special kilns that can use smaller diameter stems and branches. And many other designs are available.



## Other wood products

## Posts and poles

Ranches in Latin America use prosopis widely for fence posts, poles are commonly used for rustic dwellings where widespread, and their trade provides valuable income for some rural communities. But the white or yellow sapwood under the bark tends to be quickly attacked by insects, and as such, thin posts and poles may not last more than a few years. However, the reddish heartwood at the centre is more resistant, and larger branches will last much longer. In the native range, people tie them in bundles and soak them in ponds or the sea for several days, or put them around a fire or spread hot ashes over them, which all helps to kill the insects and increase their lifespan. In Haiti, prosopis stands are managed for pole production, with trees coppiced at around 50 cm above ground level. The many coppice shoots produced are thinned to 3 or 4 stems to grow for the next harvest.

## Carving

The pleasant red colour of prosopis wood and its hardness and wide availability is making it increasingly popular as a source of wood for carving. It is commonly used for making walking sticks, but also for making craft itemns for sale. However, the wood is much easy to carve when it is 'green', i.e. in the first week or few weeks after cutting, before it starts drying and hardening.



Prosopis wood carvings, Kenya

## Sawn timber

Sawn prosopis wood is the highest value product from prosopis trees on a weight basis, and in the USA, can reach \$1000 per cubic metre. However, producing sawn timber in developing countries where prosopis has been introduced is constrained by many factors, including the lack of sawing technology at the community level, few large sized trees in many areas, lack of markets for the often small-sized pieces of timber that are available from prosopis trees, among others. These challenges need to be addressed by carrying out training needs assessment on sawing, community empowerment and linking the communities to appropriate timber markets.

Logs can be cut 'freehand' using a chainsaw. But for accurately cutting board, an appropriate and low-cost sawmilling technique was used successfully for processing prosopis logs in rural areas of Kenya, where training and demonstrations were also conducted by the author of this manual. This involves the use of special 'mills' that are attached to standard and readily available chainsaws, and make straight cuts and reduce the risks of accidents.



Freehand' cutting, using an 'alaskan' chainsaw milling attachment in Kenya, and furniture produced



## **Minor products**

Although called 'minor products', some of these are very important in some parts of the world where local people collect for home use or for sale.

## Honey

Prosopis trees produce lots of flowers, and the resulting honey is of a very high quality. In Hawaii for example, prosopis honey fetches the highest price because the preferred taste. And in many countries where prosopis is common, beekeepers have developed businesses that exploit the heavy flowering seasons of prosopis.

## Gum resin

Gum resin exudes from wounds in the trunk and branches of trees. This has a wide variety of uses in food, pharmaceutical, chemical and manufacturing industries. Prosopis gum has similar qualities to the internationally traded acacia 'gum Arabic'. In India, prosopis resin gum is used commercially for sizing cloth and as a paper adhesive, the average production was estimated at 1 kg per tree per year. There are also stem injection treatments that can significantly increase yields.

## Seed gum

Gums extracted from seeds of some plants have a ready market in food processing industries as thickening agents in soups and other products. Common ones are guar gum and carob seed gum, but research shows that prosopis seed yield a gum extracted of equivalent quality and that could be used in the same way. A processing facility was developed in Peru to produce seed gum commercially, and companies in India are thought to be starting production.

## Leaves for fodder

Prosopis leaves are rich in protein and minerals and are digestible, but livestock do not generally eat them due to the presence of tannin and other chemicals that reduce unpalatability. Leaf buds and young leaves are most palatable, possibly due to low levels of tannins, and dry leaves are readily eaten by livestock because the tannin degrades as they dry, and as such they should be incorporated into feed mixes as a 'free' resource.

## Mulch

Prosopis have an ameliorating effect on the soil under trees from nitrogen fixation and leaf litter incorporation, improving soil physical and nutritional status. Leaves decay rapidly and contain about 4% nitrogen, 45% carbon and have a high mineral content.

## **Bio-pesticides**

Leaves and leaf extracts have bio-control properties, effective against some weeds, insects, nematodes, pathogenic fungi and viruses. Effects have been observed on parthenium and congress weed, aphids, the brown leaf hopper and the common house fly, sheath blight of rice and many diseases of okra, for example.

## Medicinal uses

All parts of the prosopis plant have been used somewhere for preparing certain traditional medicines. Due to their noted bactericide and fungicide effects, plant extracts are widely known to treat four main groups of ailments; eye infections, diarrhoea and stomach disorders, skin ailments and superficial wounds. Leaves extracts have antiseptic qualities, and rubbing leaves on scratches can help prevent the risk of secondary infection.



## Tannins and dyes

Bark and roots of prosopis contain up to 10% tannins that are sometimes used to cure leather. A yellow dye can also be made but is considered to be of low quality.

## **Bio-energy**

In India, there are, at least 15 power stations have been built, and that produce electricity from burning *only* prosopis wood. This technology is now being introduced to Africa, where the first power plant has just been completed in Kenya, and others are planned.

## Ethanol

Research showed the potential of turning the sweet pods into ethanol as a biofuel. Results suggested reasonable yields, but no industrial production has as yet been undertaken.

# 4. What is prosopis?

## Where does prosopis come from?

Prosopis is the name given to a group of more than 40 similar species of trees and shrubs, almost all from the deserts of North, Central and South America. They have many common names, but the most widespread are 'mesquite' in English and 'algarrobo' in Spanish/Portuguese.

When Europeans arrived in the Americas, they saw how local people valued prosopis trees for their pods which they used for food and animal fodder; wood for fuel, posts, poles and timber; and the shade and shelter they provided. They also saw how they were very tolerant to drought, and fast growing even in poor and salty soils where few other trees survive.

Because of their uses and adaptability to harsh climates, Europeans introduced prosopis to dry areas in their colonies in Africa, Asia and Australia. The first introduction was to Senegal in 1822 by the French. In the late 1800s the English brought prosopis to South Africa, India and Australia, and in the early 1900s to many other countries including Egypt and Sudan.



Historical introductions of prosopis around the world (Source: Pasiecznik et al., 2001)

Then in the 1970s and 1980s there was a new wave of introductions to Africa as a response to the widespread reporting of droughts. Plantations were established by international organisations in dry areas across the continent to control desertification and provide much needed fuelwood. In tropical dry areas, by far the most common species is *Prosopis juliflora* which was widely planted in the Horn of Africa, the Sahel and East Africa in the 1970s and 1980s. *Prosopis juliflora* is also the common prosopis in India, the Middle East and other parts of Asia. But trees and shrubs can look quite different depending on where the original seed came from. *Prosopis juliflora* from northern South America can have longer, sweeter pods, and is generally more erect and has fewer or smaller thorns. *Prosopis juliflora* from Central America and the Caribbean tend to be shrubbier, thornier and have smaller and more bitter pods.

Also, if they grow close together and water is available, prosopis trees can grow straight and to more than 15 metres high. But on higher, drier grounds, they are more likely to become multi-stemmed shrubs often only 3-5 metres high, with lower branches drooping to the ground.

Occasionally another closely related species is found, *Prosopis pallida* which tends to be thornless or have fewer and smaller thorns, is more upright, and has longer and sweeter pods. *Prosopis pallida* is also much less likely to become an invasive weed.

## Why and how does it spread?

Prosopis thrive in hot dry climates, and they can often be the only 'green' plant in a landscape. Trees are very tolerant to drought, and can thrive equally well on salt flats or infertile, rocky soils. But they don't tend to grow on steep slopes, or on periodically waterlogged areas where they 'drown'.

Prosopis often begins invading along dry river beds after rains, and on adjacent farmland frequented by livestock. Animals feed on the highly palatable pods, and the hard seed is not digested, passing undamaged through the gut not only undamaged, but actually made more likely to germinate by the effect of stomach acids. It is then spread wherever animals excrete. And as seeds can remain in animal stomachs for up to 5-6 days, free-ranging livestock can spread prosopis long distances. Pods float and can also spread along coastlines. And wherever they are deposited, seeds can remain viable in the soil for at least 40 years and probably much longer, just waiting for the right conditions to germinate.

The bitter leaves are not liked by animals, so seedlings establish without being browsed by livestock or wild animals. Being drought and salt tolerant and able to fix their own nitrogen, they can survive and grow where other plants cannot, and crowd out and kill native species. Because of these aspects, prosopis trees are included in a list of the World's Worst 100 invasive species.

## Impacts of invasion

If prosopis is left unmanaged and unutilised, it will spread and spread. Eventually, prosopis thickets can also cover the ground entirely, out-competing native species and killing off forage plants. They grow quickly on the banks of dry river beds and around wells, and rapidly invade neighbouring farmland, Invading trees will also block footpaths and roads completely if not cleared. And in some countries, entire pastoral communities are known to have moved their villages because of prosopis invasions.

Prosopis are particularly disliked by pastoralists. Animals that eat whole prosopis pods and little else tend to lose their teeth due to the high sugar content, suffering digestive and other health problems, and in extreme cases can even die. Thorns pierce feet and vehicle tyres and scratch man and animal alike. And untreated wounds can readily become infected – but the thorns do not contain any poison, although many people firmly believe this to be true.



Prosopis invading native acacia woodlands and encroaching on a paved road



## Prosopis: a new resource for the future

Prosopis causes negative impacts as an invasive weed, but trees also produce valuable products. Some communities make money from exploiting prosopis, especially its wood for charcoal and its pods to make animal feed. In doing so, they begin to manage their prosopis – and the problem is turned into a resource. And this manual shows how.

Prosopis was introduced to Africa and Asia, but the indigenous knowledge from the Americas on how to use and manage it was not introduced at the same time. So, it was left unmanaged and underutilised, and quickly spread. People in countries where it only arrived a few decades came to think that prosopis was just a thorny, troublesome weed, and even that it is poisonous. Now they are learning about its uses and values, and how the wood and pods can be processed into valuable products that they can use and sell.

A similar situation occurred with another plant originally from the Americas – the potato. It was almost a century after it was introduced, before it started to be used as a food plant in Europe. At first people ate the fruit and unripe tubers, becoming sick and believing it to be poisonous. Only much later did it begin to become one of the most important foods in the world. Like the potato, prosopis pods have the same potential to become an important source of food and animal feed for use by many millions of people in the dry areas of Africa and Asia, and the sooner it does, the fewer poor people will go hungry.

Most people in developing countries depend on fuelwood and charcoal for daily cooking needs, and this demand had caused over-exploitation of trees especially in dry areas. Prosopis wood can meet this demand, and help to conserve native tree species by providing an alternative source of fuel.

Prosopis grows well on the poorest soils and in arid areas where few other trees can survive, and produces good yields even during drought years. The tens of millions of hectares of invasive prosopis across Africa and Asia produce millions of tonnes of wood and pods every year – an enormous 'free' resource – if only local people knew their value, how to process them, and how to market the end products.

This manual explains how to manage these prosopis forests and control their spread and negative effects, while at the same time increasing the production of wood, pods and other resources. It introduces ways to processing the pods and wood into more valuable and marketable products the way to do so, and it is hoped that it plays a role in supporting rural communities to "make prosopis make money".

## Further reading

The following selected list of publications offer more information on prosopis from the Greater Horn of Africa, and some important global literature. All are available on the internet, and can be found by copying the title and pasting into any search engine (Google, etc.).

# Turning invasive garaanwa (prosopis) trees into a new resource for feed, fuel and food security in Somaliland

PENHA and the Somaliland Ministry of Environment and Rural Development. 2pp. (Shibeshi A, Livingstone J, Pasiecznik N, 2016). [also in Somali]

Control and utilization of *Prosopis juliflora*: Ideas into action Workshop report, Hargeisa, Somaliland, 29 May 2016. 3pp. (PENHA, 2016).

The Great Green Forest is here and expanding all on its own: A call for action International Conference on Resilience, Research and Innovation, Djibouti, 26-28 October 2015. 10pp. (Pasiecznik N, Choge S, Fre Z, Tsegay B, Parra F, 2015).

## Innovative approaches to prosopis utilisation in the Horn of Africa

IGAD Resilience Focus 3, pp6-7. (Livingstone J, Yemane B, 2015).

## Exploring prosopis management and policy options in the Greater Horn of Africa

Proceedings of a regional conference, Addis Ababa, Ethiopia, 26-27 November 2014. PENHA and IFAD. 34pp. (Bereket T, Livingstone J, Fre Z, eds., 2014).

## The management and utilization of prosopis

Paper, in the PENHA Policy and Practice workshop, Hargeisa, Somaliland, September 2014. (Libah AB, 2014).

## **Improving food security in famine-prone areas using invasive and underutilised prosopis** Food Chain 2(2): 197-206. (Pasiecznik NM, Choge SK, Trenchard EJ, Harris PJC. 2012).

## Prosopis beans - a new source of food in dryland Africa

Policy brief. KEFRI, Kenya and CAFS, Coventry University, UK. 2pp. (Pasiecznik NM, Choge SK, Harris PJC, Eyden-Wood P, 2013).

## Making the most of invaded landscapes

Farming Matters, 30.3: 20-24. (Choge SK, Pasiecznik NM, 2014).

# Training manual on improved animal feeding and fodder conservation practices from *Prosopis juliflora* in Sudan

PENHA and IFAD. 24pp. (Talib NH, 2013).

## Prosopis control and/or utilisation

ELMT Good Practice Bibliography, ELMT/ELSE, Addis Ababa, Ethiopia. (Flintan F, 2009).

The use of alternative animal feeds to enhance food security and environmental protection in the Sudan: The case for *Prosopis juliflora* PENHA-APRC, Khartoum, Sudan. 38pp. (Fre Z, ed., 2009).

The ecological and socio-economic role of Prosopis juliflora in Eritrea PhD thesis. Johannes Gutenberg University, Mainz, Germany. 227pp. (Bokrezion H, 2008).

The invasion of *Prosopis juliflora* in Somalia and piloting of positive utilization Report. SATG, Mogadishu, Somalia. (Somali Agriculture Technical Group, 2007).

# Proliferation of honey mesquite (*Prosopis juliflora*) in Somaliland: opportunities and challenges

Case study. Candlelight, Hargeisa, Somaliland. 19pp. (Awale AI, Sugule AJ, 2006).

## Cooking with Prosopis flour. Recipes tried and tested in Baringo District, Kenya

KEFRI, Nairobi, Kenya and HDRA, Coventry, UK. 6pp. (Choge SK, Harvey M, Chesang S, Pasiecznik NM, 2006).

## Controlling the spread of Prosopis in Ethiopia by its utilisation

Policy brief. HDRA, Coventry, UK. 2pp. (Sertse DM, Pasiecznik NM, 2005).

## Identifying Tropical Prosopis Species: A Field Guide

HDRA, Coventry, UK. 30pp. (Pasiecznik NM, Harris PJC, Smith SJ, 2004).

**Prosopis (mesquite, algarrobo): Invasive weed or valuable forest resource?** Policy brief. HDRA, Coventry, UK. 2pp. (Pasiecznik NM, 2002)

## The *Prosopis juliflora - Prosopis pallida* Complex: A Monograph HDRA, Coventry, UK. 162pp. (Pasiecznik NM, Felker P, Harris PJC, Harsh LN, Cruz G, Tewari JC, Cadoret K, Maldonado LJ, 2001).



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# NOTES

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