Crops/ fruits/ vegetables
Pests/ diseases/ weeds
Medicinal plants
Artemisia
Mondia
Moringa
Neem
Ocimum kilimandscharicum
Pelargonium
Prunus

Neem
Scientific name: *Azadirachta indica*
Order/Family: Rutales: Meliaceae
Local names: Muarubaini

more Images

General Information and Agronomic Aspects

- africana
- Sutherlandia
- Tamarind

Fruit and vegetable processing

Natural pest control

Cultural practices

Geographical Distribution of Neem in Africa

The neem tree is native to India and Southeast Asia, but it is now grown in the warm lowland tropics as well as in arid and semi-arid areas of the world.

It was introduced to Eastern Africa during the 19th century by East Indian immigrants, who propagated the tree essentially for its medicinal properties. It is now widely cultivated in Mauritania, Senegal, The Gambia, Guinea, Ivory Coast, Ghana, Burkina Faso, Mali, Benin, Niger, Nigeria, Togo, Cameroon, Chad, Ethiopia, Sudan, Somalia, Kenya, Tanzania, and Mozambique.

In Kenya, especially along the Coast, the Neem tree is very well known: in Kiswahili its name is "Muarubaini", which means the tree of the forty cures. The tree, which grows up to 30 meters and can reach an age between 100 and 200 years, provides shade and timber. The seeds, leaves and bark can be used to produce medical, cosmetic and insecticidal products. Extracts from seeds and leaves can be turned into medicines against a number of ailments as well as

Neem trees
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insecticides for agricultural use. Especially the oil, produced out of the seeds, is a much sought after ingredient for cosmetic products. Because it is an evergreen and fast growing tree, Neem is a favourite for reforestation. The wood is useful as building timber because termites will not attack it. When planted on slopes, the tree can help to combat erosion and landslides. The fallen leaves help to neutralise acidic soils.

Climatic conditions, soil and water management

Climate: Neem has a wide climatic adaptability and thrives under sub-humid to semi-arid and arid climatic conditions. It is generally found in areas with mean annual temperatures of 21 to 32°C. It can survive hot temperatures (reportedly up to 50°C), but does not tolerate frost or extended cold, although there are some reports of neem trees surviving light frost. Generally, at temperature below 4°C leaf shedding and death may occur.

The neem tree grows in areas with mean annual rainfalls of 450 mm up to 1,200 mm. It can grow in regions with an annual rainfall below 400

mm, but in such cases it depends largely on the ground water levels.

Altitude: Neem grows in areas from sea level up to 1200 m, however it thrives at low altitudes. Very often the neem tree is confused with the Persian lilac or chinaberry tree (*Melia azedarach*) a relative of neem which thrives a high altitudes.

Soils: The tree grows on a variety of soils, clayey or sandy, saline or alkaline, but will not grow in waterlogged soils. It does particularly well, however, on black cotton soils and deep, well drained soils with good subsurface water. Unlike most other multipurpose tree species, neem thrives on dry, stony, shallow soils and even on soils with hard calcareous or clay pans at a shallow depth. The tree improves soil fertility and water holding capacity because it has the unusual property of calcium mining, and can thereby neutralise acidic soils. Its extensive root system also has a rare physiological capacity to extract nutrients from highly leached sandy soils. Neem can grow on soils with a wide pH range. The optimum growth is at pH 6.2 to 7, but it can also grow well down to pH 5 and survive in soils between pH 3 and .

Propagation and planting

The Neem tree is best propagated from its seeds which will only

germinate if less than three months old. The seeds need to be sprinkled daily while laying on a newspaper which is placed on plastic in the shade. The newspaper has to be renewed every second day. After a week the seed will crack and sprout ready to be planted in compost made of half soil and half cow manure. To propagate from a cutting, a small twig has to be stripped of its leaves and stuck into moist soil.

Neem nursery

© A.M.Varela

Husbandry

Nutrient deficiencies: A lack of zinc or potassium drastically reduces growth. Trees affected by zinc deficiency show chlorosis of the leaf tips

and leaf margins, their shoots exude much resin, and their older leaves fall off. Those with potassium deficiency show leaf tip and marginal chlorosis and die back (necrosis).

Yields

The tree starts bearing fruits after 3 to 5 years and is fully productive after 10 years. Under favourable conditions a tree can produce up to 30kg of seeds per year and 350kg of leaves.

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Information on Pests and Diseases

By and large, most neem trees are reputed to be remarkably pest free; however, some pests and diseases occasionally attack neem trees.

Pests

In some parts of Africa (mainly in the Lake Chad Basin), a scale insect (*Aonidiella orientalis*) has become a serious pest. This and other scale insects sometimes infest neem trees in central and south India. They feed on sap, and although they do little harm to mature trees, they may kill young ones. Now that one type has been detected in Africa, the

impact could be severe.

Another insect pest ist the scale insect *Pinnaspis strachani* (very common in Asia, Africa, and Latin America). Even though neem timber is renowned for termite resistance, termites sometimes damage, or even kill, the living trees. However, they usually attack only sickly specimens, however.

In Nigeria, 14 insect species and one parasitic plant have been recorded as pests. Few of the attacks were serious, and the trees almost invariably recovered, although their growth and branching may have been affected.

Diseases

Despite the fact that the leaves contain fungicidal and antibacterial ingredients, certain microbes may attack different parts of the tree, including the following:

- **Roots (root rot, *Ganoderma lucidum*, for instance)**
- **Stems and twigs (the blight *Corticium salmonicolor*, for example)**
- **Leaves (a leaf spot, *Cercospora subsessilis*; powdery mildew, *Oidium* sp., and the bacterial blight *Pseudomonas azadirachtae*)**
- **Seedlings (several blights, rots, and wilts - including *Sclerotium, Rhizoctonia*, and *Fusarium*)**

A canker disease that discolours the wood and seems to coincide with a sudden absorption of water after long droughts has also been observed. (OIA 1992)

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Medicinal Properties and Uses

The best-established and most widely recognised uses are as a general antiseptic. Neem preparations are reportedly effective against a variety of skin diseases, septic sores, and infected burns. The leaves can be applied in the form of poultices (cataplasms) or decoctions. They are also recommended for boils, ulcers, and eczema. The oil is used for skin diseases such as scrofula, indolent ulcers, and ringworm (OIA 1992).

Various parts of the neem tree have been used in traditional ayurvedic medicine in India for centuries. The medicinal utilities have been described, especially for leaf, fruit and bark. Neem oil and the bark and leaf extracts have been therapeutically used as folk medicine to control leprosy, intestinal helminthiasis, respiratory disorders, constipation and

also as a general health promoter. Its use for the treatment of rheumatism, chronic syphilitic sores and indolent ulcer has also been evident. Neem oil is used to control various skin infections. Bark, leaf, root, flower and fruit together cure blood morbidity, biliary afflictions, itching, skin ulcers, burning sensations and pthysis (tuberculosis). Neem leaf extract has been prescribed for oral use for the treatment of malaria by Indian ayurvedic practitioners from time immemorial. Dried neem leaves in the form of tea are also used by the people of Nigeria and Haiti to treat this disease.

There are also reports on the biological activities and pharmacological actions of neem based on modern scientific investigations.

Neem extract:
Clinical studies with dried neem leaf extracts indicated their effectiveness to cure ringworm, eczema and scabies. Lotions derived from neem leaf, when locally applied, can cure these dermatological diseases within 3 to 4 days in acute stage or a fortnight in chronic case. Application of neem oil on the hair has been shown to kill head lice. Recently, a clinical trial has been carried out to see the efficacy of neem extract to control hyperlipidemia in a group of malarial patients severely infected with *Plasmodium falciparum*. The lipid level, especially cholesterol, was found to be lower during therapy when compared to

non-malaria patients. (Biswas 2002)

Neem bark contains a strong antiseptic and neem is used to make soap and toothpaste. Neem twigs are used to clean teeth.

Neem may also be a ready source of low-cost analgesic (pain relieving), or antipyretic (fever-reducing) compounds. It is used for these purposes everywhere it is grown. In trials, positive results have been obtained for significant analgesic, antipyretic, and anti-inflammatory effects. This may explain its wide use for treating fevers in general. (OIA 1992). There have been studies of Neem's possible toxicity, which have resulted in a determination that the leaf and bark are very low in toxicity. Very large doses of neem leaves taken internally by some of the animals tested have caused some side effects. Neither leaves or bark should be taken in large doses for extended periods of time. As with any substance taken internally, neem should not be taken to excess, as even a good thing can be misused. Keeping this in mind, there are a few recipes for various ailments:

To make enema leaf tea:
1. Use distilled water.
2. Measure one handful or one cup of whole leaf to one litre of water. If using neem powder, use 30g or a 1/4 cup

of powder per litre of water.
3. Bring water to boil.
4. Remove from heat.
5. Add whole leaf or powder.
6. Cover, and let stand overnight or 24 hours.
7. Strain liquid, put in bottle, and drink as needed.
8. Refrigerate for long term storage.

To improve the immune system:
Chew 8 to 10 neem leaves early in the morning for 24 days. This protects your body from diseases like diabetes and hypertension; skin problems are also improved.

For wounds, bedsores, varicose veins:
Prepare neem water with 8 to 10 leaves, boiled in one litre of water, let cool and bathe wounds as needed. (Ethnobotanical leaflet of Southern Illinois University Carbondale)

Caution:

Medicines from plants should, of course, be treated with the same caution as medicines from laboratories. Neem oil seems to be of particular concern. Consuming it, although widely practiced in parts of Asia, is not recommended. Doses as small as 5 ml have killed infants, and animal studies showed acute toxicity at doses as low as 14 to 24 ml per kg of body weight. It seems possible that this was caused by contaminants rather than by the oil itself. In Germany, toxicological tests using oil obtained from clean neem kernels resulted in no toxicity, even at a concentration of 5,000 mg per kg of body weight in rats. Nonetheless, caution is called for. The leaves or leaf extracts also should not be consumed by people or fed to animals over a long period (OIA 1992).

Health products:

Saroneem Ltd. offer a wide range of health products made from Neem:

Neem Herbal Tea

The tea is 100% pure Neem product made from dried Neem leaves. It contains no additives. It is best used as preventive-curative in treatment of sore throat, colds, fever, food poisoning, low in

cholesterol, malaria, hypertension, respiratory problems, diabetes, hepatitis and kidney ailments. Taken regularly, helps to eliminate fatigue. Neem is regarded as one of the best blood purifying herbs.

Neem Seed Oil

This product is refined Neem oil from the neem seeds. It has been blended with lemon grass to create an excellent therapeutic oil and skin cleanser. Seed oil can be applied directly to the affected areas of skin and scalp. It is a natural treatment for rashes, burns, cuts, bruises, fungal infections, acne, pimples and other skind blemishes. Neem seed oil has been found to be effective against Tinea pedis or athlete's foot is a skin infection caused by a fungus. Fungal infections of this type affect eight out of ten people at some time.

Neem Soap

This is a herbal soap made from pure Neem oil. It has natural skin moisturising oil that makes the skin soft and supple. It assists in preventing as well as healing many skin and scalp ailments, inflammation, fungal infections, burns, cuts and bruises. Neem soap alleviates the intense itching and scarring which are the main problems associated with chickenpox. Take cool baths to reduce itching.

Neem Leaf Capsules

Made from sun dried neem leaves, they are used for the same purpose as Neem tea. Neem is one of the most potent immuno-stimulant available herbs.

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Neem in Pest Control

The neem tree has an over 100 compounds with pesticidal properties. The best known is azadirachtin. This substance is found in all parts of the tree.
Neem is unique among plants with pesticidal properties since it has so many different effects on pests: It acts as a broad spectrum repellent, insect growth regulator and insect poison. It discourages feeding by making plants unpalatable to insects; if they still attack, it inhibits their ability to moult and lay eggs. Unlike most botanical insecticides, neem also has a somewhat "systemic" effect. This means that plants can take up neem extracts through their roots and leaves, spreading the material throughout the plant tissues. For this reason neem can help control pests like leafminers, which feed within leaves and are normally not affected by sprays that only cover the outsides of the plant.

Neem extracts do not kill insect pests immediately. They change the feeding behaviour and life cycle of the pests until it is no longer able to live or reproduce. Therefore, neem extracts are not immediately effective. Effects are often not visible before 10 days after application. Pests may continue feeding lightly on plants until the spray takes effect. On adult insects, in fact you may not see any direct effect, but they will produce no or very few offspring, reducing future damage. Consequently, severe pest attacks will not be controlled within time. For a reliable and satisfying control neem extracts must be treated at an early stage of pest attack.

Neem products break down fairly quickly - usually within 5-7 days - in sunlight and in the soil; heavy rains within a few days of application may wash off the protective cover of neem on plants. So, usually repeated spot sprays of affected plants are necessary to achieve control.

Some neem products, especially the ones with high oil content, are phytotoxic to some plants. Therefore, the extracts should be tested on few plants before going into full scale spraying. Neem based pesticides are suitable for use in developing countries because leaf or seed extracts can easily be done without the use of expensive and

complicated equipment. However, neem extracts are rapidly destroyed when exposed to sunlight (UV, ultra-violet rays). For this reason, commercial products usually contain a sunscreen.

Because neem's chemical structure is so complex (the tree has many different compounds with pesticidal properties), scientists believe it will take a long time for insects to develop resistance to it. However, in order to minimise the chance of affecting beneficial organisms and encouraging pest resistance, use neem sprays only when absolutely necessary, and only on plants you know are affected by pests. The effect of neem as a pesticide depends on the concentration of the active principles, on the formulation, on the pest type and on the crop.

Use as an insecticide: The seeds are the primary source of insecticides. They can be used in the form of simple aqueous extracts or as a basic raw material for formulated pesticides. The leaves are also used as simple aqueous extracts to repel insects.

Use as a nematicide: The neem cake, a by-product of oil extraction, from the seeds, worked into the soil has shown to reduce to a considerable extent the reproduction and population density of numerous pathogenic nematode species.

Use as a fungicide: One of the latest discoveries is neem's potential application in the control of phytopathogenic fungi. Neem oil based emulsions have proven to be the most effective. Use as a molluscicide and acaricide: These pests are only controlled on to a limited extent with neem. Neem showed deterrent effects on land snails. Alcoholic extracts have a negative effect on the reproduction of spider mites.

Neem cake

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The susceptibility of different groups of pests to neem products is shown on the table below.

Pests	Level of control	Recommended neem formulation
Beetle larvae, butterfly and moth caterpillars	excellent	aqueous neem extracts
Stalkborers	good	aqueous neem extracts and neem cake, neem powder
True bugs, plant- and leaf-hoppers Grasshoppers	good	neem oil, neem kernel extracts
Grasshoppers	good	neem oil
Adult beetles	good/ fair	aqueous neem extracts, neem cake powder, leaves, neem oil
Thrips, fruit flies, scale insects, mealybugs	fair/ poor	neem oil, aqueous neem extracts
Mites	fair/ poor	alcoholic extracts
Aphids and whiteflies	good/ fair	neem oil
Plant parasitic nematodes	good	neem cake, neem leaves

Neem preparations, being medium- to broad-spectrum pesticides, also have side effects on some non-target organisms. However, these effects are as a rule relatively slight. This has been explained by the special mode of action of neem compounds, and on the feeding behaviour of the insects as well as the, in the rule, low contact effect of neem products. The degree of side effects is largely dependent on a number of factors such as formulations, time, frequency and methods of applications. Adults of predatory insects are apparently not affected by dosages of neem products recommended for effective pest control. However, their activity, fecundity and longevity may be negatively affected with high dosages. Hover flies are one of the most sensitive groups to neem applications.

Parasitoids are in general less sensitive to neem products than predators. However, especially in very small species of parasitic wasps, treatment of the developmental stages of the host (for instance eggs or puparia of whiteflies), may have negative effects on the emergence rate, walking ability, searching ability, longevity and fecundity of the natural enemy.

In general, neem products based on neem oil or with high oil content have more or stronger side effects on non-target organisms than oil-free preparations. Thus, their application should be avoided or

restricted on crops where natural enemies play an important role in pest control.

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Neem in Reforestation

Neem seems to be a good candidate for planting in most warm parts of the world. It grows vigorously in many semiarid and tropical areas and is regarded as a valuable forestry species in many parts of Africa; but even there it could become more widely employed. It is a multipurpose species that provides villagers with various products from which to derive an income during the years when the trees are maturing. It is also promising for planting in areas now suffering desperate fuelwood shortages. It is useful as a windbreak, exceptional as a city tree, and it can grow in (and perhaps neutralise) acid soils in the tropics. (OIA 1992)

On the farm and around the house neem is useful not only as a windbreak and a welcome source of shade, but its seedcake is a good fertiliser. It contains nitrogen, potash, phosphorus, calcium and

magnesium. (OIA 1992)

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Local Reference Address for Neem Products

- **Health products and Neemros® and Neemroc®, locally produced pesticides. Produced by Saroneem Biopesticides Limited. Babadogo road, opposite Catholic Church P. O. Box 64373-00620 Nairobi. Contact: Mr. Dorian Rocco Mobile: 072 8592478, email: saroneem@yahoo.com saroneem@yahoo.com**

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Moringa
Scientific name: *Moringa oleifera*
Order/Family: Capparales: Moringaceae
Local names: Mkimbo, Mlonge, Mlongo, Mronge, Mrongo, Mzungu, Mzunze (Kenya), Mlonge (Tanzania),
Common names: horse-radish tree / drumstick tree

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General Information and Agronomic Aspects

Moringa is a slender, fast growing, deciduous

africana
Sutherlandia
Tamarind

Fruit and vegetable processing

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Geographical Distribution of Moringa in Africa

shrub or small tree reaching 9 to 15 m in height, with an umbrella shaped, open crown. It is an exceptionally nutritious tree with a variety of potential uses.

Almost every part of plant is of value for food. Seed is said to be eaten like a peanut in Malaya. The thickened root is used as a substitute for horseradish. Foliage is eaten as greens, in salads, in vegetable curries, as pickles and for seasoning. Seeds yield 38 to 40% of a non-drying oil, known as "ben oil", used in arts and for lubricating watches and other delicate machinery. Ben oil is clear nd odorless, has an unusually long shelf life, never becoming rancid. It is edible (with a sweet, mild pleasant taste) and useful in the manufacture of perfumes and hairdressings.

Climatic conditions, soil and water management

It grows best in direct sunlight below 500 meters altitude, but it can grow in altitudes up to 1200 m in the tropics. It grows best between 25 to 35°C, but will tolerate up to 48°C in the shade and can survive a light frost. It tolerates a wide range of soil conditions, but prefers a neutral to slightly acidic (pH. 6.3 to 7.0), well-drained sandy or loamy soil.

Minimum annual rainfall requirements are estimated at 250mm with maximum at over 3,000mm, but in waterlogged soil the roots have a tendency to rot. (In areas with heavy rainfall, trees can be planted on small hills to encourage water run-off). Presence of a long taproot makes it resistant to periods of drought. It readily colonises stream banks and savannah areas where the soils are well drained and the water table remains fairly high all the year round (EcoPort, AVRDC, Fuglie, Moringa Farms)

Propagation and planting

- **Moringa trees grow easily from seeds or hard-stem cuttings. When using seeds they can be directly sown in the field or used for raising seedlings in nursery beds and transplanted.Direct seeding is preferred when plenty of seed is available and labour is limited, and when enough water is available. Thus, direct seeding can be done in the backyard garden, when there is enough water available for irrigation. In a large field, trees can be seeded directly at the beginning of the wet season. Transplanting allows flexibility in field planting but requires extra labour and cost in raising seedlings. Stem cuttings are used when the availability of seed is limited but labour is plentiful.**

Moringa seeds have wings and are about the size of a large pea. Seeds don't need sunlight in order to germinate. Moringa seeds have no

dormancy period, so they can be planted as soon as they are mature and they will retain the ability to germinate for up to one year (Fuglie, Trees for Life, AVRDC) . To encourage rapid germination, one of three preseeding tretments can be employed:

- **Soak the seeds in water overnight before planting.**
- **Crack the shells before planting.**
- **Remove shells and plant kernels only.**

Land preparation

- **Choose an area with light and sandy soil, not heavy with clay or water-logged.**
- **If planting a large plot it is recommended to first plough the land.**
- **Prior to planting a seed or seedling, prepare a planting pit by digging holes 30 to 50 cm wide and deep, water, and then fill in the pit with topsoil mixed with compost or manure (at the rate of five kg per pit) before planting seeds. This planting hole serves to loosen the soil and helps retain moisten in the root zone. This will enable the seedlings? roots to develop rapidly. Compost or manure will help the tree grow better, even though Moringa trees can grow in poor soils. Avoid using the soil taken out of the pit for this purpose: fresh topsoil contains beneficial microbes that can promote more effective root growth.**

- **Moringa can also be planted on 30-cm-high raised beds to facilitate drainage (AVRDC).**

To plant seeds directly in the ground:

- **Plant 2 or 3 seeds in each hole, 5 cm apart. Plant the seeds at a depth of 2 cm (approximately the size of one's thumbnail).**
- **Do not water heavily for the first few days. Keep the soil moist enough so that the top soil will not dry and choke the emerging saplings, but not too wet or else the seeds can drown and rot.**
- **Two weeks after germination, or when the seedlings are four to six inches (10 to 15 cm) tall, keep the healthiest seedling in the ground and remove the rest.**

(Fuglie, Trees for Life, AVRDC)

In the nursery:
Seedlings for transplanting can be grown in divided trays, individual pots, plastic bags, or seedbeds. Use of divided trays and individual containers such as poly bags is recommended because there is less damage to seedlings when they are transplanted. Grow seedlings under shade or in a screenhouse.

Use poly bags with dimensions of about 18 cm in height and 12cm in

diameter. The soil mixture for the bags should be light, i.e. three parts soil to one part sand. Plant two or three seeds in each bag, one to two centimetres deep. Keep moist but not too wet. Germination will occur within 5 to 12 days, depending on the age of the seed and pre-treatment method used. Remove extra seedlings, leaving the strongest seedling in each bag. Seedlings can be transplanted in the field when they are 60 to 90 cm high. When transplanting, cut a hole in the bottom of the bag big enough to allow the roots to emerge. Be sure to retain the soil around the roots of the seedling (AVRDC).

Transplanting to the field

- **The day before transplanting, water the filled pits (see land preparation) or wait until a good rain before out-planting seedlings. Fill in the hole before transplanting the seedling. In areas of heavy rainfall, the soil can be shaped in the form of a mound to encourage drainage**
- **Do not water heavily for the first few days. Keep the soil moist enough so that the topsoil will not dry and choke the emerging saplings, but not too wet or else the seeds can drown and rot.**
- **If the seedlings fall over, tie them to stick 40 cm high for support.**

Growing from cuttings

To grow trees from cuttings use hard wood, avoid using young green stem tissue. Cut off the branches after the trees have stopped producing fruits. This will promote fresh growth and the cutbranches provide excellent cuttings for growing new trees. Compared to trees planted from seed, trees from stem cuttings grow faster but develop a shallow root system that makes them more susceptible to moisture stress and wind damage.

Cuttings can be planted directly or planted in sacks in the nursery. When the cuttings are planted in the nursery, the root system is slow to develop. Cuttings planted in a nursery can be transplanted planted after 2 or 3 months. Cuttings can be 45 to 180 cm long with diameters of 4 to 16 cm. Cuttings can be dried in the shade for three days before planting in the nursery or in the field.

When planting direct in the field:

- **Dig a hole 1m x 1m wide and one m deep**
- **Place cutting in this hole and fill with a mixture of soil, sand and composted manure. Pack firmly around base of the cutting. This will facilitate drainage. It is not desirable that water touches the stem of the new tree**
- **Water generously, but do not drown the cutting in water. If the soil is too heavy or wet, the roots may rot.**

In India, some cow dung is put on top of the open end of the cutting to protect the cutting from pests (Trees for Life)

Spacing

For intensive Moringa production, plant the tree every three meters in rows three meters apart. When the trees are part of an alley-cropping system, there should be 10 meters between the rows. The area between trees should be kept free of weeds (Fuglie and Sreeja).

The World Vegetable Center (AVRDC) recommends, if using raised beds, to form beds with 2-m-wide tops, and space plants 3 to 5 meters apart in a single row. For production of leaves only, space plants 50 cm within rows spaced one meter apart. If using raised beds, form beds with 60-cm-wide tops and space plants one meter apart in a single row. For intensive production of leaves, space plants 10 to 20 cm within rows 30 to 50 cm apart. Closer spacing allows harvest of young edible shoots every two to three weeks.
Trees are often spaced in a line one meter apart or closer to establish living fence posts.

Intercropping

Moringa Trees are planted in gardens to provide support for climbing

crops such as pole beans, although only mature trees should be used for this purpose since the vine growth can choke off the young tree. Moringa trees can be planted in gardens to provide shade to vegetables less tolerant to direct sunlight. Trees are planted in hedgerows forming wide alleys where vegetables are planted within. Choose vegetables that are adapted to alley cropping, such as shade-tolerant leafy vegetables and herbs, since moringa hedgerows are highly competitive and can reduce yields of companion plants significantly. From the second year onwards, Moringa can be intercropped with maize, sunflower and other field crops. Sunflower is particularly recommended for helping to control weed growth. However, Moringa trees are reported to be highly competitive with eggplant and sweet maize and can reduce their yields by up to 50% (Fuglie and Sreeja; AVRDC).

Husbandry

Moringa trees do not need much watering. In very dry conditions, water regularly for the first two months and afterwards only when the tree is obviously suffering. Moringa trees will flower and produce pods whenever there is sufficient water available. If rainfall is continuous throughout the year, Moringa trees will have a nearly continuous yield. In arid conditions, flowering can be induced through irrigation.

Prunning

Pinching the terminal tips: When the seedlings reach a height of 60cm in the main field, pinch (trim) the terminal growing tip 10cm from the top. This can be done using fingers since the terminal growth is tender, devoid of bark fibre and brittle, and therefore breaks easily. A knife blade can also be used. Secondary branches will begin appearing on the main stem below the cut about a week later. When they reach a length of 20cm, cut these back to 10cm. Use a sharp blade and make a slanting cut. Tertiary branches will appear, and these are also to be pinched in the same manner. This pinching, done four times before the flowers appear (when the tree is about three months old), will encourage the tree to become bushy and produce many pods within easy reach. Pinching helps the tree develop a strong production frame for maximising the yield. ***If the pinching is not done, the tree has a tendency to shoot up vertically and grow tall, like a mast, with sparse flowers and few fruits found only at the very top.*** **During its first year, a Moringa tree will grow up to five meters in height and produce flowers and fruit. Left alone, the tree can eventually reach 12 meters in height with a trunk 30cm wide; however, the tree can be annually cut back to one meter from the ground. The tree will quickly recover and produce leaves and pods within easy reach (Fuglie).**

Harvesting

When harvesting pods for human consumption, harvest when the pods

are still young (about one cm in diameter) and snap easily. Older pods develop a tough exterior, but the white seeds and flesh remain edible until the ripening process begins.

When producing seed for planting or for oil extraction, allow the pods to dry and turn brown on the tree. In some cases, it may be necessary to prop up a branch that holds many pods to prevent it breaking off. Harvest the pods before they split open and seeds fall to the ground. Seeds can be stored in well-ventilated sacks in dry, shady places.

For making leaf sauces, harvest seedlings, growing tips or young leaves. Older leaves must be stripped from the tough and wiry stems. These older leaves are more suited for making dried leaf powder since the stems are removed in the pounding and sifting process (Fuglie).

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Nutritional Values and Recipes

Moringa oleifera **has an impressive range of medicinal uses and a high nutritional value.**

Nutrition:

Moringa is one of the world's most nutritious crops. Different parts of this plant contain a profile of important minerals, and are a good source of protein, vitamins, beta-carotene, amino acids and various phenolics (Anwar 2007). The leaves are outstanding as a source of vitamins A and, when raw, vitamin C. They are also a good source of B vitamins and among the best plant sources of minerals. The calcium content is very high for a plant and phosphorous is low. The content of iron is very good (it is reportedly prescribed for anaemia in the Philippines) and the leaves are an excellent source of protein and a very low source of fat and carbohydrates. Thus, the leaves are one of the best plant foods that can be found (Moringa Garden Circle).
According to a gram-to-gram comparison of nutritional information, Moringa leaves contain four times the vitamin A of carrots, four times the the calcium of milk, three times the potassium of bananas and twice the protein of yoghurt and more iron than spinach (Trees of Life; Gopalan 1971; AVRDC.

Recipes:
Virtually every part of Moringa is edible. The leaflets can be stripped from the feathery, fernlike leaves and used in any spinach recipe. Small trees can be pulled up after a few months and the taproot ground, mixed with vinegar and salt and used in place of horseradish. Very young plants can be used as a tender vegetable.

Leaves: Of all parts of the tree, the leaves are most extensively used. The growing tips and young leaves are best. The leaves can be used any way you would use spinach. One easy way to cook them is this: Steam two cups freshly picked leaves for just a few minutes in one cup water seasoned with an onion, butter and salt. Vary or add other seasons according to your taste.
In India, leaves are used in vegetable curries, seasonings and in pickles. (Moringa Garden Circle)

Pods: Young Moringa pods, known as "drumsticks" are edible whole, with a delicate flavour like asparagus. They can be used from the time they emerge from the flower cluster until they become too woody to snap easily (the largest ones usable in this way will probably be 30 to 40cm long and 0.6 cm in diameter). At this stage, they can be prepared in many ways. These are three possibilities:

- **1. Cut the pods into one-inch lengths. Add onion, butter, and salt. Boil for ten minutes or until tender. Steam the pods without seasonings, and then marinade in a mixture of oil, vinegar, salt, pepper, garlic, and parsley.**
- **2. Steam the pods without seasonings, and then marinade in a mixture of oil, vinegar, salt, pepper, garlic, and parsley**
- **3. Make a soup by boiling the pods with onion until tender. Add**

milk, thicken, and season to taste.

(Source:Moringa Garden Circle)

Root: The root, best known in India and the Far East, is extremely pungent. When the plant is only 60 cm tall, it can be pulled up, its root scraped, ground up and vinegar and salt added to make a popular condiment much like true horseradish. However, the root bark MUST be completely removed because of its toxicity; it contains two alkaloids (e.g. moringinine and spirachin), that affects the nerve system and which can be fatal following ingestion. Even when free of bark, the condiment, in excess, may be harmful. (Echo Technical Notes, 1996)

Peas:

The seeds (peas) can be used from the time they begin to form until they begin to turn yellow and their shells begin to harden. Only experience can tell you at what stage to harvest the pods for their peas. To open the pod, take it in both hands and twist with your thumbnail; slit open the pod along the line that appears. Remove the peas with their soft winged shells intact and as much soft white flesh as you can by scraping the inside of the pod with the side of a spoon. Place the peas and flesh in a sieve and wash well to remove the sticky, bitter film that coats them. A better option is to blanch them for a few minutes, then pour off the water before boiling again in fresh water.

Now they are ready to use in any recipe you would use for green peas.

They can be boiled as they are or, seasoned with onion, butter and salt, much the same as the leaves and young pods. They can be cooked with rice as you would any bean. The peas can also be prepared using this recipe:

Ingredients:

- **12-15 horseradish tree pods**
- **1 medium onion, diced**
- **4 cups grated coconut**
- **2 bouillon cubes**
- **2 inches ginger root**
- **4 tablespoons oil or bacon grease**
- **1 clove garlic**
- **2 eggs, hard-boiled**
- **Salt and pepper to taste**

Blanch both peas and pods, drain. Remove milk from 2-1/2 cups grated coconut by squeezing water through it two or three times. Crush ginger root and garlic, save half for later. Mix peas, flesh, coconut milk, ginger root and garlic together with onion, bouillon cubes, oil, salt and pepper. Bring to a boil and cook until the peas are soft - about 20 minutes. Fry remaining half of crushed ginger root and garlic in two tablespoons of oil. Dice eggs. Add coconut, ginger, garlic and eggs to first mixture. Heat through. Serve. (Moringa Garden Circle)

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Medicinal Properties and Uses

In addition to its high nutritional value, *M. oleifera* is very important for its medicinal value. (Anwar 2007)

The flowers, leaves and roots are widely used as remedies for several ailments.

Leaves:

- **Fresh leaves are good for pregnant and lactating mothers; they improve milk production and are prescribed for anaemia.**
- **Leaf juice is used as a diuretic; it increases urine flow and cures gonorrhoea. Leaf juice mixed with honey treats diarrhoea, dysentery and colitis (colon inflammation).**
- **The leaf juice has a stabilising effect on blood pressure and controls glucose levels in diabetic patients.**
- **In India and Nicaragua, leaves and young buds are rubbed on the temple for headache.**
- **In India and the Philippines, a poultice made from fresh leaves is**

applied to reduce glandular swelling.

- **Leaf juice is sometimes used as a skin antiseptic.**
- **Leaves are used as an irritant and as a purgative.**
- **In Nicaragua, Guatemala and Senegal, leaves are applied as poultice on sores and skin infections.**

(Source: Maroyi, 2006; Moringa for Life: Moringa Medicine Pharmacopoeia)

Seeds:
Moringa seeds are effective against skin-infecting bacteria *Staphylococcus aureus* and *Pseudomonas aeruginosa* (Council of Scientific and Industrial Research 1962; Oliver-Bever 1986).

Bark:
The bark of the moringa root should be scraped off because of its toxicity and the flesh of the root should be eaten sparingly (Oliver-Bever 1986). A paste made from bark treats boils. Paste from ground bark can be applied to relieve pain caused by snake, scorpion and insect bites. Oil is sometimes applied externally for skin diseases (Maroyi, 2006).

***Moringa oleifera* is already highly esteemed by people in the tropics and sub-tropics for the many ways it is used medicinally by local**

herbalists. In recent years, laboratory investigation has confirmed the efficacy of some of these applications (Moringa for Life).

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Information on Pests and Diseases

Moringa is resistant to most pests and diseases, but outbreaks may occur under certain conditions. For example, diplodia root rot may appear in waterlogged soils, causing severe wilting and death of plants. Mite populations can increase during dry and cool weather. Mite attack may lead to yellowing of leaves, but plants usually recover during warm weather. Other insect pests include termites, aphids, leafminers, whiteflies, and caterpillars. Termites can be a problem, especially when cuttings are planted. Suggested measures to protect seedlings from termite attack include:

- **Applying mulches of castor oil plant leaves, mahogany chips, tephrosia leaves or Persian lilac leaves around the base of the plants.**
- **Heaping ashes around the base of seedlings.**
- **Spreading dry and crushed stems and leaves of lion's ear or Mexican poppy around the base of plants.**

Cattle, sheep, pigs, and goats will eat moringa seedlings, pods and leaves. Protect moringa seedlings from livestock by installing fence or by planting a hedge around the plot (AVRDC, Fuglie and Sreeja).

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- **Purdue University, Center for New Crops & Plant Products:**

http://www.hort.purdue.edu/newcrop/duke_energy/Moringa_oleifera.html

- **Trees for Life: Moringa book**

http://www.treesforlife.org/project/moringa/book/moringa_book_view.pdf

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Contact information

- **You can buy high-quality seed and obtain cultural information from:**

Dr. David Odee
Head Biotechnology Division
Kenya Forestry Research Institute
PO Box 20412
Nairobi
KENYA
011 254 (0)154 32891-3 or 32541 (voice)
011 254 (0)154 328-44 (fax)
email: kefri@arcc.or.ke; put "ATTN DAVID ODEE" in the subject line.

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Pelargonium
Scientific name: *Pelargonium sidoides*
Order/Family: Geraniales: Geraniaceae
Common names: Pelargoniums

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General Information and Agronomic Aspects

***Pelargonium sidoides* is indigenous to South Africa and Lesotho.**

The pelargonium is a tender evergreen perennial.

Tamarind

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Geographical Distribution of Pelargonium in Africa

Climatic conditions, soil and water management

Pelargoniums like a sunny exposure, but in very hot areas they benefit from partial shade. They grow well in average soil that is well drained. They are very drought resistant.

Propagation and planting

Propagation is from cuttings, sometimes from seeds. Cuttings can be taken any time of the year except for the coldest months. Choose a compact side shoot about 10cm long and pull off a small "heel". Remove the lower leaves and press into wet sand. Keep protected and damp until rooted. Plant 90cm apart, as the rose-scented varieties grow very quickly (Margaret Robert's A-Z Herbs).

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Medicinal Properties and Uses

***Pelargonium sidoides*: This herb is most commonly known by the name "Umckaloabo" which originates from the Zulu language and means "heavy cough". It has long been used in South African traditional medicine to treat coughs and respiratory ailments. Tests in Europe show it may be especially useful against sore throats and bronchitis. the 3-year old roots are the plant parts most often used to obtain extracts, although all plant parts contain active agents. Use certified and tested products.**

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Information on Pests and Diseases

To avoid problems is obtain plants that are insect and disease-free. Diseases are rare on cultivated *Pelargonium* species. Overwatering can lead to root-rot; to avoid it regulate watering and use soil or a planting medium with good drainage. Never plant in containers that do not have drainage holes.

Mealybugs maybe maiby be a problem for pelargoniums. Usually they do not occur on the above ground parts, but produce large colonies of insects on the roots, especially tuberous roots, that can seriously damage plants. Above ground they are easy to identify as they appear as white cottony masses.

Aphids can become a problem but they can be easily removed by washing with a strong stream of water.

The caterpillar larvae of some butterflies and moths do damage pelargoniums, but they are easily controlled with any of the biological sprays or dusts that contain the bacteria *Bacillus thuringenesis* (Bt) (UCI Arboretum).

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Information Source Links

- **Margaret Roberts' A-Z Herbs: Identifying Herbs, How to Grow Herbs, the Uses of Herbs. Struik Publishers, ISBN: 9781868724994**
- **South African Biodiversity Institute: http://www.plantzafrica.com/plantnop/pelargsidoid.htm**

- **UCI Arboretum 'Arboretum Quarterly' Vol. 3 No. 4: Pelargonium Species Part II http://darwin.bio.uci.edu/arboretum/pel.htm**

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Artemisia
Scientific name: *Artemisia annua*
Order/Family: Asterales: Asteraceae
Common names: Annual wormwood, sweet wormwood

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General Information and Agronomic Aspects

Artemisia annua **is a crop for the production of anti-malarial and possibly antibacterial agents and natural pesticides. It was originally collected by the Chinese as a herbal medicine and is currently processed by pharmaceutical firms for the production of artemisinin for Artemisinin-based Combination Therapies (ACTs) in the treatment of malaria. (EcoPort) ACTs have been shown to have rapid resolution to fever and parasitaemia; low toxicity and are well tolerated. The artemisinin compounds are effective against *Plasmodium falciparum* and *P. vivax*, including multi-drug-resistant strains.**

Geographical Distribution of

Artemisia is native to Asia, the center of origin is most probably China; wild populations occur both in China and Vietnam. It has become naturalized in many countries and is widely dispersed throughout the temperate regions of the world. In Africa, Artemisia has been introduced for cultivation to Cameroon, Ethiopia, Kenya, Mozambique, Tanzania, Uganda, Zambia etc. - all in high-altitude regions and/or regions with a pronounced cool period.

Artemisia in Africa

Climatic conditions, soil and water management

Artemisia annua **is a fast-growing annual plant. It prefers a sunny position but it can also grow under light shade. It prefers light to medium textured soils (sandy and loamy soils). It requires well drained or dry soils and thrives in fertile soils but will grow in nutritionally poor soils. (Plants for a Future, 2000). Plants are more aromatic when grown in a poor dry soil. Often found on low and alluvial ground and on mudflats. The plants are longer lived, more hardy and more aromatic when they are grown in a poor dry soil (Genders, 1994). Artemisia is useful for filling gaps at the back of a border. It has become a weed of waste places in many areas of the world.**

It thrives in many temperate to sub-tropical ecologies, but the plant is not adapted to the tropics because flowering will be induced when the plants are very small; with the possible exceptions of high altitude plateaus and/or regions with a pronounced cool period. (Per Diemer, 2005, FAO). A special hybrid of *Artemisia annua*, known as *Artemisia annua anamed* (A-3) is especially important for the natural treatment of malaria, because it is adapted for the warmer climes where malaria is endemic. Whereas wild varieties of *Artemisia* grow to only 5 cm in the tropics, A-3 can reach heights of 3m and contains 20 times more artemisinin (World Agroforestry Center). *Artemisia annua* is extremely

vigorous and essentially disease and pest free. (Plants for a Future, 2000)

Land preparation

Prepare your the land well where you will transplant the seedlings to. Well prepared land leads to uniform growth. Poor land preparation and lack of care leads to poor production. Artemisia has been grown successfully under minimal till systems, the aim of which is to conserve soil moisture. Some soils of Kenya are known to have a natural hard pan or a compaction pan that has been created by earlier cultivation practices. If these occur, it is advisable to deep rip the soil to ensure good root penetration and water percolation through the soil profile. A deep rip is better than a shallow rip to allow maximum penetration. The seedlings can then be planted by hand along the rip line, into prepared soil. In some soils, when a very deep rip is made, it may be necessary to lightly roll the land afterwards in order to close the rip slightly, to reduce the risk that the seedling drowns in a heavy rainstorm.

Start soil preparations well before the rain season to ensure that the soil is not cultivated when too wet as this will lead to loss of soil structure and compaction of the soil resulting in poor plant performance. Early preparation will also assist in weed control that is an extremely important factor in growing Artemisia successfully as

weeds will germinate in between first and second cultivations. By destroying these with the second cultivation (ploughing or ridging) it will reduce the amount of time required for hand weeding.

If organic matter such as well rotted animal manure can be added to the soil it will materially assist in improving the structure, giving better aeration, greater root penetration and water percolation and greater efficiency in utilizing irrigation water. The addition of up to 20 tonnes per hectare of composted or well rotted manure is highly recommended both as a short term crop stimulant as well as a long term measure to improve soil fertility.

Propagation and planting and husbandry

Growing *Artemisia annua anamed* plants from the tiny seeds is difficult. 1 gram of seed contains an estimated 12,000 seeds. Vegetative propagation is therefore favoured as multiplying the plant from cuttings is easy, takes less time and maintains the genetic qualities of the plant (World Agroforestry Center).

To obtain an A-3 starter kit, please see on www.anamed.net for further information.

The time of establishment will be related to the availability of irrigation

water/rainfall, temperature and daylength and to the desired period during of harvest. These factors will vary from region to region but the timing should allow for a seed germination time of about 4 weeks, a further period of about 5 weeks before transplanting and about another 12 weeks to reach maximum dry leaf weight and artemisinin content. Rain-fed crops should be drilled 3 weeks before the onset of the rainy season. E.g. in Kenya, should rains be expected mid-April, then sowing should be done in the last week of February. Water stress as well as low temperatures will accelerate flowering. In Kenya, direct drilling is not used due to the tiny seed (1000 seed weight = 0.03g) and the need for a vigorous seedling. (Stress will induce early flowering).

Nursery Preparation The nursery must be sited in a different position every year, to prevent build-up of soil-borne pests and diseases, and to prevent nutrient build up or depletion. Soil fumigation may be necessary prior to planting. Ideally, soil pH should be between 5.5 and 6.5 - the pH should be determined by soil analysis and any lime requirement (in case of acidic soil) should be applied at least 2 months prior to sowing. The site chosen should either be partially shaded, or out of direct sunlight. Nursery areas should be prepared well in advance of sowing. Weed control around the site to a distance of 10 meters is advisable and the site should be fenced to prevent access by unauthorized persons or animals. (EABL). The area should be cultivated

as early as possible, to a depth of 35-40 cm, and raked to a fine tilth, and any weed roots removed. The use of a jembe handle can be helpful in breaking soil clods to the required tilth. A suggested bed size is 1.5 m wide and 20 m long, raised 20 cm high. Prior to sowing, the beds should be thoroughly irrigated, to allow residual weed seeds to germinate. Proper preparation for weed control in the seedbed is essential- as Artemisia seeds are so small, it can be difficult to identify weed seedlings from Artemisia seedlings at an early stage. (EABL, 2005).

Sowing Irrigate the field before sowing. There are several suggested methods of sowing. Pelleted seed can be mixed with fine grade sand, which is then sprinkled lightly over the surface of the bed, at the rate of about 1 gm seed per m2. The aim should be to produce 500 healthy seedlings per m2. EABL recommends that growers estimate an establishment rate of 50%. Thus 1000 seeds should be sown per per m2. These can then be thinned out to the correct density. Note that 1 gram of raw seed is sufficient to sow 13 m2. Artemisia requires light and uniformly high levels of moisture, at temperatures of 18-20°C for germination. It is essential that the seeds are not covered with soil after sowing - this is one of the main reasons for failures in the nursery.

The plantlets will emerge in 6 or 7 days and as they appear, the cover

can be removed, and the plantlets kept moist with regular applications of fine-droplet water from a can or (preferably) a mist-sprinkler. If no shade is used it is essential that the seedbed be irrigated with LIGHT but frequent irrigating.

It is recommended to transplant seedlings that have been raised either in trays or in seedbeds and that have produced vigorous, upright plants for transplanting. The ideal transplanting size is 12 cm tall, with well-developed roots. To be able to lift the plants successfully, the beds should be well watered the evening before transplanting is to start. This watering must be very thorough and the beds should not be able to absorb any more water, with the soil being wet to at least 50 cm deep. This will ensure that the soil in the immediate root zone contains adequate moisture during transplant. The next morning, to lift the plants, use a fork or a shovel and GENTLY raise the soil being careful not to damage the plant roots. It is important to have as many roots as possible to support the plant after it is put in the field and the seedlings should be ?teased? from the soil to prevent damage. Only lift as many seedlings as you can plant in an hour. The soil around the plant roots must be pressed firmly into contact with the plant - this will prevent the plant from wilting too much and increase the rate at which it recovers from the shock of transplanting.

There are a number of trials that have been conducted in Kenya to determine the best plant number per hectare. Based on several years experience, (using vigorous seedlings) the current recommendation is to plant at a spacing of 1.0 m between plants and 1.0 m along the row. This will give a plant population of 10,000 per hectare. Measure the distance between plants, do not guess. If there is just 5 cm too much between plants it will reduce the plant numbers by almost 500 per hectare and production will be correspondingly lower. Use a marked measuring stick. (EABL, 2005).

Irrigation: Give some water after planting to assist recovery of the seedlings. The plant is able to withstand dry conditions when it is fully established, but stress at early point in its life can induce premature flowering and this is in turn may be reflected in a reduced artemisinin content in the leaf and a lowering of production per hectare which results in lower returns for the crop.

A rain-fed crop requires between 600 m and 650 mm of rain during the season, so timely planting is important in all circumstances. The most critical stage of growth for additional water is in the first 12 weeks of the crop life after transplanting. Water requirements vary according to soil type and climate, they should be discussed with the local contractor (in Kenya - EABL) who will advise on the need for water.

Mulching is essential to retain soil moisture and suppress weeds. (EABL)

Harvesting

Harvest timing is critical, as artemisinin content tends to climb steeply during late active growth, then to plateau briefly and finally, to fall off sharply once flowering has initiated, with its corresponding leaf drop. The plant begins to flower from laterals originating at the bottom of the main stem. With the current variety (East Africa), when approximately half to three quarters of the plants show signs of bud initiation, artemisinin content will be at a maximum and the plants will be ready to harvest. (EABL, 2005).

The plants are cut and can be left to wilt in the field or hung up to dry in an enclosed space, to prevent post harvest losses. If you dry the plants in the field, they should be stooked, to prevent leaf rotting. Be careful not to dry the leaf to much, or leaves will be lost to the wind. Removal of leaf can be done using a tractor, or by manual beating. The plants should be stacked on plastic to catch the leaves.

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Medicinal Properties and Uses

Every year 2 million people die from malaria, most of them children. Drugs that have been used for decades are of lesser and lesser help, because the agents that cause malaria have become resistant. Newer drugs now promise a remedy. They are produced from the inner material of the Artemisia plant. The tablets, so-called ACTs, are combined with another anti-malaria agent, thus they should cure malaria and the combination of drugs should simultaneously avoid the development of resistance. ACTs have been shown to have rapid resolution to fever and parasitaemia; to be low in toxicity and well tolerated. The artemisinin compounds are effective against *Plasmodium falciparum* and *P. vivax*, including multi-drug-resistant strains. Despite promises of the pharmaceutical industry, not enough tablets can be supplied and they are not to be found in the rural areas of Africa and often not even in the cities. This is where the Artemisia plant can help:

***Artemisia annua* can grow almost anywhere in the world, in every kitchen garden, in every field. It is actually only an inconspicuous mugwort plant, and yet the hope for the many millions of people that suffer from malaria. Its inner substance, artemisinin, is highly potent, effective and compatible, according to the international aid organistion "Doctors Without Borders". After the first dose 90% of the agents that**

cause malaria were destroyed. The simplest way to take advantage of its curing properties is in the form of tea made from the plant. Even on its own it can work miracles with the most serious form of malaria - *Malaria tropica*.

Previous studies attribute the tea only 80% effectivity. However, when it is combined with other anti-malaria drugs it becomes over 90% effective, exactly the same as the ACTs. However, the WHO has prohibited the use of artemisia single drug therapy, and artemisia tea itself can be seen as single drug therapy. Dr. Wirt from ANAMED ("Aktion natürliche Medizin") does not agree with that. In the many studies he has arried out he ascertains that the tea is not a single drug treatment. Dr. Wirt: *" We can say that the tea contains 60 active agents. These 60 agents often work in synergy and so prevent resistance. We have also shown that tea can be dosed very exactly. We have shown that the concentration remains stable for over 3 years if the tea is properly dried and stored. We have compiled guidelines on how the tea should be prepared for one person or for groups of people who suffer from immunodeficiency, for example those with HIV, or children under 5 years whose body defenses are not yet strong enough. For these groups of people we combine the tea with old, patent-free anti-malaria drugs and so reach a good level of effectiveness."*
(Transcript Context Science and Medicine, 2006)

News: Coartem® is a pre-qualified, fixed-dose artemisinin-based combination therapy (ACT) that pairs artemether, a derivative of the plant *Artemisia annua* with lumefantrine to effectively treat both short- and long-term effects of malaria. It is considered a breakthrough in the treatment of multi-drug resistant malaria and has been added to the WHO's Essential Medicines list (Ärzte Zeitung 2002)

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Production and Markets

Commercial production of Artemisia in Africa has largely been limited to Kenya and Tanzania. Current demand for artemisinin has led to a significant increase in the commercial production, both in established as well as new areas.

Leaf production is very variable depending on climatic conditions and harvesting techniques used. In East Africa yields average 2.5 t/ha.

Markets:

Hundreds of millions of people at risk of drug-resistant falciparum malaria are in urgent need of access to quality artemisinin-based

combination therapies (ACTs) at affordable prices. (Diemer, FAO)

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Ocimum kilimandscharicum
Scientific name: *Ocimum kilimandscharicum*
Order/Family: Lamiales: Lamiaceae
Common names: kilimanjaro basil, camphor basil, hoary basil, feverplant

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General Information and Agronomic Aspects

Geographical Distribution of Ocimum kilimandscharicum in

Ocimum kilimandscharicum **is one of the species of the genus *Ocimum* plant that is native in East Africa and was introduced and cultivated in India and some parts of Turkey. It is an evergreen aromatic perennial under shrub belonging to the *Lamiaceae* family. It thrives as a natural rounded woody shrub that can reach 2 m high in warm temperate regions of the tropics but can be propagated both by seeds and vegetative.**

The plant has pubescent quadrangular branchlets with simple leaves that are opposite and oblong, narrow at the base and deeply serrated (Warrier, et.al., 1996). The leaves contain aromatic oils, which is the essence of the

Africa plant. The essential oil is extracted using distillation, expression or solvent extraction methods. The oil constitutes liquid oil and white solid crystals, where the pure crystals possess a characteristic odour and taste of natural Camphor.

Agronomic aspects

- ***O.kilimandscharicum* can be propagated by seeds and cuttings;**
- **Farmer experience indicates that seed propagation is the most suitable;**
- **70-140 g of *O.kilimandscharicum* seeds can plant 1-hectare of land (Wealth of India, 1966);**
- ***O.kilimandscharicum* seeds are black and very small, oval shaped and about 1mm in the middle and 2mm long;**
- **Seedlings are raised in nurseries and transplanted on the farms;**
- **Once the shrub is established, it can be harvested three times per annum for more than three years;**
- **It requires well-drained soils, though does well in clayey and sandy**

soils, with an average annual rainfall of 1250 mm, fairly high temperatures and at altitudes of up to 900 mm (Wealth of India, 1966);

- **The plant is not grazed or browsed by animals;**
- **It has an efficient rooting system and perennial habits which prevent soil erosion where it is grown;**
- **During growth, the plant requires little management in the field thus it is not labour intensive;**
- **However, harvesting is slightly labour intensive where cutting and plucking of leaves can be tedious.**

1. Establishing an *O. kilimandscharicum* seedbed nursery

- **Seedlings are raised in seedbeds and these are prepared using specific equipment that depends on the land characteristics;**
- **Seedbeds can be prepared in nurseries at farmer or CBO levels;**
- **This is done gradually by following a series of steps;**
- **The nursery should be prepared by observing hygienic and careful seedling production that involves seed selection, site selection, tillage and seed propagation.**

a) Seed selection and preparation

- **Ocimum kilimandscharicum seeds are collected from mature plants;**
- **The seed is prepared hygienically by drying under shade, threshing, winnowing and storing;**
- **Records are kept of the region where the seed is obtained so that it is easy to trace their origin;**

b) Site selection

The site selected for raising a nursery should be convenient enough to:

- **Minimize any possible damage to the seeds or seedlings;**
- **Be easily accessed;**
- **Have windbreaks or trees that provide shade and protection;**

The site should be free from contamination and too much manure.

c) Land preparation

- **The seedbed should be prepare properly to produce a suitable medium for seedling germination, establishment and growth;**
- **It should be firm and smooth;**
- **The land is prepared in two successive stages that are primary and secondary tillage.**

Primary tillage

- **This is undertaken to break-up the soil compaction, loosen the size of the soil clods and invert plant residues to kill them;**
- **The soil moisture should be sufficient enough so that it crumbles when worked by farm implements;**
- **The selected site should be cleared to free the land from previous crops and other vegetation;**
- **Mark out the size of the nursery required on the land;**
- **Using hoes as tillage implements, prepare the marked land by digging and cross digging;**
- **Shake the soil from any plant roots, tree stumps and other vegetation matter;**
- **Leave the land for a few days to allow the waste vegetation to rot.**

Secondary tillage

- **This is undertaken to remove all kinds of waste materials on the tilled land, level it properly and prepare beds for plant propagation;**
- **Using forked hoes as tillage implements, prepare the tilled land by cross digging to remove all wastes;**
- **Raised seedbeds are constructed measuring 1000 mm wide and of**

any convenient length;

- **Use the implement to establish smoothness on the seedbeds land;**
- **Before sowing, amend the soil by incorporating compost manure with the top layer of the soil;**
- **Level the soil using a rake.**

d) Sowing the *O.kilimandscharicum* seeds in the seedbed

- **Because of their size, the *O.kilimandscharicum* seeds cannot be sown directly to the soil;**
- **Take dry soil and work it into a powder;**
- **Mix dry clean seeds with dry powdered soil;**
- **Using the edge of a board or the back of a rake, make shallow furrows or drills or 'valleys' in the seedbed at a spacing of 150 mm;**
- **Sow the mixed seeds uniformly in the drills;**
- **Do not cover with soil after sowing.**

e) Seedbed management

Protection

- **After sowing the seeds, cover the soil with dry mulch using either grass or soft banana leaves;**

- **The cover ensures protection from birds and direct sunlight, and also improves germination and growth;**
- **Germination is noticed after 7-10 days (Kannan, in.lit., 1966);**
- **After a few days, remove the mulch cover and construct a shade over the seedbed.**

Watering

- **Sufficient water is required for O.kilimandscharicum germination and growth;**
- **When it is dry, the seedbeds should be watered regularly with clean water to keep the soil moist throughout the germination period;**
- **Water should be applied by fine sprinkling of water in the early evening for the first one week;**
- **From the second week onwards, water should be applied for 3 days per week;**
- **Watering during sunlight should be avoided.**

Aftercare

- **Weeding by hand should be done regularly;**
- **Germinating seedlings should not be mistaken with weeds;**
- **Remove weeds that appear in the seedbed using a knife by cutting**

just below the ground level. Pulling can disturb the seedling roots.

Drainage

- **The pathways between seedbeds should be slightly sloped to ensure good drainage of water;**
- **The slope ensures that water logging does not occur in and around the beds.**

f) Transplanting *O. kilimandscharicum* seedlings

- **Once the seeds have germinated, the plant grows rapidly above the ground after 2 months;**
- **The seedlings are ready for transplanting after 5-7 weeks in the seedbed (Wealth of India, 1966;**
- **The land where the plants will be transplanted should be well prepared and free of waste materials;**
- **Holes are dug and a handful of clean dry manure applied;**
- **The seedlings are removed from the seedbed and moved to the transplanting site where they are kept in a shade for a day;**
- **Transplanting should be done when it is not too sunny, preferably in the evening;**

- **After transplanting, the maturation period of the plant is 4-6 months before the first harvest commences (wealth of India, 1966).**

2. Growth and development of *O. Kilimandscharicum* plant

- **O.kilimandscharicum requires minimal care and no pesticide control;**
- **Minimal clean manure should be applied. Records of any pre and post manure applications on the plots should be kept and a calendar of any manure applications prepared to ascertain consistency and yields changes;**
- **Once mature, it thrives as a perennial, and can be harvested three times in a year for more than three years.**

3. Harvest, post-harvest handling and processing of *O. Kilimandscharicum* plant leaves

- **Harvesting is undertaken very early in the morning before sunrise to minimize wilting of leaves and loss of oil from volatization when it is hot;**
- **During harvesting, the plants are cut 50 - 75 mm above the ground and collected in heaps where the leaves are plucked and air-dried under shade (Kannan, in.lit., and Deogun, in.lit. 1961/2);**

- **The yield of wet and dry leaves of O. Kilimandscharicum depends on the agronomic, soil, environmental and post harvest handling factors;**
- **From literature, yields of cultivated O. kilimandscharicum dry leaves range between 2,200 - 5,500 Kg per hectare per annum (Deogun, et.al., in.lit., 1961/2);**
- **After 5 years, the shrub can be cut off and the farm replanted;**
- **Oil from the plant leaves is extracted using steam hydro distillation method;**
- **Experience show that too much manure results in good leaf harvests but low oil content.**

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Medicinal Properties and Uses

Traditionally, extracts of *Ocimum Kilimandscharicum* were used to alleviate many ailments in East Africa including treatment of colds, coughs, abdominal pains, measles, diarrhea, insect repellent, particularly against mosquitoes and storage pest control (Kokwaro, 1976; Hassanali, et.al., 1990, The Herb Society of America; Golob et al., 1999). Toxicity and protectant potential of Camphor has been found to work against product beetles (Ofori and Hassanali, 1998). Research

undertaken on this plant?s medicinal and insecticide efficacy classifies it as an aromatic plant whose bioactive properties can find use in pharmaceutical, aroma therapeutic and pesticide industries (Bekele and Hassanali, 2000; Bekele, et.al., and Nyamasyo, 1995; Deogun, in.lit., 1961-62). The low boiling point of the oil may be used as a solvent for metallic lustres on ceramic bodies (Chowdhiri and Haksar, in.lit., 1959).

Kilimanjaro basil has many different uses, some of them are:

- **Traditional medicine**
- **Raw material for commercial production of "Naturub" (see below)**
- **Mosquito repellent**
- **Source of nectar for bees in apiculture**
- **Protection against storage pests**
- **Flavouring agent**

Pest control:
Dried leaves and essential oil extracts are used as a grain protectant. A hundred percent mortality was observed in adults of the maize weevil (*Sitophilus zeamais*), the lesser grain borer (*Rhizopertha dominica*) and the Angoumois grain moth (*Sitotroga cerealella*) exposed for 48 hours to dried ground leaves and essential oil extract at doses of 25 g and 0.3 g per 250 g of grain respectively (Golob et al., 1999).

Relative proportion of identified chemical constituents of *O. Kilimansdcharicum* essential oil

GC Peak Number	Component (%)	
3	Camphene	5.07
5	Limonene	6.23
6	1,8-Cineole	7.20
11	Camphor	70.43
12	Linalool	0.47
13	4-Terpineol	1.44
14	Trans-caryophyllene	2.80
15	Alpha-Terpineol	0.60
16	Endo-borneol	0.60
20	Myrtenol	1.30

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Case Study on Sustainable Use - Kakamega Forest integrated conservation forest project

To minimise the uncontrolled collection and sale of large quantities of plant materials from the forest, which leads to the destruction of many forest plants, a project was started to support sustainable utilisation of medicinal plants (including *Ocimum kilimandscharicum*) in the Kakamega forest in Kenya. Harvested leaves of *O. kilimandscharicum* are being used in the production of essential oils for the manufacture of aroma therapeutic products.

O. Kilimandscharicum **oil is the main ingredient used in the manufacture of two Naturub® range of products (balm and ointment) that were developed by International Centre of Insect Physiology and Ecology (ICIPE), University of Nairobi (UoN) and Kenya Wildlife Service (KWS) and produced for Muliru Farmers Conservation Group Enterprise (MFCG). The balm is used to alleviate colds, flu, insect bites and muscular aches while the ointment is used for the fast relief of muscular strain, rheumatism, arthritic joint, fibrositis, bruises, lumbargo, neuralgia and sciatica. Naturub® is certified and registered as the first natural product by the Pharmacy and Poisons Board of Kenya, it is sold widely in corporate retail chains in Kenya .**

Case Study: Kakamega forest, where farmers cultivate *Ocimum kilimandscharicum*

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Pests and Diseases

The most notable pests are termites, which attack the plant roots after the first harvest due to the handling disturbances caused;

The attack is random based on the extend of disturbance per plant;

When they attack, alkali ash is sprinkled around the seedbed furrows. This deters the termites from attacking.

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Tamarind
Scientific name: *Tamarindus indica*
Order/Family: Fabales: Fabaceae
Local names: Swahili: ukwaju, mkwayo

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General Information and Agronomic Aspects

Geographical Distribution of Tamarind in Africa

The actual origin of *Tamarindus indica* is unknown. It is generally believed to be indigenous to the drier savannahs of tropical Africa, but certainly became naturalised long ago in tropical Asia. The species was known and cultivated in Egypt as early as 400 B.C. *T. indica* is now cultivated in most tropical countries. (EcoPort). It grows in Burkina Faso, Cameroon, Central Africa Republic, Chad, Ethiopia, Gambia, Guinea, Guinea-Bissau, Kenya, Madagascar, Mali, Niger, Nigeria, Senegal, Sudan, Tanzania and Uganda. Farmers commonly cultivate it in parklands in the arid and semiarid zones of West Africa (Kalinganire et al.).

The fruit is edible and can also be used as a sort of spice to be added to food. Young leaves and very young seedlings and flowers are cooked and eaten as greens and in curries in India. In Zimbabwe, the leaves are added to soup and the flowers are an ingredient in salads. Tamarind seeds have been used in a limited way as emergency food. They are roasted, soaked to remove the seedcoat, then boiled or fried, or ground to a flour or starch (Morton 1987).

Climatic conditions, soil and water management

Tamarind is well adapted to semi-arid tropical conditions; it also grows well in many humid tropical areas with seasonally high rainfall. It grows well over a wide range of soil and climatic conditions, occurring in low-altitude woodland, savannah and bush, often associated with termite mounds. It grows in well-drained, slightly acidic soils and although it cannot withstand stagnant inundation, it can tolerate a wide range of physical site characteristics. It prefers semi-arid areas and wooded grassland, and can also be found growing along stream and riverbanks. It does not penetrate into the rainforest. Its extensive root system contributes to its resistance to drought and wind. It also tolerates fog and saline air in coastal districts, and even monsoon climates, where it has proved its value for plantations.

Young trees are killed by the slightest frost, but older trees seem more cold resistant than mango, avocado or lime. A long, well-marked dry

season is necessary for fruiting (EcoPort).

Propagation and planting

The tamarind becomes a fairly large tree, so keep this in mind when planting the tree. It should be planted in full sun. It is highly wind-resistant with strong, supple branches.
Tamarind may be propagated from seeds, and vegetatively by marcotting (air layering), grafting and budding. Rootsstocks are propagated from seed, which germinate within a week. Seeds retain their viability for several months if kept dry. Plant seeds 1 to 1.5cm deep in containers. Seeds should be selected from viable trees with good production and quality. Germination is best when seeds are covered by 1.5 cm loose, sandy loam or by a mixture of loam and sand. Seedlings should attain at least 80 cm before being transplanted to their final location at the beginning of the rainy season. Seedlings should begin to produce fruit in 6 to 8 years.

Outstanding mother trees are vegetatively propagated; shield and patch budding and cleft grafting are fast and reliable methods, currently used in large-scale propagation in the Philippines. Trees can also be started from branch cuttings, and superior clones can also be grafted onto seed-propagated rootstock. Vegetatively propagated trees come into bearing within 3 to 4 years. They produce more fruits as well

as more-uniform fruits than seed propagation. Trees also seem to remain smaller - making them easier to harvest and handle (ICRAF, CRFG; Lost Crops of Africa). Young trees should be planted in holes larger than necessary to accommodate the root system. They should be planted slightly higher than ground level to allow for subsequent settling of the soil and a water basin should be built around each tree to assure adequate moisture for young trees. (Morton 1987)

Husbandry

Young trees are pruned to allow three to five well spaced branches to develop into the main scaffold structure of the tree. Maintenance pruning only is required after that to remove dead or damaged wood (CRFG).

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Information on Pests and Diseases

The tamarind tree is seldom affected by pests and diseases. Ripe fruit in humid climates is readily attacked by beetles and fungi, so mature fruit should be harvested and stored. The most serious pests of the tamarind are scale insects (*Aonidiella orientalis*, *Aspidiotus destructor*

and *Saisetia oleae*), mealy-bugs (*Nipaecoccus viridis* and *Planococcus lilacinus*), and seed beetles. Tamarind pods are attacked by the bruchid beetle (*Caryedon (Pachymerus) serratus* or *C. gonagra*). Diseases, reported from India, include leaf spot, powdery mildews, a sooty mould, stem disease, stem, root and wood rot, stem canker, a bark parasite and a bacterial leaf-spot (ICRAF; ECHO).

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Medicinal Properties and Uses

Fruits: The flesh of the fruits is edible. The sweet fruit-pulp is used for the preparation of a refreshing drink and is eaten as an occasional snack. When the fruits are soaked in water overnight the liquid becomes a tasty fruit juice, which is especially appreciated by children (EcoPort).
In the Sahel, the fruit pulp is used primarily for sauces, porridge and juice. In eastern and western Africa, the fruit pulp is eaten raw, but local varieties generally have a strong acidic taste compared with sweet-tasting cultivars introduced from Thailand. In Kenya, the fruit pulp is also used to tenderise meat (Kalinganire et al.).

The fruit pulp has laxative properties and is highly nutritive. It is often added to boiled cereal pap for the treatment of constipation. In China it is dispensed to treat nausea during pregnancy. (Iwu 1993). Tamarind preparations are universally recognised as refrigerants in fevers and as laxatives and carminatives (induce the expulsion of gas from the stomach or intestines). Alone, or in combination with limejuice, honey, milk, dates, spices or camphor, the pulp is considered effective as a digestive, even for elephants, and as a remedy for biliousness and bile disorders, and as an antiscorbutic. The pulp is said to aid the restoration of sensation in cases of paralysis (Morton 1987).

Roots: It northern Nigeria, the roots are used for leprosy treatment. In many parts of West Africa, a decoction of the roots is the principal ingredient in remedies for cardiac diseases (Iwu 1993).

Leaves: Tamarind leaves and flowers, dried or boiled, are used as poultices for swollen joints, sprains and boils. Lotions and extracts made from them are used in treating conjunctivitis, as antiseptics, as vermifuges, treatments for dysentery, jaundice, erysipelas (a skin infection that offen follows strep throat) and hemorrhoids and various other ailments (Morton 1987).

Bark: The bark of the tree is regarded as an effective astringent, tonic

and febrifuge. Fried with salt and pulverised to an ash, it is given as a remedy for indigestion and colic. A decoction is used in cases of gingivitis and asthma and eye inflammations; and lotions and poultices made from the bark are applied on open sores and caterpillar rashes (Morton 1987). The bark infusion is drunk by woman after childbirth as a general tonic (Iwu 1993).

Seeds: The seeds are a rich source of protein, and have a favourable amino acid composition. The powdered seeds are made into a paste for drawing boils and, with or without cumin seeds and palm sugar, are prescribed for chronic diarrhoea and dysentery (Kalinganire et al.; Morton 1987).

Tamarind is also a valuable timber species, used in making furniture, tool handles and charcoal and as fuelwood (Kalinganire et al.).

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Sutherlandia
Scientific name: *Sutherlandia frutescens*
Order/Family: Fabales: Leguminosae
Common names: cancer bush

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General Information and Medicinal Properties

Sutherlandia is native to South Africa, Namibia and Botswana. It grows naturally in the southern part of both Cape-provinces and in the Little Karoo (African Herbs).

Sutherlandia

Tamarind

Fruit and vegetable processing

Natural pest control

Cultural practices

Sutherlandia frutescens **sub-species microphylla, is regarded as the most profound and multi-purpose of the medicinal plants in Southern Africa. Because of its efficacy as a safe tonic for diverse health conditions it has enjoyed a long history of use by all cultures in Southern Africa. (Afrikaanse Kruiden)**

Sutherlandia helps the organism to mobilise its own resources to confront various physical and mental stress situations; it should therefore, more correctly, be known as an adatpogenic tonic (CMA). A multi-disciplinary team headed by Dr Nigel Gericke, a botanist, medical doctor and indigenous plant specialist, found that Sutherlandia contained a powerful combination of molecules which have been identified and used in the treatment of patients with cancer tuberculosis, diabetes, schizophrenia and clinical depression and as an antiretroviral agent. Gericke set up a company, Phyto Nova, to produce tablets, powder, tea and gel from the plant and has been distributing it to AIDS patients (BBC news, 30.11.2001).

Sutherlandia herbal tablets are available from African Herbs: AfricanHerbs (www.africanherbs.info) or from AfricanDrugs (www.africandrugs.com) in bottles that contain 60 tablets of 300 mg.

Each patient takes two tablets after meals twice a day (in all four tablets a day). So 36 bottles will last three patients for six months of treatment each.

HIV/AIDS Improvements in appetite, weight-gain, sleep, exercise tolerance, anxiety and overall sense of well-being can be expected. Researchers anticipate that there will be a delayed progression of HIV into AIDS. This will require compliance of taking appropriate doses of the correct selection of Sutherlandia on an ongoing basis, in addition to meticulous attention to diet. Alcohol, recreational drugs and other drugs that damage the immune system should be avoided. Anecdotal evidence from doctors and health workers using the plant on HIV patients describes remarkable results (New Scientist, 30.11.2001). It has to be stressed, however, that Sutherlandia is not a cure for AIDS.

Gilbert Matsabisa, Director of Indigenous Knowledge Systems, says it is important that people receive advice on how to prepare and standardise the drug from the common plant. A very bitter powder can be ground from the leaves and branches of the shrub. (New Scientist, 30.11.2001)

Precautions
In keeping with World Health Organisation guidelines of the assessment

of herbal medicines, Sutherlandia is generally regarded as safe on the basis of its long history of safe use in South Africa. No severe adverse effects are known.
Known side-effects include occasional reports of dry mouth, occasional reports of mild diuretic effect; occasional reports of loose stool, occasional reports of constipation. Slight dizziness has been occasionally noted in very wasted and weak patients (e.g. in an ill adult weighing 35kg) who take Sutherlandia without meals this is corrected by instructing wasted patients to take the product after meals.
Although there is a well-established traditional use of taking Sutherlandia in pregnancy, this is not recommended until there is further evidence of safety during pregnancy.

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Mondia
Scientific name: Mondia whytei; Mondia whitei
Order/Family: Asclepiadaceae (Apocynaceae)
Local names: Kenya: Mkombela
Common names: White's ginger

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General information

Geographical Distribution of Mondia in Africa

Distribution

It is widely distributed in tropical Africa from Guinea through Cameroon to East Africa. It is widespread in Zimbabwe but threatened in South Africa, due to over collection for medicinal purposes. In Kenya its more prevalent in the remnant tropical rain forest of Kakamega and its outliers Malava, Kisero and Bunyala, scattered in Nandi forests and ranges, Chyulu hills, Mt. Kilimanjaro regions, Mt. Kenya ecosystem and some parts of Coastal regions especially Arabukosokoke (Mukonyi et al 2001) and in Malawi, Uganda.

Description

Mondia whitei (Hook. F.) Skeels (Apocynaceae) is also known as mondia, or Whites's ginger. Mondia is a vigorous climber (3-6 m high) with attractive heart-

shape leaves and a vanilla aroma. The flowers are arranged in panicles of cream-yellow buds which open to reveal deep reddish-purple inner petals. Habitat: it is found in a variety of woodland habitats.

***Mondia whytei* is a slow growing vine that used to be abundant in Kakamega Forest but is now getting scarce. Main threat to the species has been over exploitation by local communities for subsistence and commercial purposes. The species is reported extinct from wild source in Tugela river in South Africa (Crouch et al 1998). In Kenya its among the heavily exploited species from Kakamega forest by local communities (Mukonyi 1998). It is reported to have disappeared from central province due to over exploitation and increase in demand for agricultural land.**

The roots of Mondia whytei are harvested extensively from Kakamega Forest in a well organized trade leading to scarcity of the plant Mondia whytei roots are sold in towns in Kenya and in other African countries. The

Mondia whitei **climber in Kakamega, Kenya, Oct 2008**

© Monique Hunziker

roots are eaten by the young and old as a flavoring and appetizing agent. More than 500 members of the community adjacent to Kakamega Forest were trained in methods of cultivating *M. whytei* on-farm. Community members are shown how to prepare seedbeds for *M. Whytei* seedlings. Once mature, roots from the farmer's plots of *M. whytei* will be purchased and used for commercial production in powder and other forms.

***Mondia whytei* market. The roots are eaten by the young and old as a flavoring and**

***Mondia whitei* flower. Leopard Rock Game Reserve, Vumba, Zimbabwe, 30 Dec 2003 © Mark Hyde and Bart Wursten, Flora of Zimbabwe**

appetizing agent.

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The roots of *Mondia whytei* are harvested extensively from Kakamega Forest in a well organized trade leading to scarcity of the plant Mondia whytei roots are sold in towns in Kenya and in other

African countries.
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Medicinal properties and uses

Mondia whytei **root infusion is popularly used as an aphrodisiac in Malawi and as a natural appetizer, enhancer of cerebral and peripheral blood circulation.**

Food: the fleshy bark of the narrow roots is eaten raw or occasionally in the dried state for its good taste, as an appetizer, to freshen the mouth or for pleasure leaving a persistent spicy taste in the mouth; a source of vitamin A, D, K and E, the minerals, magnesium, zinc, iron, calcium and protein.

Medicinal use: anorexia, treatment of sexually transmitted diseases, stomach ailments and impotence, in countries where it occurs in Africa. The Luhya community of western Kenya use it for; love potion, symbol of peace, sign of power, treatment of hypertension, stroke, anemia, improved sleep, body warmth, asthma, enhanced urination, hang-over, mastitis, allergies, eases after birth pain, heartburns, bilharzias, stress and tension, measles, hepatitis, rickets, typhoid, stops vomiting,

meningitis, pneumonia and improved vision. Others include, mouth fresheners, aphrodisiac (root infusion), food and mouth diseases, enhanced memory, appetizer, toothbrush, leaves for animal fodder and human vegetables.

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Phytochemicals and nutritional status

Studies were undertaken to establish important phytochemicals and its nutritional status to support the traditional claims and enhance the species value for improved marketing and conservation. The main flavouring principle preferred by consumer was identified as 2-hydroxy-4-methoxy benzaldelyde. Both root and leaves extract were active against, brine shrimp. The root extract were active against Neisseria gonorrhea, and superior to minoglycine drug used for control of sexually transmitted diseases (STD). Both root and leaves showed antibacterial effect against *Escherichia coli*, *Salmonella typhii, Pseudomonas auriginosa, Bacilus subtilis, Staphylococcus aureus* and *Shigallae dysentrae*. *Escherichia coli* was more susceptible while *Salmonella tyhpii* showed the least. Fungal bioassay carried out on *Candida albicans* and *Aspergillus niger* showed root extract to be more

potent than leaf extracts.

Roots and leaves showed varied significant amount of proteins mineral vitamins and sugars depending on source. Mean concentration levels of minerals varied as potassium 11.34 - 32.05 mg/g, Sodium 5.61 - 24 mg/g, Magnesium 1.40 - 2.83 mg/g, Calcium 3.08 - 8.25mg/g, Iron 0.20 - 0.43 mg/g, Zinc 0.03 - 0.07 mg/g, Copper 0.003 - 0.06 mg/g, Manganese 0.64 - 0.05 mg/g, Cadmium and Lead were in trace amounts. Crude protein ranged form 4.35 mg/g - 21.8 mg/g, highest being from leaves. Vitamin varied as B carotene 4.35 - 21.81 ugg-1, Thiamine 0.78 - 3.70 mgg-1, Niacin 0.52 - 8.15 mgg-1, Riboflavin 0.62 - 2.45 mgg-1 and sugars, fructose 7.908 - 15.26 ugg-1, Xylose 9.17 - 18.70, glucose 2.40 - 9.0.

Comparison of basal diets for animal feeds, showed Mondia leaves had high crude protein and ash percentage of 20.25 and 16.98 respectively while dairy meal had crude protein and ash percentages 16.76 and 7.83 respectively. These results support traditional medical claim on use of Mondia whytei. The results show it has potential for human and animal health care. The chemical and phytochemical results have been used to reschedule Mondia whtyei products for quality assurance that are now being sold in leading Kenyan supermarkets.

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Case Study - Commercial Cultivation of Medicinal Plants

The uncontrolled collection and sale of large quantities of plant material from the forest leads to the destruction of many forest plants. Local communities, traditional medicinal herbalists and herbal medicine vendors popularly collect roots, bark and whole shrubs.

More than 500 members of the community adjacent to Kakamega Forest were trained in methods of cultivating *Mondia whytei* on-farm

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The Kakamega project has introduced a new action plan to support sustainable utilization of medicinal plants. Farmers have been mobilized to practice on-farm cultivation of selected medicinal plants. This

Community members are shown how to prepare seedbeds for *Mondia whytei* seedlings

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results in reduced pressure on forest herbal medicine while providing alternative income to the local community. Candidate medicinal plants for on-farm cultivation and commercialization were selected on the basis of their product effectiveness, toxicity, propagation potential as well as product market evaluation. Extensive agronomic studies accompanied the selection process.

Once mature, roots

The formulation of the plant products was refined by ICIPE in collaboration with the, Pharmacology Department, University of Nairobi and the Kenya Forestry Research Institute (KEFRI). Mondia whytei root (known locally as mukombera) is being formulated into a high value powder by KEFRI. The plant is used as a natural appetizer, enhancer of cerebral and peripheral blood circulation. It is a source of nutrients such as vitamin A, D, K and E, the minerals, magnesium, zinc, iron, calcium and protein while its aroma

from the farmer's plots of *Mondia whytei* will be purchased and used for commercial production of M. whytei in powder and other forms

makes it useful as a food-flavoring agent. A total of 14,000 *M. whytei* have been planted by the forest adjacent communities in their farms. The farmers also plant endangered tree species such as *Prunus africanus* adjacent to the vine to support it.

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Mondia tonic

Mondia tonic

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Prunus africana
Scientific name: *Prunus africana*
Order/Family: Rosales: Rosaceae
Local names: Kamba: Mumbaume / Keiyo: Tenduet / Kikuyu: Muiri / Kipsigis: Arareut / Kisii: Omoiri / Luhya (busuku): Kumutura / Maasai: Olkojuk / Marakwet: Tenduet / Meru: Mweria / Nandi: Tendwet / Ogiek: Tenduet / Sabaot: Oromoti / Swahili: Kiburabura / Tugen: Kunyukwa
Common/Trade names: Red stinkwood, Prunus (Kenya)

General Information and Agronomic Aspects

***Prunus africana* is native to the montane tropical forests of Sub-Saharan Africa and Madagascar. It**

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Geographical Distribution of Prunus in Africa

occurs inwild in forests from 22 countries, majority in the Eastern and Southern Africa region such as Ethiopia, Uganda, Kenya, Tanzania, Zambia, Malawi, Mozambique, South Africa, but also Cameroon, Nigeria, Sao Tome, Angola etc.

A valuable timber and medicinal tree has more recently come under heavy pressure for wild harvest for timber and bark extraction, as there is a fast growing market for the bark. It has been added to Appendix II of CITES list of endangered species, for regulation of trade from wild harvest. Kenya has the largest planted area (628 ha planted by year 2000), but the tree is increasingly becoming a popular agroforestry tree and coppices (it can be cut back and produces shoots from stools or roots) well when young. Leaves and twigs contain the same medicinal properties as the bark; so can be harvested sustainably while coppicing the tree in agroforestry systems.
The timber is hard and durable and is used in Africa for the manufacture of various household products such as axes, hoes and furniture.

Prunus works well as shade tree for coffee plants and other crops. It

grows best in tropical highlands from 1000 to 2500m above sea level with rainfall between 500 to 2000 mm/year and fertile loam soils.

Description

An evergreen tree up to 25 m tall or rarely, a shrub. In the forest the dense foliage is open, in grassland the tree is more stunted. The bark is black to dark brown, and has a rough corrugated or fissured and scaly texture, fissuring in a characteristic rectangular pattern. The leaves are leathery, glossy dark green and have margins with shallow rounded teeth. The leaf stalk is typically pink to reddish brown. The fruit is red to brown, rounded and about one cm; it is often bilobed containing one seed in each lobe. It grows in bunches. Prunus flowers and fruits from about 4 m high.

Propagation and planting

The seeds are collected from directly underneath the trees. Seeds from dark red to brown fruits germinate better than seeds from green fruits. Remove the fruit flesh and sow the seeds in a nursery while fresh; they do not store well. Also wild seedlings (wildlings) can be collected and planted. There is evidence that seeds and seedlings survive best in soil with relatively high humus content. Nursery soils should contain either peat or decomposed sawdust. Seeds generally germinate 50 to 90 days

after planting. Up to 50 seedlings/m² in the nursery can do well - with higher density the survival rate diminishes. Young seedlings need about 40% shade.

Husbandry

Plant young seedlings on contours and borders. Prepare two- feet deep planting holes. Fill it with back soil mixed with compost and leaf matter. Water once a week for the first year. Use a filled and upended bottle or other water conserving system.

Harvesting

Do not harvest bark till the tree is at least 30 cm in diameter at breast height. From trees 30 to 50 cm diameter two bark panels of not more than 15 to20 cm wide can be harvested from each side of the tree from about one meter above ground level up to the first branch. After 4 to 5 years two more panels can be harvested on the other sides of the tree. If bark is over harvested the tree dies. However leaves contain the same medicinal properties as the bark, so these can be used in local medicine. From younger trees only the leaves and twigs can be pruned or coppiced.

Market

At least four European companies are actively buying bark of *Prunus Africana*. In 2000 the bark trade amounted to US$ 150 million/year or 3500 tonnes of this commodity. It was estimated that this demand would triple or quadruple to 7 to 11000 tons/year in export and about 500 tonnes/year for use in Africa the next few years.

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Medicinal Properties of Prunus Africana

The active ingredients in *Prunus Africana* are effective treatment for benign Prostatic Hyperplasia and Prostate gland Hypertrophy (enlarged prostate gland), ailments that affect about 60% of men over the age of 50, especially in Europe and USA. Traditional healers also use the bark in treatment of stomachache, wound dressing, infusion of leaves to improve appetite, treatment of both bacterial and non-bacterial chronic prostesis and genital infection as well as hirsutism in women.

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Information on Major Diseases and Pests

These are mainly coleopterous borers causing wood degradation, but there can be pathogenic fungi affecting nurseries.

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Neem (*Azadirachta indica*)

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Neem seeds

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Neem flower

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Neem mill for oil extraction

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Milling of cake

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Moringa leaves

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Moringa flower

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Moringa seeds

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Pelargonium sidoides

© Courtesy of Ulrich Katz, Botanischer Garten, Ruhr-Universität Bochum

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Ocimum kilimandscharicum harvest

Kakamega forest integrated conservation project

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Sutherlandia frutescens flowers

The flowers are bright red, 35mm long, and are borne on short stalks in loose clusters.

Sutherlandia (www.ecoport.org)

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Sutherlandia frutescens

This soft sub-shrub is widespread throughout South Africa. Prefers disturbed and gravelly soils.

Sutherlandia frutescens bush with fruit

The fruit, which are inflated

pods, become pale brown and papery when ripe and accumulate under and on the bush in large numbers.

Sutherlandia frutescens seeds

Seeds black, flattened, reniform and pitted, with funicle; about 5 mm long.

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Mondia whitei, flower

Leopard Rock Game Reserve, Vumba, Zimbabwe, 30 Dec 2003

Mondia whytei

Mondia in Kakamega, Kenya, Oct 2008

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Mondia whitei, stipules

Mondia whitei. Perennial climber. False stipules with stiff fimbriae between each pair of leaves. in open miombo

woodland, 23 Jul 2004

Mondia whytei, root

Mondia in Kakamega, Kenya, Oct 2008

© Monique Hunziker

Mondia harvesting

The roots of Mondia whytei are harvested extensively from Kakamega Forest in a well organized trade leading to scarcity of the plant Mondia whytei roots are sold in towns in Kenya and in other African countries.

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Mondia whytei market

The roots are eaten by the young and old as a flavoring and appetizing agent.

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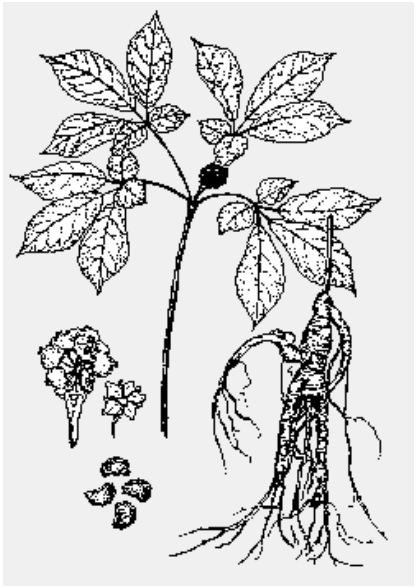

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Information of www.infonet-biovision.org

Neem
Scientific name: *Azadirachta indica*
Family: Rutales: Meliaceae
Local names: Muarubaini

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Cultural practices

Geographical Distribution of Neem in Africa

The neem tree is native to India and Southeast Asia, but it is now grown in the warm lowland tropics as well as in arid and semi-arid areas of the world.

It was introduced to Eastern Africa during the 19th century by East Indian immigrants, who propagated the tree essentially for its medicinal properties. It is now widely cultivated in Mauritania, Senegal, The Gambia, Guinea, Ivory Coast, Ghana, Burkina Faso, Mali, Benin, Niger, Nigeria, Togo, Cameroon, Chad, Ethiopia, Sudan, Somalia, Kenya, Tanzania, and Mozambique.

In Kenya, especially along the Coast, the Neem tree is very well known: in Kiswahili its name is "Muarubaini", which means the tree of the forty cures. The tree, which grows up to 30 meters and can reach an age between 100 and 200 years, provides shade and timber. The seeds, leaves and bark can be used to produce medical, cosmetic and insecticidal products. Extracts from seeds and leaves can be turned into medicines against a number of ailments as well as insecticides for agricultural use. Especially the oil, produced out of the seeds, is a

Neem trees
© A.M.Varela

much sought after ingredient for cosmetic products. Because it is an evergreen and fast growing tree, Neem is a favourite for reforestation. The wood is useful as building timber because termites will not attack it. When planted on slopes, the tree can help to combat erosion and landslides. The fallen leaves help to neutralise acidic soils.

Climatic conditions, soil and water management

Climate: Neem has a wide climatic adaptability and thrives under sub-humid to semi-arid and arid climatic conditions. It is generally found in areas with mean annual temperatures of 21 to 32°C. It can survive hot temperatures (reportedly up to 50°C), but does not tolerate frost or extended cold, although there are some reports of neem trees surviving light frost. Generally, at temperature below 4°C leaf shedding and death may occur.

The neem tree grows in areas with mean annual rainfalls of 450 mm up to 1,200 mm. It can grow in regions with an annual rainfall below 400 mm, but in such cases it depends largely on the ground water levels.

Altitude: Neem grows in areas from sea level up to 1200 m, however it thrives at low

altitudes. Very often the neem tree is confused with the Persian lilac or chinaberry tree (*Melia azedarach*) a relative of neem which thrives a high altitudes.

Soils: The tree grows on a variety of soils, clayey or sandy, saline or alkaline, but will not grow in waterlogged soils. It does particularly well, however, on black cotton soils and deep, well drained soils with good subsurface water. Unlike most other multipurpose tree species, neem thrives on dry, stony, shallow soils and even on soils with hard calcareous or clay pans at a shallow depth. The tree improves soil fertility and water holding capacity because it has the unusual property of calcium mining, and can thereby neutralise acidic soils. Its extensive root system also has a rare physiological capacity to extract nutrients from highly leached sandy soils. Neem can grow on soils with a wide pH range. The optimum growth is at pH 6.2 to 7, but it can also grow well down to pH 5 and survive in soils between pH 3 and .

Propagation and planting

The Neem tree is best propagated from its seeds which will only germinate if less than three months old. The seeds need to be sprinkled daily while laying on a newspaper which is placed on plastic in the shade. The newspaper has to be renewed every second day. After a week the seed will crack and sprout ready to be planted in compost made of half soil and half cow manure. To propagate from a cutting, a small twig has to be stripped of its leaves and stuck into moist soil.

Neem nursery

© A.M.Varela

Husbandry

Nutrient deficiencies: A lack of zinc or potassium drastically reduces growth. Trees affected by zinc deficiency show chlorosis of the leaf tips and leaf margins, their shoots exude much resin, and their older leaves fall off. Those with potassium deficiency show leaf tip and marginal chlorosis and die back (necrosis).

Yields

The tree starts bearing fruits after 3 to 5 years and is fully productive after 10 years. Under favourable conditions a tree can produce up to 30kg of seeds per year and 350kg of leaves.

Information on Pests and Diseases

By and large, most neem trees are reputed to be remarkably pest free; however, some pests and diseases occasionally attack neem trees.

Pests

In some parts of Africa (mainly in the Lake Chad Basin), a scale insect (*Aonidiella orientalis*) has become a serious pest. This and other scale insects sometimes infest neem trees in central and south India. They feed on sap, and although they do little harm to mature trees, they may kill young ones. Now that one type has been detected in Africa, the impact could be severe.

Another insect pest ist the scale insect *Pinnaspis strachani* (very common in Asia, Africa, and Latin America). Even though neem timber is renowned for termite resistance, termites sometimes damage, or even kill, the living trees. However, they usually attack only sickly specimens, however.

In Nigeria, 14 insect species and one parasitic plant have been recorded as pests. Few of the attacks were serious, and the trees almost invariably recovered, although their growth and branching may have been affected.

Diseases

Despite the fact that the leaves contain fungicidal and antibacterial ingredients, certain microbes may attack different parts of the tree, including the following:

- **Roots (root rot, *Ganoderma lucidum*, for instance)**
- **Stems and twigs (the blight *Corticium salmonicolor*, for example)**
- **Leaves (a leaf spot, *Cercospora subsessilis*; powdery mildew, *Oidium* sp., and the bacterial blight *Pseudomonas azadirachtae*)**
- **Seedlings (several blights, rots, and wilts - including *Sclerotium, Rhizoctonia*, and *Fusarium*)**

A canker disease that discolours the wood and seems to coincide with a sudden absorption of water after long droughts has also been observed. (OIA 1992)

Medicinal Properties and Uses

The best-established and most widely recognised uses are as a general antiseptic.

Neem preparations are reportedly effective against a variety of skin diseases, septic sores, and infected burns. The leaves can be applied in the form of poultices (cataplasms) or decoctions. They are also recommended for boils, ulcers, and eczema. The oil is used for skin diseases such as scrofula, indolent ulcers, and ringworm (OIA 1992).

Various parts of the neem tree have been used in traditional ayurvedic medicine in India for centuries. The medicinal utilities have been described, especially for leaf, fruit and bark. Neem oil and the bark and leaf extracts have been therapeutically used as folk medicine to control leprosy, intestinal helminthiasis, respiratory disorders, constipation and also as a general health promoter. Its use for the treatment of rheumatism, chronic syphilitic sores and indolent ulcer has also been evident. Neem oil is used to control various skin infections. Bark, leaf, root, flower and fruit together cure blood morbidity, biliary afflictions, itching, skin ulcers, burning sensations and pthysis (tuberculosis). Neem leaf extract has been prescribed for oral use for the treatment of malaria by Indian ayurvedic practitioners from time immemorial. Dried neem leaves in the form of tea are also used by the people of Nigeria and Haiti to treat this disease.

There are also reports on the biological activities and pharmacological actions of neem based on modern scientific investigations.

Neem extract:

Clinical studies with dried neem leaf extracts indicated their effectiveness to cure ringworm, eczema and scabies. Lotions derived from neem leaf, when locally applied, can cure these dermatological diseases within 3 to 4 days in acute stage or a fortnight in chronic case.
Application of neem oil on the hair has been shown to kill head lice.
Recently, a clinical trial has been carried out to see the efficacy of neem extract to control hyperlipidemia in a group of malarial patients severely infected with *Plasmodium falciparum*. The lipid level, especially cholesterol, was found to be lower during therapy when compared to non-malaria patients. (Biswas 2002)

Neem bark contains a strong antiseptic and neem is used to make soap and toothpaste. Neem twigs are used to clean teeth.

Neem may also be a ready source of low-cost analgesic (pain relieving), or antipyretic (fever-reducing) compounds. It is used for these purposes everywhere it is grown. In trials, positive results have been obtained for significant analgesic, antipyretic, and anti-inflammatory effects. This may explain its wide use for treating fevers in general. (OIA 1992). There have been studies of Neem's possible toxicity, which have resulted in a determination that the leaf and bark are very low in toxicity. Very large doses of neem leaves taken internally by some of the animals tested have caused some side effects. Neither leaves or bark should be taken in large doses for extended periods of time. As with any substance taken internally, neem should not be taken to excess, as even a good thing can be misused. Keeping this in mind, there are a few recipes for

various ailments:

Neem leaves

© A.M.Varela

To make enema leaf tea:
1. Use distilled water.
2. Measure one handful or one cup of whole leaf to one litre of water. If using neem powder, use 30g or a 1/4 cup of powder per litre of water.
3. Bring water to boil.
4. Remove from heat.
5. Add whole leaf or powder.
6. Cover, and let stand overnight or 24 hours.
7. Strain liquid, put in bottle, and drink as needed.
8. Refrigerate for long term storage.

To improve the immune system:
Chew 8 to 10 neem leaves early in the morning for 24 days. This protects your body from diseases like diabetes and hypertension; skin problems are also improved.

For wounds, bedsores, varicose veins:
Prepare neem water with 8 to 10 leaves, boiled in one litre of water, let cool and bathe wounds as needed. (Ethnobotanical leaflet of Southern Illinois University Carbondale)

Caution:

Medicines from plants should, of course, be treated with the same caution as medicines from laboratories. Neem oil seems to be of particular concern. Consuming it, although widely practiced in parts of Asia, is not recommended. Doses as small as 5 ml have killed infants, and animal studies showed acute toxicity at doses as low as 14 to 24 ml per kg of body weight. It seems possible that this was caused by contaminants rather than by the oil itself. In Germany, toxicological tests using oil obtained from clean neem kernels resulted in no toxicity, even at a concentration of 5,000 mg per kg of body weight in rats. Nonetheless, caution is called for. The leaves or leaf extracts also should not be consumed by people or fed to animals over a long period (OIA 1992).

Health products:

Saroneem Ltd. offer a wide range of health products made from Neem:

Neem Herbal Tea
The tea is 100% pure Neem product made from dried Neem leaves. It contains no additives. It is best used as preventive-curative in treatment of sore throat, colds,

fever, food poisoning, low in cholesterol, malaria, hypertension, respiratory problems, diabetes, hepatitis and kidney ailments. Taken regularly, helps to eliminate fatigue. Neem is regarded as one of the best blood purifying herbs.

Neem Seed Oil

This product is refined Neem oil from the neem seeds. It has been blended with lemon grass to create an excellent therapeutic oil and skin cleanser. Seed oil can be applied directly to the affected areas of skin and scalp. It is a natural treatment for rashes, burns, cuts, bruises, fungal infections, acne, pimples and other skind blemishes. Neem seed oil has been found to be effective against Tinea pedis or athlete's foot is a skin infection caused by a fungus. Fungal infections of this type affect eight out of ten people at some time.

Neem Soap

This is a herbal soap made from pure Neem oil. It has natural skin moisturising oil that makes the skin soft and supple. It assists in preventing as well as healing many skin and scalp ailments, inflammation, fungal infections, burns, cuts and bruises. Neem soap alleviates the intense itching and scarring which are the main problems associated with chickenpox. Take cool baths to reduce itching.

Neem Leaf Capsules

Made from sun dried neem leaves, they are used for the same purpose as Neem tea. Neem is one of the most potent immuno-stimulant available herbs.

Neem in Pest Control

The neem tree has an over 100 compounds with pesticidal properties. The best known is azadirachtin. This substance is found in all parts of the tree.
Neem is unique among plants with pesticidal properties since it has so many different effects on pests: It acts as a broad spectrum repellent, insect growth regulator and insect poison. It discourages feeding by making plants unpalatable to insects; if they still attack, it inhibits their ability to moult and lay eggs. Unlike most botanical insecticides, neem also has a somewhat "systemic" effect. This means that plants can take up neem extracts through their roots and leaves, spreading the material throughout the plant tissues. For this reason neem can help control pests like leafminers, which feed within leaves and are normally not affected by sprays that only cover the outsides of the plant.

Neem extracts do not kill insect pests immediately. They change the feeding behaviour and life cycle of the pests until it is no longer able to live or reproduce. Therefore, neem extracts are not immediately effective. Effects are often not visible before 10 days after application. Pests may continue feeding lightly on plants until the spray takes effect. On adult insects, in fact you may not see any direct effect, but they will produce no or very few offspring, reducing future damage. Consequently, severe pest

attacks will not be controlled within time. For a reliable and satisfying control neem extracts must be treated at an early stage of pest attack.

Neem products break down fairly quickly - usually within 5-7 days - in sunlight and in the soil; heavy rains within a few days of application may wash off the protective cover of neem on plants. So, usually repeated spot sprays of affected plants are necessary to achieve control.

Some neem products, especially the ones with high oil content, are phytotoxic to some plants. Therefore, the extracts should be tested on few plants before going into full scale spraying. Neem based pesticides are suitable for use in developing countries because leaf or seed extracts can easily be done without the use of expensive and complicated equipment. However, neem extracts are rapidly destroyed when exposed to sunlight (UV, ultra-violet rays). For this reason, commercial products usually contain a sunscreen.

Because neem's chemical structure is so complex (the tree has many different compounds with pesticidal properties), scientists believe it will take a long time for insects to develop resistance to it. However, in order to minimise the chance of affecting beneficial organisms and encouraging pest resistance, use neem sprays only when absolutely necessary, and only on plants you know are affected by pests. The effect of neem as a pesticide depends on the concentration of the active principles, on the formulation, on the pest type and on the crop.

Use as an insecticide: The seeds are the primary source of insecticides. They can be used in the form of simple aqueous extracts or as a basic raw material for formulated pesticides. The leaves are also used as simple aqueous extracts to repel insects.

Use as a nematicide: The neem cake, a by-product of oil extraction, from the seeds, worked into the soil has shown to reduce to a considerable extent the reproduction and population density of numerous pathogenic nematode species.

Use as a fungicide: One of the latest discoveries is neem's potential application in the control of phytopathogenic fungi. Neem oil based emulsions have proven to be the most effective. Use as a molluscicide and acaricide: These pests are only controlled on to a limited extent with neem. Neem showed deterrent effects on land snails. Alcoholic extracts have a negative effect on the reproduction of spider mites.

Neem cake

© A.M.Varela

The susceptibility of different groups of pests to neem products is shown on the table below.

Pests	Level of control	Recommended neem formulation
Beetle larvae, butterfly and moth caterpillars	excellent	aqueous neem extracts
Stalkborers	good	aqueous neem extracts and neem cake, neem powder
True bugs, plant- and leaf-hoppers Grasshoppers	good	neem oil, neem kernel extracts
Grasshoppers	good	neem oil
Adult beetles	good/ fair	aqueous neem extracts, neem cake powder, leaves, neem oil
Thrips, fruit flies, scale insects, mealybugs	fair/ poor	neem oil, aqueous neem extracts

Mites	**fair/ poor**	**alcoholic extracts**
Aphids and whiteflies	**good/ fair**	**neem oil**
Plant parasitic nematodes	**good**	**neem cake, neem leaves**

Neem preparations, being medium- to broad-spectrum pesticides, also have side effects on some non-target organisms. However, these effects are as a rule relatively slight. This has been explained by the special mode of action of neem compounds, and on the feeding behaviour of the insects as well as the, in the rule, low contact effect of neem products. The degree of side effects is largely dependent on a number of factors such as formulations, time, frequency and methods of applications. Adults of predatory insects are apparently not affected by dosages of neem products recommended for effective pest control. However, their activity, fecundity and longevity may be negatively affected with high dosages. Hover flies are one of the most sensitive groups to neem applications.

Parasitoids are in general less sensitive to neem products than predators. However, especially in very small species of parasitic wasps, treatment of the developmental stages of the host (for instance eggs or puparia of whiteflies), may have negative effects on the emergence rate, walking ability, searching ability, longevity and fecundity of the natural enemy.

In general, neem products based on neem oil or with high oil content have more or

stronger side effects on non-target organisms than oil-free preparations. Thus, their application should be avoided or restricted on crops where natural enemies play an important role in pest control.

Neem in Reforestation

Neem seems to be a good candidate for planting in most warm parts of the world. It grows vigorously in many semiarid and tropical areas and is regarded as a valuable forestry species in many parts of Africa; but even there it could become more widely employed. It is a multipurpose species that provides villagers with various products from which to derive an income during the years when the trees are maturing. It is also promising for planting in areas now suffering desperate fuelwood shortages. It is useful as a windbreak, exceptional as a city tree, and it can grow in (and perhaps neutralise) acid soils in the tropics. (OIA 1992)

On the farm and around the house neem is useful not only as a windbreak and a welcome source of shade, but its seedcake is a good fertiliser. It contains nitrogen, potash, phosphorus, calcium and magnesium. (OIA 1992)

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Local Reference Address for Neem Products

- **Health products and Neemros® and Neemroc®, locally produced pesticides. Produced by Saroneem Biopesticides Limited. Babadogo road, opposite Catholic**

Church P. O. Box 64373-00620 Nairobi. Contact: Mr. Dorian Rocco Mobile: 072 8592478, email: saroneem@yahoo.com saroneem@yahoo.com

Information of www.infonet-biovision.org

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Moringa

Moringa
Scientific name: *Moringa oleifera*
Family: Capparales: Moringaceae
Local names: Mkimbo, Mlonge, Mlongo, Mronge, Mrongo, Mzungu, Mzunze (Kenya), Mlonge (Tanzania),
Common names: horse-radish tree / drumstick tree

General Information and Agronomic Aspects

Moringa is a slender, fast growing, deciduous shrub or small tree reaching 9 to 15 m in height, with an umbrella shaped, open crown. It is an exceptionally nutritious tree with a variety of potential uses.

Almost every part of plant is of value for food. Seed is said to be

Geographical Distribution of Moringa in Africa

eaten like a peanut in Malaya. The thickened root is used as a substitute for horseradish. Foliage is eaten as greens, in salads, in vegetable curries, as pickles and for seasoning. Seeds yield 38 to 40% of a non-drying oil, known as "ben oil", used in arts and for lubricating watches and other delicate machinery. Ben oil is clear nd odorless, has an unusually long shelf life, never becoming rancid. It is edible (with a sweet, mild pleasant taste) and useful in the manufacture of perfumes and hairdressings.

Climatic conditions, soil and water management

It grows best in direct sunlight below 500 meters altitude, but it can grow in altitudes up to 1200 m in the tropics. It grows best between 25 to 35°C, but will tolerate up to 48°C in the shade and can survive a light frost. It tolerates a wide range of soil conditions, but prefers a neutral to slightly acidic (pH. 6.3 to 7.0), well-drained sandy or loamy soil. Minimum annual rainfall requirements are estimated at 250mm with maximum at over 3,000mm, but in waterlogged soil the roots have a tendency to rot. (In areas with heavy rainfall, trees can be planted on small hills to encourage water run-off). Presence of a long taproot makes it resistant to periods of drought. It readily colonises stream banks and savannah areas where the soils are well drained and the water table remains fairly high all the year round (EcoPort, AVRDC, Fuglie, Moringa Farms)

Propagation and planting

- **Moringa trees grow easily from seeds or hard-stem cuttings. When using seeds they can be directly sown in the field or used for raising seedlings in nursery beds and transplanted.Direct seeding is preferred when plenty of seed is available and labour is limited, and when enough water is available. Thus, direct seeding can be done in the backyard garden, when there is enough water available for irrigation. In a large field, trees can be seeded directly at the beginning of the wet season. Transplanting allows flexibility in field planting but requires extra labour and cost in raising seedlings. Stem cuttings are used when the availability of seed is limited but labour is plentiful.**

Moringa seeds have wings and are about the size of a large pea. Seeds don't need sunlight in order to germinate. Moringa seeds have no dormancy period, so they can be planted as soon as they are mature and they will retain the ability to germinate for up to one year (Fuglie, Trees for Life, AVRDC) . To encourage rapid germination, one of three preseeding tretments can be employed:

- **Soak the seeds in water overnight before planting.**
- **Crack the shells before planting.**
- **Remove shells and plant kernels only.**

Land preparation

- **Choose an area with light and sandy soil, not heavy with clay or water-logged.**
- **If planting a large plot it is recommended to first plough the land.**
- **Prior to planting a seed or seedling, prepare a planting pit by digging holes 30 to 50 cm wide and deep, water, and then fill in the pit with topsoil mixed with compost or manure (at the rate of five kg per pit) before planting seeds. This planting hole serves to loosen the soil and helps retain moisten in the root zone. This will enable the seedlings? roots to develop rapidly. Compost or manure will help the tree grow better, even though Moringa trees can grow in poor soils. Avoid using the soil taken out of the pit for this purpose: fresh topsoil contains beneficial microbes that can promote more effective root growth.**
- **Moringa can also be planted on 30-cm-high raised beds to facilitate drainage (AVRDC).**

To plant seeds directly in the ground:

- **Plant 2 or 3 seeds in each hole, 5 cm apart. Plant the seeds at a depth of 2 cm (approximately the size of one's thumbnail).**
- **Do not water heavily for the first few days. Keep the soil moist enough so that the top soil will not dry and choke the emerging saplings, but not too wet or else the seeds can drown and rot.**
- **Two weeks after germination, or when the seedlings are four to six inches (10 to 15 cm) tall, keep the healthiest seedling in the ground and remove the rest.**

(Fuglie, Trees for Life, AVRDC)

In the nursery:
Seedlings for transplanting can be grown in divided trays, individual pots, plastic bags, or seedbeds. Use of divided trays and individual containers such as poly bags is recommended because there is less damage to seedlings when they are transplanted. Grow seedlings under shade or in a screenhouse.

Use poly bags with dimensions of about 18 cm in height and 12cm in diameter. The soil mixture for the bags should be light, i.e. three parts soil to one part sand. Plant two or three seeds in each bag, one to two centimetres deep. Keep moist but not too wet. Germination will occur within 5 to 12 days, depending on the age of the seed and pre-treatment method used. Remove extra seedlings, leaving the strongest seedling in each bag. Seedlings can be transplanted in the field when they are 60 to 90 cm high. When transplanting, cut a hole in the bottom of the bag big enough to allow the roots to emerge. Be sure to retain the soil around the roots of the seedling (AVRDC).

Transplanting to the field

- **The day before transplanting, water the filled pits (see land preparation) or wait until a good rain before out-planting seedlings. Fill in the hole before transplanting the seedling. In areas of heavy rainfall, the soil can be shaped in the form of a mound to encourage drainage**
- **Do not water heavily for the first few days. Keep the soil moist enough so that the topsoil will not dry and choke the emerging saplings, but not too wet or else the**

seeds can drown and rot.

- **If the seedlings fall over, tie them to stick 40 cm high for support.**

Growing from cuttings

To grow trees from cuttings use hard wood, avoid using young green stem tissue. Cut off the branches after the trees have stopped producing fruits. This will promote fresh growth and the cutbranches provide excellent cuttings for growing new trees. Compared to trees planted from seed, trees from stem cuttings grow faster but develop a shallow root system that makes them more susceptible to moisture stress and wind damage.

Cuttings can be planted directly or planted in sacks in the nursery. When the cuttings are planted in the nursery, the root system is slow to develop. Cuttings planted in a nursery can be transplanted planted after 2 or 3 months. Cuttings can be 45 to 180 cm long with diameters of 4 to 16 cm. Cuttings can be dried in the shade for three days before planting in the nursery or in the field.

When planting direct in the field:

- **Dig a hole 1m x 1m wide and one m deep**
- **Place cutting in this hole and fill with a mixture of soil, sand and composted manure. Pack firmly around base of the cutting. This will facilitate drainage. It is not desirable that water touches the stem of the new tree**

- **Water generously, but do not drown the cutting in water. If the soil is too heavy or wet, the roots may rot.**

In India, some cow dung is put on top of the open end of the cutting to protect the cutting from pests (Trees for Life)

Spacing

For intensive Moringa production, plant the tree every three meters in rows three meters apart. When the trees are part of an alley-cropping system, there should be 10 meters between the rows. The area between trees should be kept free of weeds (Fuglie and Sreeja).

The World Vegetable Center (AVRDC) recommends, if using raised beds, to form beds with 2-m-wide tops, and space plants 3 to 5 meters apart in a single row. For production of leaves only, space plants 50 cm within rows spaced one meter apart. If using raised beds, form beds with 60-cm-wide tops and space plants one meter apart in a single row. For intensive production of leaves, space plants 10 to 20 cm within rows 30 to 50 cm apart. Closer spacing allows harvest of young edible shoots every two to three weeks.
Trees are often spaced in a line one meter apart or closer to establish living fence posts.

Intercropping

Moringa Trees are planted in gardens to provide support for climbing crops such as pole beans, although only mature trees should be used for this purpose since the vine growth can choke off the young tree. Moringa trees can be planted in gardens to provide shade to vegetables less tolerant to direct sunlight. Trees are planted in hedgerows forming wide alleys where vegetables are planted within. Choose vegetables that are adapted to alley cropping, such as shade-tolerant leafy vegetables and herbs, since moringa hedgerows are highly competitive and can reduce yields of companion plants significantly. From the second year onwards, Moringa can be intercropped with maize, sunflower and other field crops. Sunflower is particularly recommended for helping to control weed growth. However, Moringa trees are reported to be highly competitive with eggplant and sweet maize and can reduce their yields by up to 50% (Fuglie and Sreeja; AVRDC).

Husbandry

Moringa trees do not need much watering. In very dry conditions, water regularly for the first two months and afterwards only when the tree is obviously suffering. Moringa trees will flower and produce pods whenever there is sufficient water available. If rainfall is continuous throughout the year, Moringa trees will have a nearly continuous yield. In arid conditions, flowering can be induced through irrigation.

Prunning

Pinching the terminal tips: When the seedlings reach a height of 60cm in the main field, pinch (trim) the terminal growing tip 10cm from the top. This can be done using fingers

since the terminal growth is tender, devoid of bark fibre and brittle, and therefore breaks easily. A knife blade can also be used. Secondary branches will begin appearing on the main stem below the cut about a week later. When they reach a length of 20cm, cut these back to 10cm. Use a sharp blade and make a slanting cut. Tertiary branches will appear, and these are also to be pinched in the same manner. This pinching, done four times before the flowers appear (when the tree is about three months old), will encourage the tree to become bushy and produce many pods within easy reach. Pinching helps the tree develop a strong production frame for maximising the yield. ***If the pinching is not done, the tree has a tendency to shoot up vertically and grow tall, like a mast, with sparse flowers and few fruits found only at the very top.*** **During its first year, a Moringa tree will grow up to five meters in height and produce flowers and fruit. Left alone, the tree can eventually reach 12 meters in height with a trunk 30cm wide; however, the tree can be annually cut back to one meter from the ground. The tree will quickly recover and produce leaves and pods within easy reach (Fuglie).**

Harvesting

When harvesting pods for human consumption, harvest when the pods are still young (about one cm in diameter) and snap easily. Older pods develop a tough exterior, but the white seeds and flesh remain edible until the ripening process begins.

When producing seed for planting or for oil extraction, allow the pods to dry and turn brown on the tree. In some cases, it may be necessary to prop up a branch that holds many pods to prevent it breaking off. Harvest the pods before they split open and

seeds fall to the ground. Seeds can be stored in well-ventilated sacks in dry, shady places.

For making leaf sauces, harvest seedlings, growing tips or young leaves. Older leaves must be stripped from the tough and wiry stems. These older leaves are more suited for making dried leaf powder since the stems are removed in the pounding and sifting process (Fuglie).

Nutritional Values and Recipes

Moringa oleifera **has an impressive range of medicinal uses and a high nutritional value.**

Nutrition:

Moringa is one of the world's most nutritious crops. Different parts of this plant contain a profile of important minerals, and are a good source of protein, vitamins, beta-carotene, amino acids and various phenolics (Anwar 2007). The leaves are outstanding as a source of vitamins A and, when raw, vitamin C. They are also a good source of B vitamins and among the best plant sources of minerals. The calcium content is very high for a plant and phosphorous is low. The content of iron is very good (it is reportedly prescribed for anaemia in the Philippines) and the leaves are an excellent source of protein and a very low source of fat and carbohydrates. Thus, the

leaves are one of the best plant foods that can be found (Moringa Garden Circle). According to a gram-to-gram comparison of nutritional information, Moringa leaves contain four times the vitamin A of carrots, four times the the calcium of milk, three times the potassium of bananas and twice the protein of yoghurt and more iron than spinach (Trees of Life; Gopalan 1971; AVRDC.

Recipes:
Virtually every part of Moringa is edible. The leaflets can be stripped from the feathery, fernlike leaves and used in any spinach recipe. Small trees can be pulled up after a few months and the taproot ground, mixed with vinegar and salt and used in place of horseradish. Very young plants can be used as a tender vegetable.

Leaves: Of all parts of the tree, the leaves are most extensively used. The growing tips and young leaves are best. The leaves can be used any way you would use spinach. One easy way to cook them is this:
Steam two cups freshly picked leaves for just a few minutes in one cup water seasoned with an onion, butter and salt. Vary or add other seasons according to your taste.
In India, leaves are used in vegetable curries, seasonings and in pickles. (Moringa Garden Circle)

Pods: Young Moringa pods, known as "drumsticks" are edible whole, with a delicate flavour like asparagus. They can be used from the time they emerge from the flower

cluster until they become too woody to snap easily (the largest ones usable in this way will probably be 30 to 40cm long and 0.6 cm in diameter). At this stage, they can be prepared in many ways. These are three possibilities:

- **1. Cut the pods into one-inch lengths. Add onion, butter, and salt. Boil for ten minutes or until tender. Steam the pods without seasonings, and then marinade in a mixture of oil, vinegar, salt, pepper, garlic, and parsley.**
- **2. Steam the pods without seasonings, and then marinade in a mixture of oil, vinegar, salt, pepper, garlic, and parsley**
- **3. Make a soup by boiling the pods with onion until tender. Add milk, thicken, and season to taste.**

(Source:Moringa Garden Circle)

Root: The root, best known in India and the Far East, is extremely pungent. When the plant is only 60 cm tall, it can be pulled up, its root scraped, ground up and vinegar and salt added to make a popular condiment much like true horseradish. However, the root bark MUST be completely removed because of its toxicity; it contains two alkaloids (e.g. moringinine and spirachin), that affects the nerve system and which can be fatal following ingestion. Even when free of bark, the condiment, in excess, may be harmful. (Echo Technical Notes, 1996)

Peas:

The seeds (peas) can be used from the time they begin to form until they begin to turn yellow and their shells begin to harden. Only experience can tell you at what stage to harvest the pods for their peas. To open the pod, take it in both hands and twist with

your thumbnail; slit open the pod along the line that appears. Remove the peas with their soft winged shells intact and as much soft white flesh as you can by scraping the inside of the pod with the side of a spoon. Place the peas and flesh in a sieve and wash well to remove the sticky, bitter film that coats them. A better option is to blanch them for a few minutes, then pour off the water before boiling again in fresh water.
Now they are ready to use in any recipe you would use for green peas. They can be boiled as they are or, seasoned with onion, butter and salt, much the same as the leaves and young pods. They can be cooked with rice as you would any bean. The peas can also be prepared using this recipe:
Ingredients:

- **12-15 horseradish tree pods**
- **1 medium onion, diced**
- **4 cups grated coconut**
- **2 bouillon cubes**
- **2 inches ginger root**
- **4 tablespoons oil or bacon grease**
- **1 clove garlic**
- **2 eggs, hard-boiled**
- **Salt and pepper to taste**

Blanch both peas and pods, drain. Remove milk from 2-1/2 cups grated coconut by squeezing water through it two or three times. Crush ginger root and garlic, save half for later. Mix peas, flesh, coconut milk, ginger root and garlic together with onion,

bouillon cubes, oil, salt and pepper. Bring to a boil and cook until the peas are soft - about 20 minutes. Fry remaining half of crushed ginger root and garlic in two tablespoons of oil. Dice eggs. Add coconut, ginger, garlic and eggs to first mixture. Heat through. Serve. (Moringa Garden Circle)

Medicinal Properties and Uses

In addition to its high nutritional value, *M. oleifera* is very important for its medicinal value. (Anwar 2007)

The flowers, leaves and roots are widely used as remedies for several ailments.

Leaves:

- **Fresh leaves are good for pregnant and lactating mothers; they improve milk production and are prescribed for anaemia.**
- **Leaf juice is used as a diuretic; it increases urine flow and cures gonorrhoea. Leaf juice mixed with honey treats diarrhoea, dysentery and colitis (colon inflammation).**
- **The leaf juice has a stabilising effect on blood pressure and controls glucose levels in diabetic patients.**
- **In India and Nicaragua, leaves and young buds are rubbed on the temple for headache.**
- **In India and the Philippines, a poultice made from fresh leaves is applied to reduce**

glandular swelling.

- **Leaf juice is sometimes used as a skin antiseptic.**
- **Leaves are used as an irritant and as a purgative.**
- **In Nicaragua, Guatemala and Senegal, leaves are applied as poultice on sores and skin infections.**

(Source: Maroyi, 2006; Moringa for Life: Moringa Medicine Pharmacopoeia)

Seeds:
Moringa seeds are effective against skin-infecting bacteria *Staphylococcus aureus* and *Pseudomonas aeruginosa* (Council of Scientific and Industrial Research 1962; Oliver-Bever 1986).

Bark:
The bark of the moringa root should be scraped off because of its toxicity and the flesh of the root should be eaten sparingly (Oliver-Bever 1986). A paste made from bark treats boils. Paste from ground bark can be applied to relieve pain caused by snake, scorpion and insect bites. Oil is sometimes applied externally for skin diseases (Maroyi, 2006).

***Moringa oleifera* is already highly esteemed by people in the tropics and sub-tropics for the many ways it is used medicinally by local herbalists. In recent years, laboratory investigation has confirmed the efficacy of some of these applications (Moringa for Life).**

Information on Pests and Diseases

Moringa is resistant to most pests and diseases, but outbreaks may occur under certain conditions. For example, diplodia root rot may appear in waterlogged soils, causing severe wilting and death of plants. Mite populations can increase during dry and cool weather. Mite attack may lead to yellowing of leaves, but plants usually recover during warm weather. Other insect pests include termites, aphids, leafminers, whiteflies, and caterpillars. Termites can be a problem, especially when cuttings are planted. Suggested measures to protect seedlings from termite attack include:

- **Applying mulches of castor oil plant leaves, mahogany chips, tephrosia leaves or Persian lilac leaves around the base of the plants.**
- **Heaping ashes around the base of seedlings.**
- **Spreading dry and crushed stems and leaves of lion's ear or Mexican poppy around the base of plants.**

Cattle, sheep, pigs, and goats will eat moringa seedlings, pods and leaves. Protect moringa seedlings from livestock by installing fence or by planting a hedge around the plot (AVRDC, Fuglie and Sreeja).

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- **Trees for Life: Moringa book http://www.treesforlife.org/project/moringa/book/moringa_book_view.pdf**

Contact information

- **You can buy high-quality seed and obtain cultural information from:**

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Information of www.infonet-biovision.org
