Asian Journal of Applied Sciences, 2011
ISSN 1996-3343 / DOI: 10.3923/ajaps.2011.

Contribution of Moringa (*Moringa stenopetala,* Bac.), a Highly Nutritious Vegetable Tree, for Food Security in South Ethiopia: A Review

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ABSTRACT

The objective of this study was to review the biology and economic value of Moringa tree, miracle tree of hope and generate technical information for people working in universities, agricultural research and development and health institutions. *Moringa stenopetala* (syn. *Donaldsonia stenopetala* Bak.f., *M. streptocarpa* Chiov., *M. peregrina* Sensu Dale and Verdcourt), is endemic to eastern Africa. Although the species is reported in Djibouti, Uganda and the Sudan, its abundance and indigenous use is mainly confined to southern Ethiopia and northern Kenya. According to the Flora of Ethiopia, the species occurs in Ethiopia in Gamo-Gofa, Konso, Bale, Kaffa, Borena, Dherashe, Burji, Amaro and Sidama, between 500 and 1800 m.a.s.l. within the low to medium high land agro-climate. It prefers sandy, well-drained soils where the ground water level is high. It also withstands dry conditions thus it is equally well distributed in both wetlands and dry areas. Moringa has many uses: the Turkana make an infusion of Moringa leaves as a remedy for leprosy, besides using it as feed for their livestock. The Njemps, a tribe related to the Maasai, chew the bark as a treatment against coughs and use the bark extracts to flavor soups. Nomadic peoples in the Omo valley of South Omo Zone use Moringa root concoction to purify clay flood water (*M. stenopetala* roots have the properties of flocculating aqueous clay). In the Gamo Gofa (GG), Dherashe and Konso(Kon) districts, the smoke liberated from burning Moringa is used as a treatment for epilepsy (Yuputa, Kon) and malaria (Shekeriya, GG). Besides its medicinal value to various diseases, *M.stenopetala* tree is recognized nutritious food source for food in secured people in East Africa.

Key words: Food security, medicinal value, Moringa tree, nutritious food, root concoction

INTRODUCTION

Ethiopia is an agricultural country where large majority of people are engaged in cultivation of food crops and rearing of livestock. Crops are produced for subsistence (Yisehak *et al*., 2010; Yisehak, 2008). Despite an expected three-fold increase in food demand by 2050, East Africa can still deliver food security for all through a smart approach that carefully matches policies and technologies to the needs and opportunities of particular farming areas. In the last two decades, per capita food production has been lagging behind the rates of population growth and food

shortage and rural poverty have become chronic problems in Ethiopia (Kebebe *et al*., 2007). In parts of southern Ethiopia, the consumption of wild food plants appeared to be one of the most important local survival strategies and to have and to have intensified due to the reaped climatic shocks hampering agricultural production thus leading to food shortage (Guinand and Lemessa, 2000; Debela *et al*., 2011). Therefore, the nutritional problem of the rural poor in any country can be overcome either by strengthening the households' resources base (Erhabor and Emokaro, 2007; Ibrahim *et al*., 2009) by diversifying alternate food sources (Ghosh, 2011).

Traditional use and economic contribution: Moringa *(Moringa stenopetala,* Bac.) belonging to the family Moringaceae is a softwood multipurpose tree (MPT), native of north-east tropical Africa and India. It occurs wild in the Sub-Himalayan regions of Northern India and now grown worldwide in the tropics and sub-tropics (Rajangam *et al*., 2001). In Ethiopia it is grown as a backyard crop in the southern parts of the Rift Valley and adjoining lowlands for its edible leaves, flowers and tender pods. The leaf of Moringa is very popular vegetable in Southern Nations and Nationalities and Peoples Regional State of Ethiopia and valued for its special flavour. It is grown as backyard tree to make it accessible for daily use in more than six million households of Southern Ethiopia (Endeshaw, 2003). Moringa has attracted enormous attention of etnobotanists and plant genetic resource conservationists due to its widespread use in agriculture and medicine.

Although Moringa is fast growing, drought tolerant and easily adapted to poor soil and arid conditions, it has not received significant research attention to select and develop potential ecotypes that might be valuable both as horticultural and medicinal crops. Because of its multiple uses and easy of propagation and ability to thrive under harsh environments, its acreage as a cultivated crop is on the increase, as is the demand for its products (Tenaye *et al*., 2009).

The cultivation of Moringa in Ethiopia occurs mainly in the Zones and Special districts such as South Omo, Gamo Gofa, Kaffa, Sheka, Bench Maji, Wolaita, Dawaro, Bale, Borena, Sidama, Burji, Amaro, Konso and Derashe (Edwards *et al*., 2000). Perennial types of Moringa are beset with many production constraints, such as a relatively long period to bear fruit, non availability of planting materials, requirement for long rainy period in regions where water is scarce and vulnerability to pests and diseases (Price, 1985; Endeshaw, 2003; Moges, 2004). Southern part of Ethiopia is coffee growing area (Kebebew, 2010; Shumeta, 2010) where intensification of multipurpose trees is vital for food security. Various indigenous fodder trees and shrubs rich in condensed tannins including *Moringa stenopetala* are considered as nutritionally potential feed supplements under small holders farming system in the tropics (Yisehak *et al*., 2010).

Moringa foliage and fruit pods are rich in protein (including good amounts of the sulfur-containing aminoacids, methionine and cystine) and good sources of vitamins A, B and C (when raw), calcium (Ca) and iron (Fe) (Ram, 1994). Many parts of the plant have been used in medicinal preparations traditionally in the region against malaria and internal parasites. The wood is very soft; useful for paper but makes low-grade firewood and poor quality charcoal. Attracting attention in recent decades is the use of the dried, crushed seeds as a coagulant in flood water purification (Jahn, 1984). Even very muddy water can be cleared when crushed seeds are added. Solid matter and some bacteria will coagulate and sink to the bottom of a container.

Church World Service observed that powder from crushed Moringa seed kernels worked as a natural flocculent, binding to the solids in water and causing them to sink to the bottom (CWS, 2000). Since bacteria in water are generally attached to solid particles, treatment with Moringa powder can purify water with 90-99% of the bacteria removed. Additional treatment of

the water by boiling or adding chlorine or bleach is needed to render it completely safe to drink. Women in the Sudan use seed powder from Moringa stenopetala to clarify the turbid water of the Nile. Moreover, the seed extract (Oluduro and Aderiye, 2007) achieved 90 and 95% sedimentation of the suspended particles in underground and surface water samples, respectively. Sedimentation was best achieved with 0.03 mg mL^{-1} of the seed extract.

Botanical description, adaptation and ecological distribution of Moringa stenopetala: *Moringa stenopetala* belongs to family Moringaceae that is represented only by a single genus *Moringa*. The genus *Moringa* is represented by 14 different species to which *M. stenopetala* belongs. Northeast tropical Africa is a center of endemism plus diversity to the genus (Mark, 1998; Edwards *et al*., 2000) stated that the taxonomic position of the family is not clear. It has some features similar to those of Brassicaceae and Capparidaceae but the seed structure does not agree with either of the above families. Pollen studies have not provided any other suggestions and recent molecular studies have pointed to a relationship with the Carricaceae. These indicate that the taxonomic position of the family is not yet settled and is open for further studies. Its seed physiology is also not yet studied in the tropics in general and Ethiopia in particular.

According to Edwards *et al*. (2000) *M. stenopetala* is a tree 6-12 m tall; trunk: more or less 60 cm in diameter at breast height; crown: strongly branched sometimes with several branches; thick at base; bark: white to pale gray or silvery, smooth; wood: soft; leaves: up to 55 cm long; inflorescence: pubescent, dense many flowered panicles 60 cm long.

The species (*stenopetala*) is known by different vernacular names such as Shiferaw (Am), Aleko, Aluko, Halako (Gam/Wol), Kallanki (Ben), Telahu (Tse), Haleko, Shelchada (Kon), Haleko (Bur), Haleko (Dh) and Cabbage Tree (Eng) (Edwards *et al*., 2000; Dechasa, 1995; Demeulenaere, 2001).

The genus follows the distribution pathway from Rajasthan (India) to south West Africa (Africa, Madagascar and parts of Asia, including Arabia and India) (Mark, 1998). The habitat where the genus occur in Ethiopia as summarized from the herbarium vouchers of the national herbarium includes: rocky areas along rivers, dry scrub land, Acacia-Commiphora woodland, water courses with some evergreens, open Acacia-Commiphora bush land on gray alluvial soil and in cultivation around village. *M. stenopetala* is cultivated in terraced fields, gardens and small towns (Edwards *et al*., 2000; Endeshaw, 2003).

The National herbarium has few collections of Moringaceae. The overall collections were represented by 5 species of which the larger part is *M. stenopetala*. Many of the collections were from Gamo Gofa (Endeshaw, 2003). There are small seed collections of *Moringa* species at the Institute of Biodiversity Conservation and Research from Gamo Gofa. However, the viability of these seeds is not yet tested. There is no information documented on *M. stenopetala* localities in the eastern and northern parts of Ethiopia. It is not clear whether this was due to lack of exploration in the area or really absence of the species in the area (Endeshaw, 2003).

M. stenopetala grows naturally in the *Acacia tortilis-Delonix elata-Commiphora* sp. vegetation-complex. This type of vegetation is often found in well-drained soils at altitudes of 900-1200 m. The species is quite drought resistant. In southern Ethiopia, it has been found in areas of mean annual rainfalls ranging from 500-1400 mm. Cold temperatures are limiting factors for the cultivation of the species in Ethiopia because it does not tolerate frost (Moges, 2004).

Origin: *M. stenopetala* is often referred to as the East African Moringa tree because it is native only to southern Ethiopia and northern Kenya (Mark, 1998). Though it grows in many other parts of the tropics, it is not as widely known as its close relative, *Moringa oleifera* of India but often considered generally more desirable than *M. oleifera*.

The edible parts are exceptionally nutritious (Ram, 1994; Jiru *et al*., 2006). The leaves are one of the best vegetable foods that can be found in the locality. All parts of the tree except the wood are edible, providing a highly nutritious food for both humans and animals. The flowers are a good source of nectar for honey bees; can be eaten or used to make a tea and the seeds are rich oil sources for cooking and lubricant uses. Many parts of the plant have been used in medicinal preparations. The wood is very soft; useful to make low-grade firewood and poor quality charcoal. Attracting attention in recent decades is the use of the dried, crushed seeds as a coagulant (Jahn, 1984; Ram, 1994). Even very muddy water can be cleared when crushed seeds are added. Solid matter and some bacteria will coagulate and sink to the bottom of a container. The cleaned water can then be poured off and boiled. People use 100 milligrams of crushed seed to clean 1 L of muddy water in India and some localities of East Africa (Gupta and Chaudhuri, 1992).

Uses: Among the various uses of *Moringa*, a few are outlined below (Price, 1985; CWS, 2000; Edwards *et al*., 2000).

Alley cropping/Intercropping: With their rapid growth, long taproot, few lateral roots, minimal shade and large amount of biomass yield of high-protein content, Moringa trees are one of the best MPT candidates for use in alley cropping systems. Traditionally, the species is grown in mixed multi-story stands with food crops. For instance, around Arba Minch, farmers plant in their home gardens mostly 5 and sometimes up to 15 Moringa trees per 0.1 ha. Farmers practice permanent multi-storeyed cultivation with *M. stenopetala* at the uppermost level, papaya, coffee and bananas in the upper-middle level; cassava, maize and sugar cane in the lower-middle level and cotton and pepper in the lowest level.

Animal feed: Leaves are readily eaten by cattle, sheep, goats, pigs, rabbits. Leaves can also be used as food for fish.

Domestic cleaning agent: Crushed leaves are used in some parts of Nigeria to scrub cooking utensils or to clean walls.

Dye: The wood yields a blue dye, which has been used in Jamaica and in Senegal.

Fertilizer: The seed cake, although unsuitable as animal feed without treatment to remove the alkaloid and saponin content, can be used as a nitrogen-rich plant fertilizer.

Gum: The gum produced from a cut tree trunk has been used in calico printing, in making medicines and as a bland-tasting condiment.

Honey purifier: Powdered seeds can be used to purify honey without boiling. Seed powder can also be used to purify sugarcane juice.

Honey production: Flowers are a good source of nectar for honey bees.

Live fencing: A common use of Moringa trees is to produce live supports for fencing around gardens.

Medicine: Every part of the tree is widely used to make a wide variety of traditional medicines.

Ornamental: In many countries, Moringa trees are planted in gardens and along street as ornamental trees.

Plant disease prevention: Incorporating Moringa leaves into the soil before planting can prevent damping off disease (*Pythium debaryanum*) among seedlings.

Pulp: The soft, spongy wood makes poor firewood, but the wood pulp is suitable for making newsprint and writing paper.

Rope-making: The bark of the tree can be beaten into a fiber for production of ropes or mat.

Tannin: The bark and gum can be used in tanning hides.

Pollution control: One of the most promising potential uses of *M. stenopetala* is to purify turbid water. The seeds of this and some other species of the Moringaceae have flocculating and anti-microbial properties. The active substances are found only in the cotyledons of the seeds.

AGRONOMIC PRACTICE

Growth requirement: Reports indicate that *M. stenopetala* grows in the wild in elevations between 1,000 and 1,800 (Mark, 1998) but from personal observations the species grows as high as 2200 m.a.s.l and as low as 300 m (herbarium sources) in Ethiopia. On the other hand from personal communications with the local people it was learnt that currently the species is known in the wild in localized areas in Debub Omo around Turmi. Most literatures however, indicate that the species exists as a cultivated plant in most places in South Ethiopia. Various studies on the species ecological adaptations indicate that light frosts have no harm while freezes may cause it to die back to ground level, where it may produce new sprouts. It favors full sun light although it tolerates partial shade. It is resistant to dry weather. Optimum light for germination of all *Moringa* species is half shade. Seeds could be planted about 2 cm deep in soil that is moist but not too wet. Sprouting occurs normally in 1-2 weeks. It can be allowed to grow for shade (6-15 m), or kept low (about 1-1.5 m) for easier harvesting.

Rajangam *et al.* (2001) found that *M. stenopetala* quickly produces a large gray trunk and leaves covered with glistening nectars. It quickly sends out new growth from the trunk when cut, or from the ground when frozen. Living fences can be continually cut back to a few feet. It is an extremely fast-growing tree and continued to grow during the exceptionally long dry season. Very young whole plants, young leaves and even older leaflets and flowers can be harvested for food. The slender young pods are picked for use like green beans. Seeds of older pods may be shelled from the pods and cooked like green peas. The older flowering branches can be pruned repeatedly to stimulate production of new branch shoots as additional sources of leaves. Moringa is resistant to most pests, though root rot can occur if the soil is too wet.

Cold temperatures inhibit seed germination of *M. stenopetala*; under low temperatures (at and below 15°C) an enforced dormancy has been found to occur. The speed of germination of untreated seeds depends on temperature, humidity and watering. Seeds placed at 8°C in a refrigerator for 24 h before sowing showed 88% germination. The seeds remain viable for several years as evidenced by germination rates of 96-98% recorded for 44 month-old seeds (Moges, 2004).

Season and planting method: Moringa is propagated either by stem (limb) cuttings or by seed. In perennial types, limb cuttings 100-150 cm in length with a diameter of 14-16 cm are planted *in situ* during the rainy season. Elite trees are cut down, leaving a stump with a 90 cm head from which 2 to 3 branches are allowed to grow. From these shoots, cuttings 100 cm long and 4 to 5 cm in diameter are selected and used as planting material (Bezabeh, 1993; Teketay, 1995).

The branch cuttings are planted in pits of 60×60×60 cm at a spacing of 5×5 m, during the months from June to August. The monsoon rains during the period facilitate easy rooting and further growth. While planting, one-third of the cutting should be kept inside the pit. Under moderate clay situations, watering should be done just to optimum levels to avoid root rot. The seeds of annual Moringa may be directly dibbled in the pit to ensure accelerated and faster growth of the seedlings. The best suited season for sowing the seeds is March to August under Southern Ethiopian conditions. The time of sowing has to be strictly adhered to because the flowering phase should not coincide with the rainy seasons, which results in heavy flower shedding. A plant spacing of 2.5×2.5 m between rows and plants should be adopted, giving a plant population of 1600 plants ha^{-1}. The seed germinates 10 to 12 days after sowing. The seed requirement per hectare is 625 g. When planted in single rows along with irrigation channels, a spacing of 2 m is sufficient.

Treatment of Moringa seeds with Azospirillum cultures at the rate of 100 g per 625 g of seeds before sowing resulted in early germination and increased seedling vigour, growth and yield.

Food value and nutritional composition: Richer *et al.* (1993) and Jiru *et al.* (2006) tested the leaves and pods of Moringa and reported it as an extremely valuable source of nutrition for people of all ages (Table 1, 2). For a child aged 1-3, a 100 g serving of fresh leaves would provide all his daily requirements of calcium, about 75% of his iron and half his protein needs, as well as important supplies of potassium, B complex vitamins, copper and all the essential amino acids. As little as 20 g of fresh leaves would provide a child with all the vitamins A and C he needs.

For pregnant and breast-feeding women, Moringa leaves and pods can do much to preserve the mother's health and pass on strength to the fetus or nursing child. One portion of leaves could provide a woman with over a third of her daily need of calcium and give her important quantities of iron, protein, copper, sulfur and B vitamins. Just 20 g of fresh leaves will satisfy all her daily requirement of vitamin C. For both infants and mothers, pods can be an important source of fiber, potassium, copper, iron, choline, vitamin C and all the essential amino acids. Malnourished children can benefit from addition of Moringa leaves to their diet. The high concentration of iron, protein, copper, various vitamins and essential amino acids present in Moringa leaves make them a virtually ideal nutritional supplement (CWS, 2000).

Tenaye *et al.* (2009) stated the possibility of drying the leaves of *Moringa* to make them into a powder by rubbing them over a sieve. Drying (Rams, 1994) should be done indoors and the leaf powder stored in an opaque, well-sealed plastic container since sunlight will destroy vitamin A. CWS (2000) estimated that only 20-40% of vitamin A content will be retained if leaves are dried

under direct sunlight, but that 50-70% will be retained if leaves are dried in the shade. This powder can be used in place of fresh leaves to make leaf sauces, or a few spoonfuls of the powder can be added to other sauces just before serving. Addition of small amounts of leaf powder will have no perceptible effect on the taste of a sauce. In this way, Moringa leaves will be readily available to improve nutritional intake on a daily basis. One rounded soup (table) spoon of leaf powder will satisfy about 14% of the protein, 40% of the calcium and 23% of the iron and nearly all the vitamin A needs for a child aged one to three years. Six rounded spoonfuls of leaf powder will satisfy nearly all of a woman's daily iron and calcium needs during times of pregnancy and breast-feeding. If one rounded table spoon of powder is added to an infant's food, three times daily, the 25 g of leaf powder will give him roughly the amount of food nutrients. These nutrients are Protein: 42%, Calcium: 125% Iron: 71%, Magnesium: 61%, Potassium: 41%, Vitamin C: 22% and Vitamin C: 22%. Alternatively, mineral contents investigated for *Moringa olifera* (Aslam *et al*., 2005) was found to be comparable to mineral values estimated by CWS (2000).

Table 1: Chemical composition of *Moringa* leaves and pods

Chemical analytical parameters	Pods	Leaves	Leaf powder
Moisture (%)	86.90	75.00	7.50
Calories	26.00	92.00	205.00
Protein (g)	2.50	6.70	27.10
Fat (g)	0.10	1.70	2.30
Carbohydrate (g)	3.70	13.40	38.20
Fiber (g)	4.80	0.90	19.20
Minerals (g)	2.00	2.30	-
Ca (mg)	30.00	440.00	2,003.00
Mg (mg)	24.00	24.00	368.00
P (mg)	110.00	70.00	204.00
K (mg)	259.00	259.00	1,324.00
Cu (mg)	3.10	1.10	0.60
Fe (mg)	5.30	7.00	28.20
S (mg)	137.00	137.00	870.00
Oxalic acid (mg)	10.00	101.00	0.00
Vitamin A-B carotene (mg)	0.10	6.80	16.30
Vitamin B-choline (mg)	423.00	423.00	-
Vitamin B1-thiamin (mg)	0.05	0.21	2.60
Vitamin B2-riboflavin (mg)	0.07	0.05	20.50
Vitamin B3-nicotinic acid (mg)	0.20	0.80	8.20
Vitamin C-ascorbic acid (mg)	120.00	220.00	17.30
Vitamin E-tocopherol acetate (mg)	-	-	113.00
Arginine (g/16 g N)	3.60	6.00	0.00
Histidine (g/16 g N)	1.10	2.10	0.00
Lysine (g/16 g N)	1.50	4.30	0.00
Tryptophan (g/16 g N)	0.80	1.90	0.00
Phenylanaline (g/16 g N)	4.30	6.40	0.00
Methionine (g/16 g N)	1.40	2.00	0.00
Threonine (g/16 g N)	3.90	4.90	0.00
Leucine (g/16 g N)	6.50	9.30	0.00
Isoleucine (g/16 g N)	4.40	6.30	0.00
Valine (g/16 g N)	5.40	7.10	0.00

Report by Ram (1994) also showed that *Moringa foliage* and fruit pods are rich sources of calcium (Ca) and iron (Fe) and good sources of vitamins A, B and C (when raw) and of protein (including good amounts of the sulfur-containing amino acids, methionine and cystine). Both young and older leaves are edible, though older ones are milder and tender. They can be cooked in soups or boiled. Young pods can also be cooked. Immature seeds are often cooked and eaten as a fresh vegetable, while mature seeds can be dried and roasted. The flowers can be cooked or oven-dried and steeped as tea. Dried leaves can be stored for future use as soup or sauce supplements. Blossoms are edible; they taste like radish. Browning seeds from mature pods that are mashed and placed in boiling water causes an excellent cooking or lubricating oil to float to the surface. The oil preserves well although becomes rancid with age. Its roots are used as a flavoring and in poultices; and edible oil can be extracted from its seeds. The green pods and surrounding white material can be removed from larger pods and cooked in various ways.

In the Konso district, *M. stenopetala* (shelaqta in Konso and also known by the Gamo name of halako) is very widely grown for its edible leaves. The leaves are an ingredient in a daily dish, the dama, which is a major factor in the diet. The leaves are called mida, an overall term that appears to encompass in one and the same category all plants whose leaves can be eaten in the form of gruel, or pot-herb. The women of the household prepare the dama in the evening, after working in the fields, in the following way. They heat water in an earthenware pot called the okkota; when the water is boiling, they plunge the Moringa leaves into it, having first separated them from the rachis. When Moringa fruit are still soft, they can also be added, but due to the slightly bitter taste many Konso people restrict consuming the fruits to periods when food is scarcet (Demeulenaere, 2001).

Nutritional analysis of Moringa pods, fresh (raw) leaves and dried leaf powder yielded a nutritional composition per 100 g of edible portion (CWS, 2000) shown in Table 1.

Table 2 lists the composition of Moringa pods, fresh leaves and leaf powder and represents in terms of recommended daily intake for children aged 1-3 and women during lactation. The listing of pod and fresh leaf content is for each 100 g of edible portion. However, the CWS (2000) and Gardner (2002) recommended use of dried leaf powder as a nutritional additive to sauces and infant formulas, whereby one or more spoonfuls of powder would be stirred into the sauce or formula before serving. One rounded soup spoon (table spoon) contains about 8 g of powder (100 g of powder is a bit less than one and a half cups American measure). As such, the listings of leaf powder content are per heaped soup spoon.

As an example, 100 g of the edible part of pods will contain 2.5 g of protein. One hundred grams of fresh leaves will contain 6.7 g of protein and one heaped soup spoon of leaf powder will contain 2.2 g. It is recommended that during the months a woman is pregnant or breast-feeding she should be consuming 65 g of protein daily. So, a meal of 100 g Moringa pod will satisfy 3.8% of her protein needs and a meal of 100 g fresh Moringa leaves will satisfy 10.3% of her protein needs for that day. Each rounded soup spoon of leaf powder added to her diet will satisfy 3.3% of her protein needs.

The vitamin A content of fresh Moringa leaves cited above is a very conservative estimate. Other researchers have found fresh leaves to contain as much as 9 mg vitamin A per 100 g. Nonetheless, even the conservative figure means that fresh Moringa leaves contain almost three times the Beta-carotene content of spinach (3.5 mg/100 g).

Many of the above vitamins, minerals and amino acids are very important for a human and animal diet. An individual needs sufficient levels of certain vitamins, minerals, proteins and other

Table 2: Vitamin, proteins and minerals recommendation for daily diet allowances for children and women from Moringa leaves and pods

*RDA	Child	Woman
Vitamins (mg)		
A (Beta-carotene)	1.5	5.7
B1 (Thiamin)	0.5	1.6
B2 (Riboflavin)	0.8	1.8
B3 (Niacin)	9.0	20
C (Ascorbic acid)	20.0	95
Protein (mg)	16.0	65
Minerals (mg)		
Ca (Calcium)	400.0	1, 200
Cu (Copper)	0.8	2
Fe (Iron)	10.0	15
K (Potassium)	800.0	3,000
Mg (Magnesium)	150.0	340
P (Phosphorus)	800.0	1, 200

*RDA = Recommendations for daily allowances

nutrients for his physical development and well-being. A deficiency of any one of these nutrients can lead to health problems. Some of the problems caused by deficient diets are well known: scurvy, caused by lack of vitamin C; night blindness, caused by lack of vitamin A; kwashiorkor, caused by lack of protein; anemia, caused by lack of iron. Many other health problems are caused by lack of vitamins or minerals which are less known, but still essential to a person's bodily functions.

Actual need for different vitamins, etc., will vary depending on an individual's metabolism, age, sex, occupation and where he/she is living. Recommendations for daily allowances (RDA) also vary according to whom is doing the study. WHO/FAO recommend the following daily allowances for a child aged 1-3 and a woman during lactation (Table 2).

GENETIC CONSERVATION STATUS IN ETHIOPIA

It is believed by many scholars that the species (*M. stenopetala*) was introduced to northern Kenya either from Konso or Dherashe districts in southern Ethiopia, close to Arba Minch. It existed in the wild in the past in areas where it is now commonly cultivated and this provides an evidence for its origin, diversity and cultural development as human food. Nowadays, *M. stenopetala* is mostly known from cultivation in southern Ethiopia around home gardens, home compounds, farmlands, abandoned farmlands and abandoned settlement areas but rarely so in the wild as in the past. The reasons for its diminishing population in the wild is not yet investigated, even in its most favored areas of distribution around Gamo Gofa, Konso and Dherashe. The only suspected locality where one may still be able to encounter wild *M. stenopetala* is in Debub Omo around Turmi village about 800 km South of Addis Ababa. Its wild habitat has shrunk which may eventually lead to drastic genetic erosion. Edwards *et al.* (2000) have warned that in Ethiopia, *M. stenopetala* is nearly endangered in the wild. From reviewed literature as well as personal observations, this study strongly insist that something has to be done to restore and conserve the genetic resource of this highly valuable (miracle) species.

SOCIO-ECONOMIC VALUES

The economic status of an individual in low lands of southern Ethiopia is closely associated with the number of Haleko trees they have in their backyard. For example, when a young man proposes

marriage in the former administrative region of Gamo Goffa of the South Ethiopia, the girl's (bride) family enquire whether or not the would-be husband has Haleko trees in his farm (Endeshaw, 2003).

Demeulenaere (2001) observed in some parts of southern Ethiopia, especially among the Konso people, that the abundance of *Moringa* species in the garden or on farmland was an indication of the social status of the owner among the society. The one with many Moringa tree in the garden or on farmland had a higher social status and was also considered as a prosperous person. In Konso, in the course of marriage engagement, a common query posed to the to-be husband is the abundance of Moringa trees in his garden. Their belief is that if the husband has many Moringa trees in his garden or farmland then to-be wife will have no problem to feed her babies even when drought occurs. For this reason Konso people especially young men are encouraged to plant Moringa in their garden as well as on their farmlands. A lesson to learn from this practice is that culture in itself has a great role in conservation and sustainable utilization of locally important tree species.

M. stenopetala is planted together with fruit trees in the cropped fields in southern Ethiopia and many other east African countries. Sometimes the trees are also used to provide partial shade for crops like sorghum in the southern Ethiopia. Whole plants have been used as hedges and fences. *M. stenopetala* can also be planted as a windbreak. As soon as the upper branches of the tree grew broader, the tree can be pruned to stimulate more profuse growth of their lower branches, thus thickening the hedge. Vegetables cultivated behind it profited from this protection. The species can also be grown as an ornamental tree in private gardens and home compounds.

CONCLUSION

The most common method of propagating *M. stenopetala* is by direct sowing without pre-treatment of seed. But standard nursery raised seedlings are also commonly used. Removing the spongy seed coat improves germination. In a nursery it needs 7-10 days to germinate. Use of wide polythene is advised as the bulgy root requires large enough space (12 cm diameter flat). In about 3 months the seedlings will be ready for planting out. Some farmers occasionally propagate the species by using branch-sized cuttings.

M. stenopetala leaves, pods and roots are edible; bees love the flowers; and seeds are powdered and used to purify water from muddy rivers. Its parts are actually and potentially useful to extract ingredients of medicinal value. It is truly the mother's best friend in rural parts of southern Ethiopia particularly for mothers of poor family. That is one way they sometimes refer to this tree in Konso and Dherashe where the leaves are cooked and fed to the whole family. The *Moringa* is also considered as one of God's abundant resources for the struggle against world hunger. However, it is only very small portion of its uses are practiced in Ethiopia. Some people even may not know that it is edible. So much has to be done to promote the species consumption both at local and national level. Awareness should be raised and created on the importance of *M. stenopetala* and people should be encouraged to plant the species on their home garden and farmlands. This could be at individual level, regional and even at national level. Establishment of social agro-forestry and/or forestry or communal/social forestry of the species is worth mentioning to its restoration and conservation. It is one of the most exciting and all-round plants that we have to look very close for its conservation. Conservation and establishment of communal or social forestry of *Moringa* species may contribute a lot to the national and international efforts to address food shortage in rural parts of the country.

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