



Moringa (*Moringa oleifera*): An Underexploited Food Source with High Nutritive and Medicinal Values

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Abstract

Moringa oleifera popularly known as Sehjan or drum-stick, native to India, is a multi-purpose tree due to its diverse uses and helpful in eco-restoration. It is widely used as natural medicine, food, feed, biostimulant, forage and migration of bees. Moringa tree is known as a "miracle tree" due to its multipurpose uses. It is an evergreen tall tree with a straight trunk, corky and whitish bark. It grows well in hot, semi-arid and humid regions. Tree has tubular tap root system. Leaves are palish green in colour, compound, tri-pinnate with many small leaflets. Flowers are yellowish white, and fruits are pendulous, triangular which split lengthwise into 3 parts after drying. The pods are 1-4 feet long and 1.5 to 2.0 cm wide with tapering ends. Pods contain many seeds (10-20) embedded in fleshy girth. Seeds are dark brown in colour, and kernel is covered by light wooded shell with three papery wings. Moringa tree is a good source of vitamins, minerals and essential amino acids. It is used as a natural antibiotics and inhibitory biomarker for many plant pathogens. It has medicinal properties like anti-tumor, anti-inflammatory, antioxidants and antimicrobial activities. *Moringaceae* family includes about 14 species among which *Moringa oleifera* is considered most important. In this article we have reviewed the multipurpose uses of *Moringa oleifera* to establish as a promising tree to use for food supplement, soil management, animal feed, medicinal purpose and uses in cosmetic and dairy industry etc. It is envisaged that the popularization of this miracle tree will help us towards sustainability, and nutritional security particularly in arid and semi-arid regions of the country.

Keywords: Moringa; Nutritive value; Medicinal value; Semi-arid regions; Underexploited plant

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Introduction

Moringa oleifera Lam. (2n=22) popularly known as Sehjan or Drum-stick is among important indigenous plant species of India. Indians are using it as a regular component of conventional edible food for nearly 5000 years. World Health Organization (WHO) has promoted this tree as an alternative to imported food supplies to treat malnutrition in poor countries [1,2]. The tree belongs to family *Moringaceae*. Genus *Moringa oleifera* has 13 species in the world out of which two species viz. *Moringa concanensis* Nimmo ex Dalz and Gibs and *Moringa oleifera* Lam exist in India. *Moringa concanensis* is a rare tree and found in the Aravalli hills of Rajasthan. *Moringa oleifera* Lam. is referenced in more than 80 countries including India and known in over 200 local languages due to its multifarious uses in the World. In arid region of India, it is very popular and considered as an indigenous resource for fighting hunger and malnutrition [3,4]. Moringa is a fast growing and deciduous tree grown successfully in tropical and subtropical region of the world. Fahey [5] reported that it is aesthetically pleasing small tree adapted to arid and semi-arid conditions. It has vital nutritional,

industrial and medicinal applications due to the presence of various basic phyto-chemicals in its leaves, pods and seeds [6]. Moringa tree has great potential against prevention of different diseases like cancer, and anemia as well as for antimicrobial [7,8]. Moringa leaves are the potential source of nutrients and thus are combined into the delicious traditional food in arid areas [9]. They are eaten as fresh, cooked or stored as a dried powder [5]. The leaves and flowers are commonly used to prepare curry and cake. In dry areas, the moringa leaves are used as a dietary supplement of fodder to enhance milk production in cattle, or as an alternative to traditional crops for greater economic sustainability, environment friendly, safer and low-cost production crop. Its leaf extract contains growth enhancing hormone (cytokinin type) and foliar spray of which accelerates the growth of young plants, induces pest and disease resistance in the plants and can increase the yield by 25-35% [10].

The immature fruits of moringa are also used in several culinary dishes either strapping of tough skin or with the skin intact. Tender fruits are also used in sambar. Seeds are eaten green or roasted

and used in tea and curries [11]. Fried seed tastes like peanuts. Moringa seed produces valuable oil (yield 30-40% by weight) known as "oil of Ben" which is a sweet, non-sticking, non-drying, light brown to semi-transparent oil that resists rancidity. The oil is known as the most stable natural oil which is a good source of Behenic acid in nature and used as a preservative in food industries and an additive in perfumery and hair care products [12]. Moringa tree has good adaptability to weather, soil and other environmental conditions so it is also known as "Never Die plant" [13]. It is a good erosion controller, soil improver, ornamental tree, boundary/barrier/support providing plant, a good intercrop and pollution controller [14]. India is major exporters of moringa products to

the agricultural, pharmaceutical, cosmetics and food industries for over a decade. A number of value-added products like fresh fruits, moringa pickle, dehydrated moringa, moringa oil, moringa seed, moringa leaf powder, moringa cake powder, moringa root, moringa soup powder, moringa juice powder and moringa capsule etc. are prepared for domestic purpose as well as for export. Thus, Moringa plant has multipurpose uses and therefore, called as "Miracle tree" [15,16]. It is also known as "drumsticks", "mother's milk", "cabbage tree", "horseradish tree", "mother's best friend tree" and many other names (Table 1). The tree is under explored and need attention to grow, particularly in dry area where climatic conditions are harsh, and soils are not productive for other crops.

Table 1: Different names of *Moringa oleifera*.

S. No.	Language	Local names
1	Hindi	Sajana, Saina, Mungaera, Shaijmal, Lingru, Shajna, Segra
2	English	Ben Tree, Horseradish Tree, Drumstick Tree, Mothers Rest Friends, Gold of poor
3	Sanskrit	Shobhanjana
4	Rajasthani	Lal Sahinjano, Lingru
5	Sindhi	Swanjera
6	Punjabi	Sanjina, Soanjana, Sejana
7	Gujrati	Midhosaragavo, Saragavo
8	Telegu	Mulaga, Tellamunaga, Munaga
9	Tamil	Murungai, Moringa

Origin and Distribution

Moringa is a native of Himalayan foothills (India/Bangladesh). Its cultivation in India dates back many thousands of years [10]. It is cultivated in many countries in America, South America, Southeast Asia and Africa. It is well adapted to the tropics and sub-tropics.

Traditional use as medicine

The healing potential of *Moringa* was realized around 5000 years ago in the Vedic literature. In Ancient time, the use of Moringa as herbal medicine to cure more than 300 diseases in Africans and Indian continents including many countries like India, Pakistan, Philippines, Thailand, and Niger etc. [17]. The Royal families of ancient era used to include Moringa leaves and fruits in their regular diet to release stress, keep mental alertness and healthy skin [18]. Moringa has long been recognized useful in Unani and Ayurvedic systems of medicine against several diseases such as gastric ulcer, hay fever, fatigue, skin diseases and bronchitis, psychosis, eye diseases, fever, asthma and as an aphrodisiac [19]. The leaves are the most commonly used plant part. Moringa leaves are used to treat hyperglycemia, asthma, flu, heart burn, dyslipidemia, malaria, syphilis, eye and ear infections. Leaf extract can be used to overcome the respiratory disorders, digestive disorders and urinary disorders. Leaf extract also reduces blood pressure and cholesterol and acts as an anticancer, antioxidant, antimicrobial, anti-atherosclerotic, anti-diabetic agents and neuro protectant [20]. Mishra *et al.* [21] reported that 6 rounded spoonful of leaf powder will satisfy nearly all of woman's daily iron and calcium needs during pregnancy and

breast feeding. In folk medicine, *M. peregrina* leaf extract is rubbed over skin to treat paralysis and skin rashes [22]. *Moringa* flowers are used to prepare soup which prevents from throat, chest and skin infections due to the presence of antibacterial properties. It also acts as anti-arthritis, hypocholesterol emic agents and can cure urinary and cold problems [23]. The pods of Moringa are used to treat liver, spleen problems and joint pains. In northern region of Oman, the pod oil of Moringa is used to treat the convulsions or infantile paralysis [24].

Moringa seeds are acrid, bitter, anti-inflammatory and purgative in nature -. They are useful in neuralgia, inflammations and intermittent fevers. Moringa seeds help in treating Chhorn's disease, hyperthyroidism, rheumatism, antiherpes-simplex virus arthritis, cramp, epilepsy gout and sexually transmitted diseases [20- 25]. It is also effectively used for the diabetes related symptoms such as hyperlipidemia and hyperglycemia in the Indian sub-continent [26]. Seed extract of moringa is used as water purifiers. About 90% bacteria can be removed from dirty water by using moringa seed extract [10]. Moringa roots act as an anti-ulcer, anti-inflammatory and cardiac stimulant agent [27,28]. The roots of the Moringa contain some important alkaloids such as Morgenine, which raises the tension of the heart and blood vessels [12]. The roots of drumstick plants are acrid, digestive, anthelmintic, constipating, anodyne, bitter alexipharmic stimulant and vesicant. They are also useful in paralysis, inflammations, fever, cough, cold, bronchitis, pectoral diseases, epilepsy and hysteria. Drumstick bark also contains a white crystalline alkaloid, two resins, an inorganic

acid and mucilage (gum). The bark juice is also used as disinfectant [29] and also to treat fever, headache, constipation, back and muscle pains, slimness, burns and labor pain [30-32]. The roots and leaves of *M. peregrina* are mixed together with water and used to treat hypertension, malaria, asthma, stomach disorders, diabetes, and

to expel a retained placenta [33]. Traditionally, the oil of this plant is used to treat skin problems such as freckles, itches, and scabies [34]. The commercial and medicinal use of Moringa is highlighted in Table 2.

Table 2: Commercial and medicinal uses of different parts of moringa plant.

Plant Part	Commercial uses	Medicinal uses
Leaves	<ul style="list-style-type: none"> a. Leaves are supplemented as essential food to check the malnutrition. Dry leaves can serve as an alternative of tea leaves. b. Leaves and flowers are consumed by pregnant woman to increase milk for their infants. c. Twigs and immature pods are used as fodder to increase milk content in cattle. d. Leaf powder used as bio-fertilizer, bio-control agent in crops and as hand washing product to maintain hygiene conditions. 	<ul style="list-style-type: none"> ▪ Leave are purgative, applied as poultice to sores, used to cure piles, fevers, sore throat, bronchitis, eye and Ear infections, scurvy and catarrh etc. ▪ Leaf juice is believed to control glucose levels, applied to reduce glandular swelling etc.
Stem	<ul style="list-style-type: none"> a) Stem pulp is used in picking-sticks, and newspaper making and textile industries. b) Stem-bark yields fibbers which is used in making mats, paper, cordages etc. 	It is rubefacient, vesicant and used to cure eye diseases, prevents enlargement of the spleen and formation of tuberculous glands of the neck, used to destroy tumors and to heal ulcers.
Pods	<ul style="list-style-type: none"> a. Immature pods are cooked as vegetable or used to prepare pickle b. Mature pots are roasted and used to eat like pea nut. 	The juice from the root bark is put into ears to relieve earaches and also placed in a tooth cavity as a pain killer, and has anti-tubercular activity
Seed	<ul style="list-style-type: none"> a) Seed powder paste is used as water purifier because it absorbs heavy metals such as cadmium, copper, chromium, lead and zinc. b) Seeds are used as vegetable in daily consumption and in perfume industries, cosmetic, lubricate, soap industry etc. c) Seed oil is used as mud settler, lubricant, body cream etc. 	Seed extract exerts its protective effect by decreasing liver lipid peroxides

Nutritional Composition

Every part of *Moringa oleifera* tree (leaves, flowers, fruits, seeds, bark and roots) has nutritious value. The leaves and seeds of moringa are a good source of protein, calcium, iron, Vit-A and Vit-C and anti-oxidant compound like carotenoids, flavonoids, vitamin E and Phenol [35]. Gopalakrishna et al. [36] reported that 100g fresh moringa leaves contain 2.6 mg Vit-B₁ (Thiamine), 20.5 mg Vit-B₂ (riboflavin), 8.2 mg Vit-B₃ (Nicotine acid), 220 mg Vit-C, 16.3 mg Vit-A and 113 mg Vit-E along with 423 mg lipotropic element choline, 19.2 g fibre, 2003 mg Ca, 368 mg Mg, 204 mg P, 1324 mg K, 3.1 mg Cu, 28.2 mg Fe and 870 mg selenium. The protein content in leaves of moringa is higher than protein content in eggs and milk. Yameogo et al. [37] reported that on dry matter basis moringa leaves contained 27.2% protein, 17.1% fat, 5.9% moisture and 38.6% carbohydrates. Moringa leaves have 7 times more vit-C than orange and 15 times more K than banana. Moringa leaves also contain arginine and histidine amino acids which are important for infants. Animal feeding of drumstick leaves increases the live weight and milk production of animal by 32% and 65%, respectively [38]. Moringa flowers are good source of lysine, alanine, arginine, glycine,

serine, threonine, valine, glutamic acid and aspartic acids. Moringa flowers also contain Cu (0.62 mg), sulphur (137 mg), Chlorine (423 mg), oxalic acid (101 mg) and phytin P (44 mg). Moringa pods are rich in free leucine [36]. The mature seeds of Moringa contain 332.4 g crude protein, 414.0 g crude fat, 212.2 g carbohydrate and 44.4 g ash per kg dry matter. The cysteine + methionine content in moringa seeds is to the tune of 43.6 g.kg⁻¹ protein, which is exceptionally higher and close to milk, egg, chicken, and cow's milk [39]. The seed oil has been high amount of unsaturated fatty acids, especially oleic acid (71.60%), in addition to dominant saturated acids Palmitic and behenic acids (6.4% in total). Besides, the seeds oil contains high levels of β -sitosterol (45.58%), stigmasterol (23.10%) and campesterol (15.81%). α -, γ - and δ -tocopherols were detected to a levels of 15.38, 25.40 and 15.51 mg/kg of oil, respectively [12].

Botanical Description

Moringa is a fast-growing tree. It grows up to 4-meter height in the first year and can bear fruit in the first year. In humid tropic or hot dry land, it can grow up to 5-10-meter height. The trunk of moringa can reach a diameter of 45 cm. The tree has an open crown

of drooping and fragile branches. Its bark is thick and whitish-grey in colour (https://en.wikipedia.org/wiki/Moringa_oleifera). Moringa flowers are creamy white in colour with 3-winged seeds in about 70 cm long grooved, cylindrical and green pods [3]. The flowers are bisexual, oblique, stalked, axillary and heteromorphic. Flowers are highly cross-pollinated due to heteromorphism. Flowers are also surrounded by five unequal, thinly veined and yellowish-white petals. Flowers are generally 1.0-1.5cm long and 2.0 cm broad and generally produced on current season growth. Calyx and corolla of moringa flower consists five sepals and petals. The androecium part of flower has five stamens alternating with five stamindodes and gynoecium part has a superior, one celled and three carpelled ovaries containing many ovules on parietal placentation [40]. Flowering time in moringa vary region to region and time to time. It is also influenced by rain, temperature, humidity, soil temperature, soil moisture and wind. Peak period of flowering in central Kerala is Dec-Jan while in Southern Kerala Feb-March and July-August with maximum flowering in Feb-March. In Coimbatore and Bangalore conditions, flowering seasons are March-May and July-Sep., respectively. Anthesis in Moringa, continues throughout the day. The stigma becomes receptive one day prior to flower opening and continues with maximum receptivity on the day of opening and thereafter its receptibility declines [41]. Moringa leaves are large in shape up to about 90cm long with opposite pinnae. Leaf bears leaflets in opposite pairs with slightly larger terminal leaflet. The colour of leaflets is dark green on above side and pale on the under surface [42].

Genetic Diversity and Conservation

A total of 13 tropical and subtropical species of the moringa genus are known and many of these are in danger of extinction, including *M. arborea*, *M. borziana*, *M. longituba*, *M. rivae*, *M. ruspoliana* and *M. stenopetala* [43]. There is a limited knowledge of available genetic diversity present in Moringa species. However, some studies have been conducted using DNA based markers to identify and assess diversity among various genotypes of *M. oleifera*. Shibru [44] reported that *M. arborea*, *M. borziana*, *M. longituba*, *M. rivae*, *M. ruspoliana* and *M. stenopetala* is the endangered species of this genus. *M. peregrine* is a scarce species with a low rate of regeneration following herbivorous animal browsing [45], *M. arboreais* listed in the 2006 IUCN Red list of

Threatened Species (World Conservation Monitoring Centre, 2006) and *M. hildebrandtii* is extinct in the wild [46]. The preservation of the *Moringa* species is thus of great concern from biodiversity, ethnobotanical, dietary and pharmacological perspectives. There are tremendous opportunities with *M. oleifera* for sustainable agriculture and the development of cash crop in semiarid regions. All of the moringa species now in the wild have local medicinal uses but could readily become casualties of the ongoing decline in biodiversity. Moringa seed should be collected from matured and well-developed pods. Germplasm collection is a problem because seeds drop quickly in soil after maturity. Its seed are stored traditionally. Seed viability can be maintained for several years in hermetic storage at 3°C with 5-8% seed moisture [42].

Area and Production

In present scenario, Moringa is widely distributed in India, Sri Lanka, Pakistan, Singapore, Malaysia, Cuba, Jamaica, Saudi Arabia, Qatar, Oman, Yemen and Egypt. In India Tamil Nadu, Andhra Pradesh, Karnataka, Maharashtra and Gujarat are major growers of drumstick.

Soil and Climate

Moringa can be grown in a wide range of soil type but does well in sandy red soil or black soil without prolonged water logging. Soil should be neutral to slightly acidic. Ideal soil pH is 6.0-7.5. It can be grown in dry and arid tracts, but tropical and pen insular climates found in the plains of south India are best suited for its growth.

It can be grown on an altitude upto 1000 m with mean annual temperature 12.6 to 40 °C (but the best temperature is 25-30°C) and mean annual rainfall of at least 500 mm. High temperature leads heavy flower shedding.

Varieties

Agriculture universities and ICAR institutes have developed moringa varieties suitable for different areas of India. Some of them are Rohit1, Coimbatore 2, PKM-1, PKM-2, KM-1 (Kudumianmalai1), Dhanraj, Jaffna, Chavakachery Muringai, Chemmurungai, Kattumurungai, Kodikalmurungai, Yazpanammuringa, KonkanRuchira etc (Table 3).

Table 3: Important varieties of moringa grown across India.

S. No.	Variety	Characteristics
1	Rohit1	Pods are dark green in colour 45 to 60 cm in length, the pulp is soft and testy and the keeping quality is very good. From a single plant average 3 to kg pods are obtained. First yield was obtained in 4 to 6 months after plantation and gives commercial yield up to 10 years.
2	Coimbatore 2	The length of the pod is about 25 to 35cm, dark green in colour and tasteful. Each plant yields 250 to 375 pods. The pods are bulky, and they lost their market value if they are not taken from the plant earlier, and the market value of the product is lost.
3	PKM-1	This variety is developed at Horticultural Research station, TNAU. Plants grow to a height of 4-6m. Fruiting starts after 8 to 9 months of planting and twice a year. Pods are 65-70cm long with 6.3cm girth and 150g weight. Each plant can yield 250 to 350 pods. The stick length is larger, so the product has the demand in the market of big cities rather than local market.

4	PKM-2	This variety is also developed at Horticultural Research Station, TNAU, Periyakulam. The stick of this variety is greenish in colour and tastes good. The length of each stick is about 45 to 75cm. 300 to 400 sticks were obtained from each plant. Water requirement of this variety is more.
5	KM-1 (Kudumianmalai1)	The variety is bushy in nature and propagated by seeds. Fruiting starts after 6 months of planting. Productivity is 400-500 fruits/year. Developed at Anna Pannai, Kudumianmalai of Pudukottai.
6	Dhanraj	Annual drumstick variety, which is evolved at KRC College of Agriculture, UAS, Arabhavi, Karnataka.
7	Jaffna	This variety was introduced from Sri Lanka. Fruits are 60-90cm long and have soft flesh with good taste. In 2nd years of planting 400pod per plant and in 3rd year of planting 600pods per plant was obtained.
8	Chavakachery Muringai	Plant of this variety bears 90-120cm long red tipped pods.
9	Chemmurungai	Plant of this variety bear flowers and fruits throughout the year.
10	Kattumurungai	This variety is developed by pure line selection method from T.N. state. Average pod yield is about 400-500 fruits/plant annually. Fruits are 25-30cm long. Plants of this variety are headed back leaving 1m from ground level and used as ratoon. Ratooning is done for 2-3 year.
11	Kodikal murungai	The pods are generally 20-25cm in length and thick fleshed.
12	Yazpanammuringa	Pods are green and long (60-90cm).

Propagation

Moringa can be grown both by sexual (seeds) or asexual propagation.

Sexual propagation: In south India, moringa is mostly propagated by seed. The best time for seed sowing is June-July and November-December months of the year.

The seed rate is about 500 g per ha land. Average seed weight is 0.288 g. The pit size should be 45 cm X 45 cm at 2.5 to 2.5m distance and it should be dug before one week of planting. Seeds should be sown at 3 cm deep and 2 seeds per pit. Generally, seeds germinate in 7-9 days after sowing. Transplanting of the seedlings can be done one month after sowing.

Vegetative propagation: Stem/limb cutting, budding/shield budding, and air layering are the common methods of vegetative propagation in moringa. For limb/stem cutting hard wood are used. Cuttings should be 100-150 cm long and 10 cm thick. The trees are cut down leaving a stump with a 90 cm head from which 2 to 3 branches are allowed to grow. If the cuttings are planted in nursery, there will be slow development of roots so add some amount of phosphorus to the soil to encourage root development. Nursery planted cuttings can be out-planted after 2 to 3 months [47]. The shield budding is found to be successful in the Kanyakumari district of Tamil Nadu. The best time for budding is September and December. Air layering is found successful in moringa propagation.

Land Preparations

Field is ploughed 3-4 times and apply FYM@20t/ha at last ploughing. Pit size should be 45 cm X 45 cm X 45 cm at a spacing of 6 cm X 6 cm for perennial types and 2.5 m X 2.5 m for annual types. Moringa tree should be planted in east-west direction to ensure sufficient sunlight and airflow.

Water Management

Moringa plants do not need too much watering. In arid condition, first two month needs regular watering and afterwards only when the tree is obviously suffering. In arid conditions flowering can be

induced only through irrigations [47]. If there is continuous rainfall throughout the year, Moringa tree yields continuously.

Nutrient Management

Generally, moringa tree grows successfully without fertilizers. If fertilizers are applied, the crop requires 44:16:30 g NPK/tree at the time of pinching (75 days after sowing). Top dressing of nitrogen @ 44g/tree must be done at first flowering (150-160 days after sowing). During rainy season, in some parts of India 15 cm deep ring trenches are dug about 10 cm from the trees and filled with green leaves, manure and ash (Olsen, 1987). Morton [48] reported that application of 7.5 Kg farmyard manure and 0.37 Kg ammonium sulphate per tree can increase pod yield threefold.

Canopy Management

Trimming and pruning of moringa plant should be done regularly otherwise it can grow 30-50 feet tall. A row of trees can be planted close together to create a live fence. Pinching of terminal buds should be done after two months of sowing (75 cm height). After pinching irrigate the crop and apply 100g urea, 100g super phosphate and 50g MOP. Pinching of terminal buds promote the growth of many lateral branches and reduce the height of the tree. Pinching also reduces the damage due to heavy wind and makes harvesting much easier. Pinching also helps the tree to develop a strong production frame for maximizing the yield (Olsen, 1987).

Ratooning

The trees are cut down to a height of one meter above ground level for ratooning. The ratoon plants develop new shoots and start bearing four or five months after ratooning. The plants are supplied with the recommended level of N, P and K nutrients along with 30-35 Kg of FYM.

Harvesting and Yield

Annual type moringa are seasonal in terms of fruit bearing and the crop sown during September comes to harvest within six months. Before fibre development, fruits with sufficient length and

girth should be harvested. Each tree bears about 250-400 fruits. The harvest period continues for 2-3 months. The perennial type moringa which is raised by cuttings take nearly a year to bear fruit. During first two years the yield will be low (80-90 fruit/year). Gradually the yield is increases to 500-600 fruit/tree/year and reached its peak in the fourth and fifth year. For human consumption pods are generally harvested when they are still young (about 1 cm diameter) and snap easily. When seeds harvested for planting or oil production then allow them to dry and turn brown on the tree. Harvest the pods before they split open and fall on the ground. Pods are generally harvested between March and June and second crop is normally harvested from September to October. Yield of moringa basically depends on seed type/variety cultivated. The yield could be around 50-55 tonnes pod per hectare. Good quality seeds are black to brown in colour. Which maintained more than 84% germination up to 12 months if stored in 700 guage polythene bags after treatment with carbendaim @2g/kg of seeds [49].

Post-Harvest Technology

Moringa leaves should be dried in shed and protected from light to prevent the loss of vitamins. The drying process should be completed as soon as possible to prevent the growth of moulds. After drying crush the leaves by using a diesel-powered hammer mill. Then packed the leaf powered and deliver to market for sell. The average production of leaf per acre is 2400 Kg in a year (in 4 Harvests) [50-53].

Plant Protection

In India, no major disease has been reported. Sometime maturing pods show extensive rotting observed over the surface due to fungus *Drechslera haraiensis*. The elliptical or elongated sunken spots with reddish brown raised margins can be observed on green pods [54-57]. Rotting of pods occur in advance stage of disease, pods are rotten and dried up prematurely leaving uneven raised spots over them. The bud worm (*Noordia moringae*) and the scale insect (*Diaspidotus sp.*) are reportedly able to cause damage in moringa [13]. Root rot (*Diplodia spp.*) and papaya powdery mildew (*Levellulata urica*) are also observed in moringa [58-60].

Future Thrusts

Moringa tree has great potential to grow in arid and semi-arid conditions with minimum input. Efforts should be made by agriculturalists, extension workers industrialists, etc. to popularize and encourage to grow this miracle tree, particularly in water limiting areas. However, there is need to identify genotypes of higher yield, good pod length and nutrient rich pods. Standardization of its agro-techniques, value added, and processing products is also needed. Looking to its multifarious uses, the Government should take initiative to plant more and more moringa trees in unutilized areas. This tree can help the country to fight against malnutrition, hunger, poverty, and thus to earn foreign exchange. The phytochemical studies should be done to synthesize the drugs for utilization of

humankind. The tree has unlimited benefits and thus should be popularized for production of this high nutritive value crop at very low price under adverse soil and climatic conditions.

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