



Trainer`s guide for Production, Harvest, Post-Harvest Handling and Value Addition for Moringa in Tanzania

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PREFACE

This guide has been developed by Farm Africa in partnership with SUGECO. It was made possible through support provided by Feed the Future through the U.S. Agency for International Development, under the Feed the Future Tanzania Advancing Youth activity, Contract No. AID-OAA-I-15-00014 Task Order No. AID-621-TO-17-00004. The opinions expressed herein are those of the author(s) and do not necessarily reflect the views of the U.S. Agency for International Development.

This guide provides technical knowledge of farming, processing and marketing of *Moringa olifera*. It has been produced as a learning output of the partnership and is 'open source' for young farmers, traders and processors within Moringa value chain in Tanzania.

In the production of the guide, the combined team of technical staff and Young Professionals reviewed different references on:

- ∂ Best practices in Moringa production
- ∂ Business and marketing of Moringa
- ∂ Quality and safety of Moringa processing
- ∂ Moringa nutritional properties

Some of the references used in developing this guide are as follows (but are not limited to):

1. How to Grow Moringa
[http://atrc.net.pk/resources/agriculture/morinaga_tree/How%20to%20Grow%20Moringa%3F%20%7C%20Cultivate.%20Plant%20Moringa%20Oleifera%20Trees.html]
2. Moringa English Book
[<http://agritech.tnau.ac.in/horticulture/pdf/Moringa%20English%20book.pdf>]
3. Benefits of Moringa [<https://ecowatch.com/benefits-of-moringa-2611149881>]
4. Growing and Using Moringa
[<https://strongharvest.org/growing-and-using-moringa/>]
5. Orwa et al (2009). Moringa Oleifera in Agroforestry Database 4.0
[<http://www.worldagroforestry.org/sites/treedbs/treedatabases.asp>]
6. Saint Sauveur et al (2006). Fighting malnutrition with Moringa oleifera leaves: an untapped resource [www.moringanews.org]

These references were customized to fit the Tanzanian context. The reader may come across inconsistencies eg: market price of Moringa per kg, however the guide was developed in the spirit of being a living document and would need relevant adjustments at the time of use.

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ACRONYMS

cm	Centimeter
GHP	Good Hygienic Practices
GMP	Good Manufacturing Practices
g	Grams
Kg	Kilogram
L	Litre
m	Meter
OSHA	Occupational, Safety and Health Authority
SUGECO	Sokoine University Graduates Entrepreneurship Cooperative
TBS	Tanzania Bureau of Standards
Tsh	Tanzania Shillings

CHAPTER ONE

BEST PRACTICE FOR MORINGA PRODUCTION

I. Farm preparation

The following are the factors to consider before/during farming Moringa plants:

(a) Site selection

- » Select a field with well-drained soil (sandy loam)
- » Avoid termite infested soils
- » Open and well lit (sunny) area
- » Accessible area (infrastructure and transportation)
- » Available water

(b) Land preparation procedures

- » Slash and remove all debris from the field
- » Plough and harrow the field

*There are three ways of propagating Moringa: **direct seeding**, growing **cuttings** and **nursery**. Direct seeding is highly recommended since it's less expensive (work and time) and seedlings have a higher survival rate (no damage to tap root when transplanting).*

(c) Seed selection

- » Seeds must be collected from well-developed pods of healthy and productive trees.
- » Choose seeds of uniform size, weight and color.
- » Sort out and remove debris eg: stones, leaves, twigs, stems etc., wrinkled, diseased (mottled), molded, discolored, damaged and empty seeds.
- » Seed can remain viable for a few years if stored in a hermetic container at low temperatures.

Seed usually represents a relatively small part of the monetary cost of producing Moringa. Yet the profit at harvest depends heavily upon the choice of seed for planting.

2. Planting

- (a) Prepare the field by clearing the soil and making ridges.
- (b) Place 2 - 3 seeds at 2 cm depth (approximately the size of one's thumbnail) directly into the soil and cover them with soil.
- (c) Irrigate the field to ensure moisture availability.
- (d) Dehulled or soaked seeds which are properly sown should germinate in 9 - 14 days.

Planting should be done at the beginning of the wet season. For the case of Southern Tanzania, i.e. Iringa and Mbeya regions, this is between end of November and beginning of December.

3. Spacing

- (a) For semi-intensive production, plant the trees 50 cm to 1 m apart (approximately one step). When the trees are for seed, leaf and pod production, there should be 3 - 5 meters (approximately 3-5 steps) between the rows.

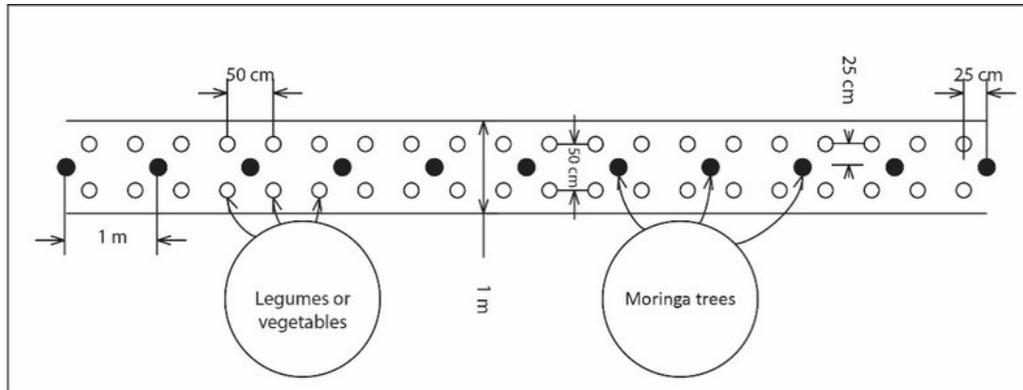


Figure 1 by Research Gate¹

- (b) For living fence posts, trees are often spaced in a line 1 m or less apart and rows must be 2 - 4 m.

Give the ground some water but not too much (> 1 L/day), otherwise the seed may rot.

4. Management of trees in the field

(a) Fertilizer application

- » Manure or compost can be mixed with the soil used to fill the pits.
- » Use 1 – 2 kg (approximately equal to one saddle)/pit of compost or well-rotted farmyard manure during planting.
- » Ensure continuous supply of organic fertilizer in vegetative phase to maximize leaf production and stem elongation.
- » During the rainy season, dig trenches 15 cm deep and 10 cm from the tree (approximately length of palm of hand), fill with ashes, green leaves and manure facilitate pods and seed formation.

(b) Pruning

When the seedlings reach a height of 60 cm - 1 m (usually 3 to 5 month after planting), prune the growing tip. This can be done using a knife or fingers since the terminal growth is tender, devoid of bark fiber and brittle, and therefore easily broken. Cut again when they reach a height of 1.5 m, 2 m and 2.5 m.

¹ https://www.researchgate.net/figure/Diagram-illustrating-the-spacing-of-moringa-and-legumes-grown-in-seasons-2-and-4-or_fig2_316832602

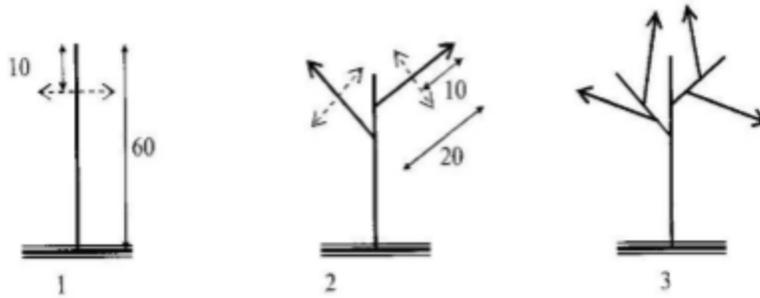


Figure 2 by Life Re Belle²

Pruning will encourage the tree to become bushy and develop a strong production frame, which can produce pods within easy reach. This will also help to maximize the yield. If the pruning 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.

(c) Weed control

- » For weed management, cultivate the soil thoroughly before planting to suppress early weed growth.
- » Control weeds three times during rainy season and once during dry.
- » The area between Moringa trees should be kept free from weeds at all times by slashing.

(d) Pest and disease control

- » For termites, among approaches recommended include:
 - Applying neem seed cakes to the soil
 - Applying mulches (castor oil leaves)
 - Heap ashes around the base of seedlings
- » Protect seedlings from livestock by installing fences or by planting a hedge around the plot.
- » Diplodia root rot as a result of waterlogged soil can cause severe wilt and ultimate plant death – avoid planting trees in waterlogged areas.

5. Harvesting, Post-Harvest Handling & Storage

It's advised to harvest on the day when buyer comes to collect - when the market is assured.

(a) Leaves

After 1 year, the tree will have reached 1.5 – 2.0 m with older leaves which are more suited for harvest.

- (i) Moringa tree has a compound leaf: one leaf is made up of multiple leaflets, which are attached to the rachis which stems from the branch.

² <http://lavierebelle.org/?meilleures-techniques-de-culture-des-moringa&lang=fr>

- (ii) Harvest leaves by snapping leaf stems from branches. It is recommended to harvest the shoots and leaves with a pair of shears, a sickle or a sharp knife. All shoots should be cut at the desired height, i.e. 30 cm to 1 m above ground. Harvesting young shoot tips will promote development of side branches where cuts along the main branches are made.

Moringa should be harvested at the coolest time of the day: early morning or late in the evening (5 – 7 AM and 6 – 8 PM). It is important to make sure there is no dew on the produce before harvesting, especially in the morning, to avoid rot during storage or transportation.

- (iii) If leaves are to be stored, they may be dried in the shade (nutrients are lost under direct sunlight) and protected from dust to prevent contamination, Use tarpaulin or clean piece of nylon/cloth to do so.
- (iv) Allow plants to develop new shoots and branches before subsequent harvests.

A high level of hygiene should be maintained ahead of harvest and handling by washing and drying your hands.

(b) Seeds

- (i) Pods should be harvested as early as possible when they reach maturity i.e. when they turn brown and dry otherwise they will split open and fall to the ground.
- (ii) When harvesting pods for human consumption, harvest when the pods are still young (about 1 cm in diameter) and snap easily.
- (iii) After harvest the pods are dried under the sun for 2 days and seeds are manually extracted by splitting open the pods.
- (iv) When producing seed for planting or for oil extraction, allow the pods to dry and turn brown on the tree. Pods should then open easily to allow the seed to be extracted.
- (v) Store seeds in well-ventilated sacks in a cool, dry and shaded area. Seeds remain viable for planting for at least two years.

CHAPTER TWO

BUSINESS AND MARKETING OF MORINGA

1. Business benefits of Moringa

The following are reasons to engage in Moringa business:

- » To reduce unemployment and earn income
- » To improve health
- » To provide animal feed nutrients

2. Profit from farming *Moringa olifera*

(a) *Estimated cost of production per 1 acre*

Item(s)	Amount	Cost (Tsh)
Seeds	0.5 kg	12,500
Fertilizer	5 ton	200,000
Tillage	1 acre	50,000
Planting	1 acre	20,000
Weeding	1 acre	30,000
Pruning	1 acre	15,000
Harvesting	1 acre	30,000
Extension Service	Per year	120,000
Miscellaneous		100,000
Total cost		1,224,000

(b) *Estimated revenue per 1 acre*

Product	Amount	Price/Kg (Tsh)	Price (Tsh)
Dry Leaves	1,130 kg /acre	8,000	9,040,000
Seeds	800	5,000	4,000,000
Others			
Total revenue			13,040,000

(c) *Estimated profit per 1 acre*

Total Profit = Total Revenue - Total Cost = 13,040,000 – 1,224,000 = **Tsh 11,816,000**

3. Profit from processing *Moringa olifera*

(a) *Estimated cost of processing 1 kg of powder*

Item(s)	Amount	Cost (Tsh)
Purchase	1 bag of dried leaves (25 kg)	11,000
Transport		
Storage		
Milling	1 bag of dried leaves (25 kg)	200
Package and labeling	4 cups of 250 g	2,400
Sales and marketing cost		
Miscellaneous		1,500
Total cost		15,100

(b) *Estimated revenue from processing 1 kg of powder*

Product	Unit/Amount	Price (Tsh)
Powdered leaves	1 kg	20,000
Powdered seeds	4 packets (250 g)	12,000
Total revenue		32,000

(c) *Estimated profit of processing 1 kg of powder*

$$\text{Total Profit} = \text{Total Revenue} - \text{Total Cost} = 32,000 - 15,100 = \text{Tsh } 16,900$$

4. Available markets

Moringa products can be sold both within our local (domestic) and international markets. However, for the case of southern Tanzania including Iringa and Mbeya regions, available local markets include:

- Herbal clinics
- Iringa Municipal market in Iringa town
- Mbeya Municipal market in Mbeya city
- Supermarkets in Dar es salaam
- SUGECO in Morogoro
- Kisarawe and Mkuranga in Coastal region

International markets require higher standards and there are companies buying high quantity Moringa such as **Kuli Kuli Foods Company** in USA and **Bio One Investment** in South Africa.

CHAPTER THREE

QUALITY AND SAFETY OF MORINGA PROCESSING

1. Benefits of applying good processing practices

Applying good manufacturing and hygienic practices during processing and handling of moringa and its products is important as it helps the processor to obtain high quality products i.e. products with adequate nutritional contents such as vitamins and minerals. This will gradually:

- » increase value of products in the market, hence higher income
 - » reduce loss of raw materials, hence increase profit
 - » simplify certification procedures by authorities such as TBS, OSHA etc.
 - » lead to increased consumer satisfaction
- > Also, good manufacturing and hygienic practices preserve medicinal properties of moringa food products. Moringa contains medicinal compounds such as antioxidants which are highly affected by poor manufacturing practices.

2. General rules and regulations for handling moringa

(a) *Personal hygiene*

- » Individual must be healthy (free from communicable diseases eg: TB)
- » Wash hands with clean water and soap/detergent
- » Avoid personal behaviors such as smoking, eating or spitting
- » Cover head, mouth, nose, chest and beard using protective gear
- » Keep fingernails short, clean, and unpolished
- » Avoid wearing jewelry, including earrings
- » Avoid wearing slippers
- » Avoid coughing or sneezing over uncovered foods
- » Visitors must follow all food safety procedures

(b) *Facilities and equipment hygiene*

- » The unit must be clean
- » Building must be supplied with potable water
- » Building must be adequately lit and ventilated
- » Floor, walls and equipment must be easy to clean
- » Clean the equipment before and after processing
- » Building must be enclosed i.e. it must prevent the entrance of dust, rodents, insects and other contaminants
- » The raw materials/products should be placed on pallets to avoid water, moisture and mould growth
- » Building must have adequate space and must be a sensible distance from residential dwellings
- » Building must contain clean toilets but at a sensible distance from the processing unit

3. During processing

- (i) During harvesting, only matured leaves should be harvested. Also, they must be harvested with clean hands and placed in clean equipment.
- (ii) The raw materials (leaves, seeds and roots) must be properly sorted to remove all types of physical contaminants such as stones, animal feces and rotten leaves which might compromise the quality of final product.
- (iii) The leaves must be thoroughly washed with potable water.
- (iv) The leaves must be dried in a clean and safe environment with no access by insect, rodents, birds and other animals, or dust, which may contaminate the product; it is advised to use either local or advanced solar drier technology.
- (v) Equipment used during processing must be selected carefully. Some equipment is not food graded, hence can affect the quality of the product. For example, some metals used to make machine parts can corrode easily and introduce metal particles to the product.
- (vi) The products must be stored in cool and dry place in well-sealed packaging.

4. Packaging

Several packages can be used for storage of Moringa products, including food grade plastic bags, plastic bottles, plastic pouches, glass and metal cans. Good packaging material must:

- » be easy to use and handle
- » provide barrier protection for water moisture, odor and gases for long periods of time
- » not produce toxic substances, affect color and other sensory attributes
- » be environmentally friendly ie: avoid plastic bags (where possible)
- » be cheap and easily available
- » be opaque since nutrients such as vitamin C are vulnerable to light

5. Labelling

The label of the product is very important to link the communication between customers and producers. Important information to appear on the label of the product is as follows:

- » Name of the product
- » Name and address of the producer(s)
- » Batch number, manufacturing and expiry date
- » Size/volume of the product
- » List of ingredients

Examples of Moringa products and their processing steps

(a) *Moringa leaves*

- » Harvesting - Fresh green leaves are plucked from Moringa tree.
- » Sorting - Leaves are separated from stalk and any dead or infected parts are cleared off.
- » Washing - Leaves are thoroughly washed in clean water.
- » Drying - Leaves are dried in a wire mesh/tarpaulin under the shade (2 - 3 days) or dried using solar drier.
- » Grinding - The dried leaves will be ground in a milling machine, blender or mortar and pestle then sieved. Before doing so, make sure the equipment is dry and clean.
- » Packaging - The ground leaves are packed and sealed in dry and waterproof material.

Moringa mixed in corn/millet/sorghum flour

Moringa leaf powder can be used to add nutrients to corn, cassava, millet or sorghum flour. Preparation of this flour involves preparation of (separately) cereal flour and Moringa powder and mixing (usually 10 g of Moringa powder into 1 kg of cereal flour) then the flour can be packed.

(b) *Moringa seed/roots*

- » Harvesting – Only mature seed are harvested by plucking the pods from their branches.
- » Sorted – Remove all seeds/roots with color other than brown/bright khaki.
- » Deshelled – Remove the outer cover to reveal the seed inside.
- » Grinding – Remember to clean the blender or pestle and mortar before grinding.
- » Consumption - seeds can be roasted and eaten like nuts or pressed as oil.

(c) *Moringa flowers*

Flowers can be harvested as described above for seeds. Moringa tea can be prepared from Moringa flower powder mixed with other tea spices such as ginger or cinnamon etc. The preparation is by mixing of already prepared powder (usually 10 g) and spices (1kg) ahead of packing.

CHAPTER FOUR

MORINGA'S NUTRITIONAL PROPERTIES

I. Moringa to boost family health

Component	Main nutritional benefits
<p>Leaf</p>  <p><i>Figure 3 by Vecteezy3</i></p>	<p>Vitamin A - protects eyes from night blindness, age-related decline and risk of skin infections.</p> <p>Vitamin C – important for boosting the immune system and wound healing.</p> <p>Protein – builds, repairs tissues and it also makes enzymes, hormones, and other body chemicals.</p> <p>Iron</p> <ul style="list-style-type: none"> » For pregnant and breastfeeding women it can help increase the amount of milk produced and it is advised in anemia cases » For diabetic patients, it can help stabilize blood pressure and restrict the amount of sugar » For skin patients, ground leaves can be applied on the skin to help treat abscesses and skin infection <p>Calcium</p> <ul style="list-style-type: none"> » For stronger bones and teeth » Proper function of heart, muscles and nerves <p>Potassium & Phosphorus</p> <ul style="list-style-type: none"> » Like Calcium, they help to maintain stronger bones and teeth » They can help protect the body against: <ul style="list-style-type: none"> - stroke by helping nerve and muscle work properly - kidney stones by reducing blood pressure and water retention <p>Zinc – regulates immune functions, learning and memory.</p> <p>Omega 3 & 6</p> <ul style="list-style-type: none"> » For children, Omega 3 plays a crucial role in brain function, and normal growth and development. » As a type of polyunsaturated Omega 6s can <ul style="list-style-type: none"> - help stimulate skin and hair growth - maintain bone health - regulate metabolism - maintain the reproductive system <p>Fiber - helps to maintain normal bowel movement, cholesterol level to achieve healthy weight.</p>
<p>Seed</p>  <p><i>Figure 4 by Shutterstock4</i></p>	<ul style="list-style-type: none"> » Pterygospermin - a potent antibiotic and fungicide effective against from infectious and skin bacteria such as <i>Staphylococcus aureus</i> and <i>Pseudomonas aeruginosa</i>. » Grounded seeds can be used to coagulate muddy water.

³ <https://www.vecteezy.com/free-vector/moringa>

⁴ <https://www.shutterstock.com/search/moringa+seed>

<p style="text-align: center;">Root and bark</p>  <p style="text-align: center;"><i>Figure 5 by India Mart⁵</i></p>	<p>» Ground roots and barks can be applied on the skin to help treat abscess and reduce pain from scorpion or snake bite.</p>
<p style="text-align: center;">Flower</p>  <p style="text-align: center;"><i>Figure 6 by Finca Traquila⁶</i></p>	<p>» The flowers of have a mild mushroom flavor and contain amino acids, Calcium and Potassium, they are also said to help to reduce high blood pressure.</p>

Let's not forget that according to Saint Sauveu et al, 5%-15% of Moringa powder for 100g of flour is accepted by mothers and children. This is from the fact that an equal amount of Moringa leaves powder has equivalent of:



Figure 7 by Herbyzone Health Store⁷

2. Moringa as animal feed

Moringa leaves (in moderate amount) are a valuable source of protein, fiber and anti-nutritional factors for ruminants, poultry, pigs and fish.

Seeds appear to be toxic to some domestic animals such as rabbits so care should be taken.

⁵ <https://www.indiamart.com/proddetail/moringa-bark-powder-12894664448.html>

⁶ <http://fincatranquilabocas.com/eco-market-2/finca-tranquila-premium-fresh-organic-edible-moringa-flower/>

⁷ <https://www.youtube.com/watch?v=KQryxvaavAY>

Pre/Post Assessment Test

Instructions:

- (a) This test will be administered to all participants at the beginning of the training and at the end.
- (b) The test will be administered in Swahili for clear understanding.

Questions:

1. What three things do you need to start Moringa farm? 30%
[Je unahitaji vitu gani vitatu kuanza kilimo cha Mlonge? Alama 30]
2. What is recommended spacing between one Moringa tree and another? 20%
[Je ni umbali gani unashauriwa kuwa kati ya mti mmoja wa Mlonge na mwingine? Alama 20]
3. What are the benefits of farming Moringa? 20%
[Je ni namna gani unaweza kufaidika kutokana na kulima Mlonge? Alama 20]
4. What are the three nutritional benefits of Moringa? 30%
[Je ni faida gani za lishe zinazopatikana kutoka kwenye Mlonge? Alama 30]