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# Participatory evaluation and demonstration of Moringa tree for leaf yield production in Kachebirra district, Southern Ethiopia

Belayneh Lemage Bongido [1,*] and Mekuria Girma Hadera [2]

[1] *Natural resource Research directorate, Agroforestry Researcher, Areka Agricultural Research Center, Southern Ethiopia Agricultural Research Institute, Areka, Ethiopia.*
[2] *Natural resource Research directorate, Agroforestry Researcher, Areka Agricultural Research Center, Southern Ethiopia Agricultural Research Institute, Areka, Ethiopia.*

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## Abstract

Moringa is a multipurpose tree distributed in the lowland areas of the southern Ethiopia. The aim of this study was to demonstrate Moringa tree for leaf yield production in smallholder farms under farmer management condition. The present study was conducted in Kachabira district, Southern Ethiopia. Two Moringa species are planted in the homestead of five farmers and one FTC (farmer training center) to enhance land productivity. Raised seedlings were planted with recommended spacing of 2m*2m between plants and rows. The growth performance data were collected for survival rate, root-collar diameter, height and fresh leaf yield. The result obtained showed that both species performed well in the studied area where it has been grown. The survival rate of both species in the studied area was 100% and 98% for *Moringa stenopetala* and *Moringa oliefera*, respectively. The plant height, root collar diameter, branch number, and fresh leaf yield parameters were recorded as an indicator for growth performance of planted Moringa species. The result of plant height, root collar diameter, leaf area and leaf yield for *Moringa stenopetala* and *oliefera* were 1.75m and 1.48m, 11.97mm and 7.84mm, 276.41mm2 and 49.93mm2, and 581.58gm and 90.47gm per plant, respectively. The growth performance information in the introduced area showed that it is suitable to grow *Moringa stenopetala* and *oliefera*. Therefore, farmers should practice and promote plantation of Moringa tree to improve production and enhance livelihood of farming community. Further research is desired on nutritional quality with respect of harvesting season, and organic amendments to improve leaf yield.

**Keywords:** Growth performance; Kachebirra district; Leaf yield; Moringa tree

## 1. Introduction

Ethiopia has diverse physio-geographic features that contributed for the formation of diverse ecosystems inhabited with a great diversity of life forms of both animals and plants [1]. Such diverse ecological conditions enabled the country to inhabit about 6000 higher plants of which about 10% are endemic [2]. The vegetation resources of Ethiopia classified into 12 types [3]. The country is also known as Vavilov center of origin and diversity for many food plants and their wild relatives [4]. Despite these rich natural resources and being an agrarian country with over 80% of its population, more than 35% of Ethiopian people are food insecure [5]. Moringa species is one of the world's most useful plants; it is a fast-growing, much more drought-tolerant and multi-purpose tree that it has been described as a 'miracle tree' [6, 7, 8].*M. stenopetala* and *M. oliefera* are the two most common species of the Moringaceae family.

The Southern parts of Ethiopia and Northern Kenya are believed to be the origin and place of endemism and diversity to *M. stenopetala* [9]. It grows within altitudinal range of 390 to 2200 m a s l receiving mean annual rainfall that ranges from 250 mm to 1400 mm [10].*M. stenopetala* is drought resistant and grown in a wide variety of poor soils, including

*Corresponding author: Belayneh lemage

barren ground, with soil pH of 4.5 to 9.0 [8].In Southern Ethiopia, farmers use *M. stenopetala* as one of the major arable tree inter-crop in their agricultural systems, especially in Konso, Derashe and Gamogofa areas [11, 9]. In these area, Moringa is cultivated mainly for its edible leaves, pods and flowers, but also used as animal fodder [12], human and animal medicine, shade and for income generation[13, 14].A single plant of *M. stenopetala* is able to support a large family for several years [15].There is scant information on the native *M stenopetala,* which has recently gained attention due to its multiple uses; little is known about its biomass production when it is managed as an intensive plantation and Agroforestry.

*M. oliefera* is a tropical plant which is native to India [16] and planted in many parts of the world. It is more well-known, grows in tropical and sub-tropical climates; is drought-resistant and can be grown in a wide variety of poor soils with soil pH of 4.5 to 9.0 [8]. *M. oliefera* was introduced to Ethiopia recently as a vegetable tree for its edible leaves and still remains unpopular despite its importance [9]. *M. oliefera* is now widely cultivated and is found in most tropical countries [4, 17] and it has also received research and development attention worldwide [9].

Cultivation of Moringa in agricultural landscape plays an important role in the livelihoods of the farming community by providing production and protection function. In the current condition it needs better attention to introduce and demonstrate in participatory way to disseminate the benefit and production of Moringa in area of favorable climatic condition for growth performance of the desired species. Therefore, this study was intiated to cultivate Moringa tree on farmer managed homesteads to demonstrate leaf yield production and promoting it's the use value in small holder farms to improve land productivity and enhancing of resilience of farming system.

## 2. Material and methods

The present study was conducted in Kechabirra district, Kembata Tembaro zone, southern Ethiopia. The livelihood of the living community is based on mixed farming system. The community relies on crop cultivation and animal production. The land size of the farming household in the area is less than 0.5ha; due to this they utilize intensive farming system to produce agricultural products and providing food for their families. Geographically, the district is located between 7° 6` 0`` N to 7° 20` 0`` N latitude and 37° 40` 0`` E to 37° 56` 0`` E longitude. The altitude of the district varies from 1900- 2800 m above sea level. The mean monthly minimum and maximum temperature of the district is 18 C and 31 C respectively. The mean total annual rainfall ranges from 1200 mm to 1500 mm. The study area has two major agro-ecological zones, Dega (highland) and Weyna-dega (midland) [18].

The materials used were seedlings of *Moringa stenopetala* and *Moringa oliefera* species. The seedlings of Moringa species are raised in the nursery site to obtain uniform planting material and it is better to manage the field performance. The seeds are obtained from mother Moringa plants managed in research station of Arba minch agricultural research center for oliefera species and stenopetala from farm households of Humbo district. The establishment and planting design for Moringa seedlings were planted in 2m*2m spacing. The plot size required for each species was 48$m^2$ and the total area on a farm 96$m^2$. The planting was carried out on 576$m^2$ area for both species. The block between two species used for gang way was 3m to easily identify and manage the species independently. The evaluated growth parameters were plant height, root collar diameter, branch number and fresh leaf yield. The collected growth performance data were processed by using SPSS software to evaluate the growth performance variation among farmer management condition.

## 3. Results and discussion

### 3.1. Survival rate and growth performance

The survival of Moringa species cultivated in the homestead is under good performance condition. *Moringa stenopetala* and *oliefera* species were identified as an important component to introduce and demonstrate these species in the farming system. The survival rate of planted seedlings attained 100% and 98% for *Moringa stenopetala* and *Moringa oliefera,* respectively. This result showed that both species can survive in newly introduced area with wide range of adaptation potential of the species in midland and lowland agro ecology. Moringa species can survive in poor soil conditions and drought tolerate tree that rehabilitate marginal land.

- **Plant height**: - Plant height is an important parameter which helps in the determination of growth performance. Under farmer management condition both Moringa species showed good growth performance in terms of plant height. Plant height is one of important growth parameter that indicates the performance of the cultivated species in 2m*2m spacing. *Moringa stenopetala* attain a mean height of 1.23m and 1.75m, and

under similar management condition *Moringa oliefera* attain a height of 1.05m and 1.48m (Table 1and 2).*Moringa stenopetala* and *oliefera* cultivated for food, fodder, shade, windbreak and medicinal value around homesteads and in farmlands [11].

**Table 1** Early (initially recorded parameters) growth performance of *Moringa stenopetala* and *oliefera* species

| **Farms** | ***Moringa stenopetala*** | | | ***Moringa oliefera*** | | |
|---|---|---|---|---|---|---|
| | **Ph(m)** | **RCD (mm)** | **Leaf number** | **Ph(m)** | **RCD (mm)** | **Leaf number** |
| F1 | 1.17 | 8 | 14.276 | 1.11 | 5.5 | 17.416 |
| F2 | 1.26 | 8.5 | 14.243 | 1.08 | 5 | 16.701 |
| F 3 | 1.24 | 8.75 | 11.202 | 1.23 | 6.25 | 18.802 |
| F4 | 1.25 | 9 | 10.976 | 0.98 | 6.25 | 18.514 |
| F5 | 1.23 | 8.5 | 9.508 | 0.87 | 5 | 17.112 |
| Mean | 1.23 | 8.55 | 12 | 1.05 | 5.6 | 17.71 |

Where Ph (Plant height), RCD (root collar diameter), mm (millimetre)

**Table 2** Plant height and leaf area of *Moringa stenopetala* and *oliefera* under farmer management condition measured in second round

| **Farms** | ***Moringa stenopetala(m)*** | | ***Moringa oliefera(m)*** | |
|---|---|---|---|---|
| | PH(m) | Leaf area (mm) | PH(m) | Leaf area(mm) |
| F1 | 1.65± 0.09 | 301±31.10 | 1.55± 0.27 | 49.81± 10.90 |
| F2 | 1.77± 0.36 | 70.94± 53.22 | 1.51± 0.31 | 46.5± 22.83 |
| F3 | 1.85± 0.41 | 284.31±182.08 | 1.72± 0.41 | 60.19± 16.81 |
| F4 | 1.75± 0.40 | 297.63±129.89 | 1.38± 0.41 | 49.44± 7.33 |
| F5 | 1.72± 0.24 | 228.19± 228.19 | 1.22± 0.09 | 43.69± 7.33 |
| G. Mean | 1.75±0.3 | 236.41± 124.90 | 1.48±0.30 | 49.93± 13.04 |

Where G. Mean (grand mean), mm (millimeter), PH (Plant height), Std(standard deviation)

- **Root collar diameter**:- another important parameter that shows the growth performance of planted Moringa species in the farmland. Moringa species planted in 2m*2m resulted with good performance; the recorded growth performance parameter result showed that in area it is possible to carry out the Moringa plantation. The mean root collar diameter results attained were 11.97mm and 7.84mm for *Moringa stenopetala* and *oliefera*, respectively under farmer management condition (Table 3).

**Table 3** Root collar diameter of *Moringa stenopetala* and *oliefera* under farmer management condition

| **Farms** | ***Moringa stenopetala (mm)*** | ***Moringa oliefera(mm)*** |
|---|---|---|
| F1 | 11.2±1.14 | 7.7±2.24 |
| F2 | 11.9±2.91 | 7±1.98 |
| F3 | 12.25±4.90 | 8.75±2.39 |

| | | |
|---|---|---|
| F4 | 12.6±4.12 | 8.75±3.50 |
| F5 | 11.9±1.81 | 7±1.14 |
| G. Mean | 11.97±2.85 | 7.84±3.58 |

Where: RCD (Root collar diameter), mm (millimeter), G. Mean (grand mean), Std (standard deviation)

- **Leaf yield**:- The fresh leaf yield obtained from both species under farmer management condition showed that there were variation depends on the type of the species difference and the management condition carried out by the farm households. The mean leaf yield result for *Moringa stenopetala* and *oliefera* was 581.58 and 90.47 gm per plant under farmer management condition (Table 4). This showed that in the current condition it is better to cultivate Moringa for the purpose of leaf yield production to enhance the resilience of the farming community. The cultivation of Moringa species provide different products used for different purposes. It is multipurpose tree and has wider adaptation potential ranging from semi-arid to humid midland agro ecology. The green leaf is consumed as a vegetable, dried leaf for tea, leaves and pods are used as fodder for animals, seeds are used to purify muddy water, seeds are also source of cooking oil or for other industrial applications, roots are used to clarify dirty water, and is a medicine to treat different aliments, wood is used for pulp production [9].

**Table 4**Fresh leaf yield of *Moringa stenopetala* and *oliefera* under farmer management condition

| **Farms** | ***Moringa stenopetala*(gm/p)** | ***Moringa oliefera*(gm/p)** |
|---|---|---|
| F1 | 547.785±49.68 | 95.370±22..82 |
| F2 | 588.577±279.95 | 92.358±26.60 |
| F 3 | 617.715±316.58 | 105.247±35.34 |
| F4 | 582.750±309.48 | 84.412±35.41 |
| F5 | 571.095±184.99 | 74.960±7.70 |
| Total mean | 581.58±228.14 | 90.47±25.57 |

Where: G. Mean (grand mean), gm/p (gram per plant), Std (standard deviation)

## 4. Conclusions

The results of the present study showed that spacing had a detrimental effect on the growth and leaf yield of *Moringa stenopetala* significantly. A pronounced effect was observed on leaf production as well as on survival rate, plant height, root collar diameter, leaf number, and branch number. The optimum plant spacing(2m×2m) which resulted with better growth performance Moringa species under farmer management condition in leaf yield, leaf area, root collar diameter, branch number and plant height parameters. Therefore, farmers in the study area could adopt and promote *Moringa stenopetala* and oliefera plantation to improve the production system and enhance livelihood resilience to overcome the shocks of climate change. Further research is required on leaf nutritional quality with regard of harvesting season and organic fertilizer application to improve the leaf biomass productivity under farmer management system.

## Compliance with ethical standards

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### *Disclosure of conflict of interest*

The authors declare that they have no conflict of interest.

*Authors Contributions*

Belayneh Lemage: Collected data, analyzed data and wrote research work, , supervised research work, drafted the manuscript and reviewed the manuscript, Mekuria Girma: conceived the research idea, designed the study, Collected data, The authors read and approved the final manuscript.

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