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Moringa Production Potential and Constraints in Selected Kebeles of Dire Dawa City Administration, Eastern Ethiopia

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Abstract
Moringa stenopetala is a deciduous plant cultivated in the southern part of Ethiopia and expands to the rest of the country. It is indigenous to Ethiopia, distributed in the lowland ecology of the southern and eastern part of the country. The plant is used for food, fodder, shade, windbreak, cash and traditional medicine. It is a contingency crop in frequently drought-affected lowland areas with its high yielding capacity under drought condition and it can be harvested all year round. This study was conducted with the objectives of analyzing the production, potential of Dire Dawa city administration of this cabbage tree, and identifying constraints and opportunities for its production. Data were collected from Addada , Balewa , Harele ,Jeledesa , Legahare , Lege Mirga and Melka Jebidu kebeles with a total usable sample of 364 households, interview was made in each selected rural kebeles to collect a primary data. In addition, interview was carried out with senior Official from Bureau of forest and rural bureau and environmental protection office and secondary data collection were undertaken to supplement the primary data. Both descriptive and inferential statistical techniques were used to analyze the data. The finding reviled that despite low understanding of the benefit of the plant and its marketability potential, the area has high potential for production of the plant.
Keywords: Cabbage tree; contingency crop; drought porn; Moringa; production; awareness

1. Introduction

With prominent population change like Ethiopia supplemented with recurrent drought and shortage of rainfall, adopting of different nutritional plants become vital specially plants which can resist climate changes and grow with unsuitable and harsh environment i.e. moringa that can be used as food and supplementary food (Foidl, *et al*., 2001; Premi *et al*., 2010). Moringa species receiving rapid increase in international media attentions based on their acclaimed potential to increase social, economic and environmental sustainability. This attention often activates investments and promotion campaigns to domesticate the species, and to establish large-scale, commercial plantations. However, often these plants are still subject to fundamental research. Further, not only investors, but also promoting agencies or organizations, generally tend to focus on the promising aspects of the species, lacking a full insight into the constraints, uncertainties and risks. Too high expectations or commercial failures might then result in the termination or further development of the plant and its potential products. This is a typical description of a "boom and bust" cycle of so-called "miracle", or "rapidly emerging" crops or trees which define as emerging species as species, which suddenly attract global attention i.e. the media, donors, academics, international organizations, researchers, industry) for large-scale commercial, developmental and/or environmental aims though species have a local function or use before attention grows gradually at global levels by promoting institutes (Wouter M. J. Achten, *et al*.,2014).

Having the above, *Moringa* is one multipurpose tree of global interest and is grown in combination with agricultural and horticultural crops by smallholder growers and this give growers a wide range of benefits (Palada and Chang, 2003; Radovich, 2009). It is a suitable tree for traditional agroforestry in the home because of its versatility (Odee *et al.*, 2001; Palada and Chang, 2003; Nduwayezu *et al*., 2007).

Moringa has a widespread use in agricultural industry and medicine. The tree benefits from mycorrhizal nitrogen-fixing association but there are no known residual nitrogen benefits for the next crop. Pod shucks and seed kernel press cake can be used as mulch and enhances soil fertility when they decompose (Prat *et al*., 2002). It can be used in livestock as a biocide. All parts of the Moringa tree are used in natural medicine. The tender leaves and pods contain a wealth of essential disease-preventing substances, for example, it is said to have known immune boosting ability (FAO, 1988; Ncube, 2006; Smith and Eyzaguirre, 2007). *Moringa* can be used as asource of oil and dye for water purification and wood fuel (Folkard and Sutherland, 1994).

In Ethiopia, *Moringa stenopetala* has the potential to be adopted as food for humans as well as a fodder. It can therefore fill in both human and animal nutrition gaps for the resource poor smallholder growers who are

in need of food and livestock feed specially in drought prone areas of the country. The animals are usually a source of sustainable livelihoods in the low land of the country including Dire Dawa city administration rural kebeles. Livestock production in addition to crop production is a strategy employed to raise farm income and reduce the food insecurity experienced by rural households due to the decline in agricultural sector (Jera and Ajayi, 2008). Considering the difficult agro-ecological conditions, which prevail in most parts of Ethiopia where smallholder growers live, challenges encountered by the growers seem to be important in successful Moringa production.

With *Moringa* having such myriad of benefits this study sought for analysis of potential and production constraints in Dire Dawa administration smallholder farming sector and highlight opportunities and further has an objective of: Exploring farmers understanding of Moringa benefit as plant and as a product, describing the potential of Dire Dawa soil and climatic zone, for the production of *Moringa* in comparison to other areas and identifying means of building awareness of the farmers and community on cultivation and harvesting and usage and this information will act as basis for supporting the small scale farming communities to secure better livelihoods future and achieving the growth and transformation plan of the country by ensuring food security.

2. Literature review

Moringa is a small fast-growing tropical tree originating from India, but nowadays grows pan tropically (tropical Africa, South East Asia, Central and South America). This multipurpose tree has many uses of which the nutritional and medicinal properties are initially considered. Studies by (Babu, S. 2000; Fuglie, L. 2000; Fuglie, 2001; Olson and Carlquist, 2001; Panga, 2002, Ramunze, 2003; Lalas *et al.,* 2003; Ludington, 2005; Judith, *et al.,* 2005; Luchington, *et al.,* 2005; Villarreal and Anyonge, 2006; Kadashi Y.D. 2008; Ozumba , 2008; Okeke , 2010; Ramalingam, 2010; Singh, *et al.,*2012) explained the benefit of the different parts of the plant from root to leaf ,seed to shell and the stem in detail focusing on both its medical and nutritional values. So that It is considered as one of the world's most useful trees (Mark, 1998 ; Edwards et al., 2000; Hsu, R.et.al., 2006) and has often been labeled as a "miracle tree" (Donovan, P. 2013, Hupston, F, 2013).

Moringa is a drought-resistant pioneer species, it grows in areas with annual average rainfall between 750 and 2250 mm preferring well drained sandy soils, Moringa is claimed to adapt easily to various soil conditions. However, it is very sensitive to water logging and frost (Rams, 1998; Fuglie, L.J, 1999; and Babu, S.C, 2000; Hsu, R.*et al*., 2006 and Kadashi Y.D, 2008). *Moringa stenopetala* grows wild in elevations between 1,000 and 1,800 m (Mark, 1994) but it will grow as high as 2200m and as low as 300m in Ethiopia and It is an extremely fast-growing tree and continued to grow during the exceptionally long dry season (Ethiopian tree foundation fund, 2004). *Moringa* grows best in well-drained soils with pH of between 5.0 and 9.0 and in temperatures between 25°c and 48°c and -1°c to 3°c (Nautiyal and Venkataram, 1987; Coote *et al*., 1997). It can survive drought as well as frost (Palada and Change, 2003, Crosby, 2007). It prefers alluvial sandy soils though it can grow in a variety of soils apart from stiff clays (Coote *et al*., 1997) the tree grows even in marginal soils and with very little care (Morton, 1991; Folkard and Sutherland, 1996).

2.1. Constraints for production

Although the production for the alternative products are very different there is one constraint to development that is common to them all and that is that they are all considered to be 'new' products which influences the awareness perception and interest to purchase the plant, Moreover, financial, research and development, awareness, perception and interest, regulatory approval are also significantly affecting production and marketing of Moringa, in addition to perishabilty of the plant, price/ quantity risks, seasonality, product bulkiness (FAO, 1986, Non-necke, 1989; *Sutherland, J.P.et.al., 2001*; cited on Abay, 2007). Furthermore, lack of market access, market information, and many biological factors (Weinberger and Lumpkin, 2005), lack of awareness on product packaging, handling, transport labeling and processing equipment(Bezabih and Hadera.,2007), lack of knowledge on efficient production practices; competition for land with other food crops; source of seed; shortage of water for irrigation during dry months; low yield levels and theft are the major finding that previous studies shows in different countries.

3. Material and Method

3.1. Description of the Study Area

Dire Dawa city is located in the eastern part of Ethiopia between $9^0$27'N and $9^0$49'N latitude and $41^0$38`Eand $42^0$19`E longitude. The total area of the administration is 128,802 ha, of which nearly 97.73% accounts for the land size of the rural areas, while the remaining 2.27% covers the land size of the urban areas of the administration with The total estimated population of 342, 827. The Administration is characterized by only two broad Agro-Ecological Zones (Kola an, its altitude ranging from 960 m.a.s.l in the North East to 2450 m.a.s.l in the Southwest, using the 1500m contour as a line of separation, the Kolla (below 1500m) and Woyina Dega (above 1500m) has been recognized and the Administration has 9 urban kebeles and 38 rural kebeles

(Mohammed *et al*, 2011).

3.2. Sampling, method

The Study implemented mixed research approach to triangulate data and in order to map out the potential of Moringa production and marketing in the urban and rural kebeles of Dire Dawa city Administration through identification of awareness, perceptions and interest to produce and use of the plant for different purposes. Meanwhile, in this study the target population were the urban and rural communities of the administration and decided to consider only respondents who are over the age 18-years-old. In this regard there were 61,763 households as target populations in the rural kebeles of Dire Dawa Administration (CSA, 2012/13).

$$n = \frac{N}{1+N(E^2)} \text{ (www.cengage.com/highered)}$$

$$398 = \frac{61763}{1+61763\,(.05^2)}$$

A total of 398 copies of printed questionnaires were distributed to each selected rural kebeles proportional to their population number in terms of households at each kebele of rural area who were engaged in farming activities mainly focusing on dry (kola) areas of rural kebeles. consequently, the survey results in the selection of seven rural kebeles Addada , Balewa , Harele ,Jeledesa , Legahare , Lege Mirga and Melka Jebidu

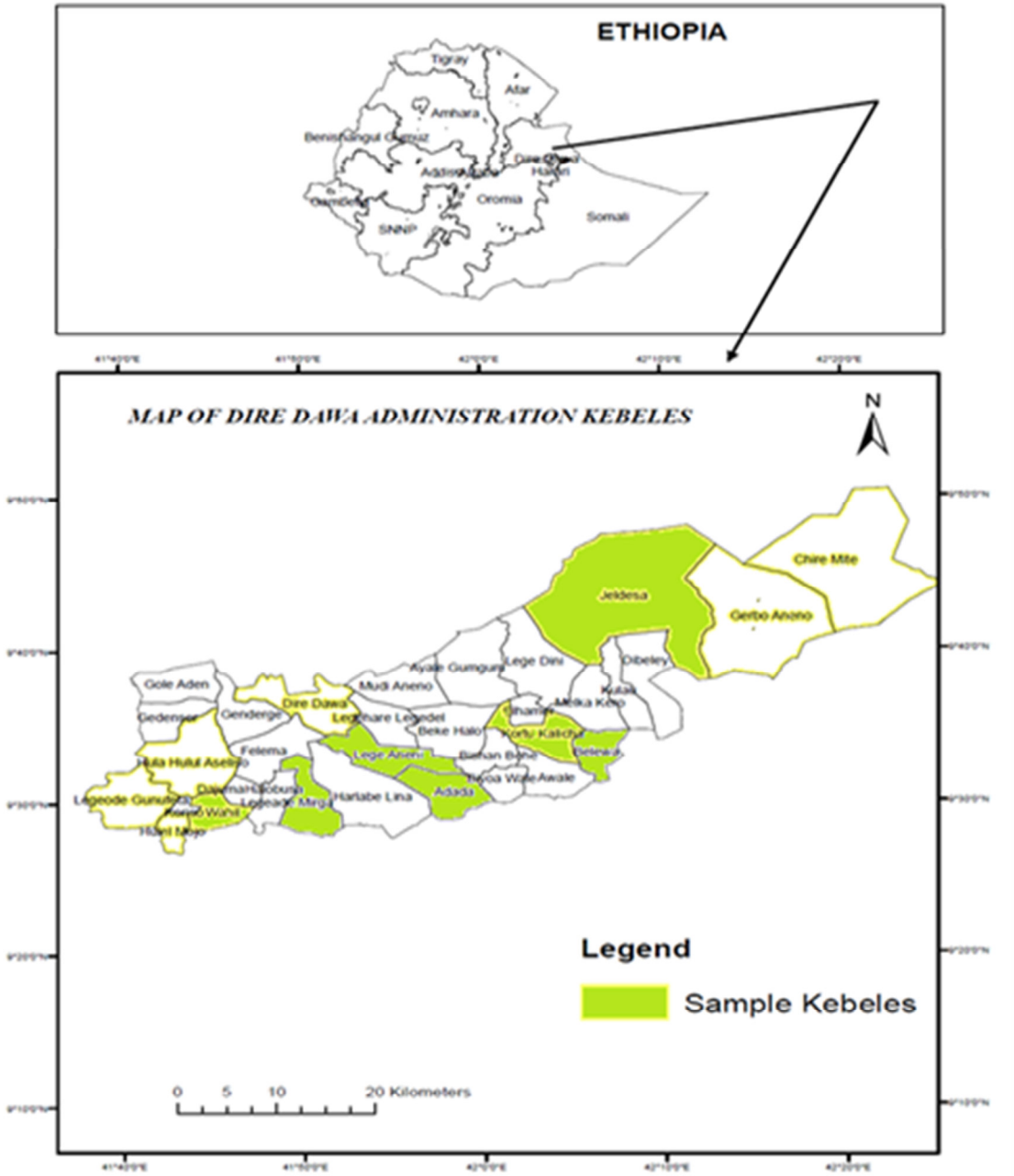

Figure 1. Map of the selected kebeles **Data collection procedure**

Linkert scale questionnaires were developed and Data collection was carried out between May to June, 2016. Intercept survey approaches were used to collect data from farmers at different geographical areas personally by the researchers as well as helps were obtained from data collectors and both descriptive and inferential statistical techniques were used to analysis the data using SPSS software package Version 21.

3.3. Data presentation analysis and interpretation

3.3.1. Data presentation

A total of 362 respondents were selected for this study. Males were dominant representing (75.4 %) 273 of the respondents. ; the majority (51.7%) 187 of them were between the age of 25-34 where as 106 of them were between the age of 34-44 and of the respondents who participated in the survey (40.3%) 146 of them completed secondary school whereas (22%) 80 of them completed primary level and the remaining 59 (16%)of the respondents attended adult education and 52 of them have no any formal education and the result also shows that the majority (98.4%) of the respondents were engaged in mixed farming activities.

Table 4.1. Socio-demographic profile of the respondents

	Characters	Frequency	Percent
Gender	Female	89	24.6
	Male	273	75.4
	Total	362	100.0
Age	25-34	187	51.7
	35-44	106	29.3
	45-54	50	13.8
	>=55	19	5.3
	Total	362	100.0
Education	No formal education	52	14.4
	Adult education	59	16.3
	Primary level	80	22.1
	Secondary level	146	40.3
	Certificate	19	5.2
	Diploma and above	6	1.7
	Total	362	100.0
Farming	Mixed	357	98.6
	Pastoralist	5	1.4
	Total	362	100.0

Source survey data 2016

3.5. Statistics Indicating level of knowledge and interest to produce the plant in large

The levels of awareness on the benefit of the plant for various purposes and interest on the plant for commercial purpose and medical purpose and knowledge on the marketability of the plant were measured by questions/statements given under part II of the questionnaire. The statements were prepared in such a way that the respondents could rate the level of their knowledge, and interest on the plant, and Liker scale was used to measure the level of awareness and interest to produce the plant.

Table 4.2. Level of awareness and interest to produce the plant

	N	Mean	Std. D.
Knowledge on the benefit of Moringa plant for Fertilizer	362	4.5359	.78425
Level of awareness on the benefit of Moringa plant for Disease Prevention	362	4.5276	.64508
Knowledge on the benefit of Moringa plant for Water Purification	362	4.5249	.73736
Knowledge on the benefit of Moringa plant for Insecticide and fungicide	362	4.5166	.52737
Knowledge on the benefit of Moringa plant for Honey Production	362	4.5028	.53285
Knowledge on the marketability potential of the plant	362	1.3729	.75293
Knowledge on the benefit of Moringa plant for Traditional medicine	362	4.0773	.97024
Knowledge on the benefit of Moringa plant for Erosion Control and wind Barrier	362	4.3343	.69537
Knowledge on the benefit of Moringa plant for Alley Cropping	362	3.3122	.71340
Interest to plant for commercial purpose	362	1.6215	.63410
Knowledge uses as animal food and increase productivity	362	1.5691	.96586
Level of awareness on the benefit of Moringa plant for food and nutrition	362	1.4613	.79465
Interest to plant for traditional medicine	362	1.4033	.52924
Valid N (list wise)	362		

Source survey data 2016

The mean scores in table 4.2 shows that there is a very high level of awareness on Moringa benefit for fertilizer and its diseases prevention with a mean value of 4.5359 and 4.5276, respectively; whereas on the benefit of the plant for water purification and as pesticide to kill insect pests had a mean value of 4.5249 and 4.5166, respectively. Respondents had also an awareness on the benefit of the plant for honey production with a mean value of 4.5028, though they did not believe on the marketability potential of the plant with a mean of 1.3729 , Generally, there was low mean on the interest of producing the plant for commercial purpose.

4.3. Correlation between level of awareness, interest and knowledge on the marketability of the plant

		Level of awareness on the benefit	Interest to plant for commercial purpose	Interest to plant for traditional medicine	Knowledge on the marketability potential
Awareness On The Benefit Of Moringa Plant	Pearson Correlation	1	.144**	.009	.154**
	Sig. (2-tailed)		.001	.000	.001
Interest to plant for commercial purpose	Pearson Correlation	.144**	1	.233**	.336**
	Sig. (2-tailed)	.005		.000	.000
Interest to plant for traditional medicine	Pearson Correlation	.009	.233**	1	-.031
	Sig. (2-tailed)	.000	.000		.000
Knowledge on the marketability potential of the plant	Pearson Correlation	.154**	.336**	.031	1
	Sig. (2-tailed)	.003	.000	.000	

**. Correlation is significant at the 0.01 level (2-tailed).N =362
Source survey data 2016

As table 4.3. shows, there is a weak correlation between their interest to grow the plant for commercial purpose and their level of awareness with correlation value of r=.144, , the correlation between their interest to plant for medical purpose and level of awareness on its benefit has weak relationship (r=.009) whereas the correlation between knowledge on the marketability potential of the plant with the interest to plant for commercial purpose has a relatively strong relationship(r=.336).

4.4. Analysis of variances for Knowledge vs. interest to plant Moringa.

		$\sum^2$	df	Mean Square	F	Sig.
Knowledge on the benefit of the plant	Between Groups	2.763	3	.921	.978	.000
	Within Groups	337.072	358	.942		
	Total	339.834	361			
Knowledge on the marketability potential of the plant	Between Groups	4.769	3	1.590	2.847	.000
	Within Groups	199.886	358	.558		
	Total	204.655	361			
Interest to plant for traditional medicine	Between Groups	1.889	3	.630	2.272	.001
	Within Groups	99.227	358	.277		
	Total	101.116	361			
Interest to plant for commercial purpose	Between Groups	1.675	3	.558	1.393	.005
	Within Groups	143.477	358	.401		
	Total	145.152	361			

Source survey data 2016

Of all the information presented in the ANOVA table , the major interest of the researchers were to focus on the value located in the "Sig." column, this is the exact significance level of the ANOVA. It shows that the values between groups in all cases were significant because all are less than .005.

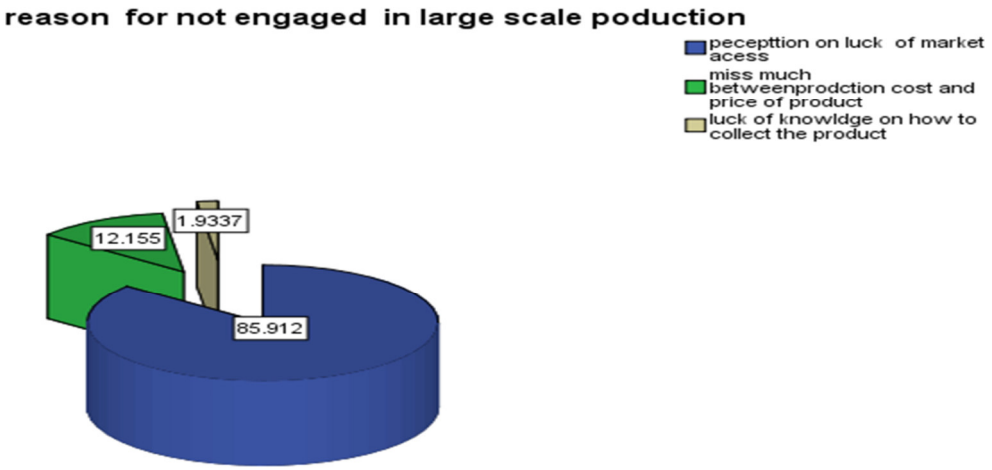

Figure 4.1. Reasons for not engaged in large scale production

As figure 4.1. shows (85%) of the respondents responded that they were not engaged in the production of the plant for market because they believe that there is no market access to the product and no demand for the product whereas, 12% of the respondents perceived that production cost and market price varies significantly and 1.9% of them did not have the knowhow to collect the product.

Table 4.5. For which reasons have you used the product /plant you can have multiple answer

Attributes	Frequency	Percent	Ranks
Treatment of headaches and fever	352	97.2	1
For treatment of, Diarrhea and intestinal worms	295	81.5	7
For treatment of wound healing	316	87.3	6
for treatment of skin infection and prevision	286	79.0	9
For treatment of Respiratory disorders	321	88.7	4
For treatment of malaria	329	90.9	3
For treatment of goiter and swelling on the head	338	93.4	2
For treatment of Catarrh	319	88.1	5
For solving problem relate with Pregnancy	268	74.0	10
For treatment of Pain in joints ,over all Sores and Sprain problems	294	81.2	8

Part II. Qualitative analysis

4.1. Interview analysis

Generally, the interview conducted with Agriculture and Rural development bureau and Environmental Protection Authority officials indicated that there is no such an understanding of the benefit of the plant and made little effort to raise the awareness of the people in the study area , they seldom gave training for the small and medium enterprises on how to cook the plant but not working on the vertical backward integration focusing on how to produce, process and provide to the market. However, the level of awareness on the use of the plant in rural kebeles is rather promising though they use it for livestock food and as shade tree in most cases.

4.2. Observation analysis

The study identified the following major constraints for production of Moringa for commercial purpose this are;

Lack of knowledge on efficient production practices: Field observations revealed that Moringa was mostly grown scattered around homesteads in association with fruit trees in family orchards without irrigation and in home gardens where trees were grown on the edges. There is no rural kebele in Dire Dawa Administration where Moringa was intercropped with different crops in the farm areas. Though the tree would benefit crops from the shade, by reducing evapo-transpiration and replenish nutrients through addition of organic manure from leaf litter which would reduce the need to apply inorganic fertilizers (Prat *et al*., 2002). The farmers lack efficient production systems, which make use of improved models. They still use their indigenous cultivation practices to grow all plants in their kebeles. Thus the cultivation of Moringa needs to evolve to such an extent that growers can focus on commercial production.

Competition for land with other food crops: Growers had small portions of land under Moringa production only in there yard and fencing purposes the highest proportion of observed growers had less than 5 trees per homestead under Moringa production.

Source of seed:- Farmers had difficulties in the procurement of the seed as well as the seedlings because it is costly to have the plant reaching 15 to 50 birr per seedlings on the area and no governmental or nongovernmental

organization that currently working on duplication and distributing of the seed at all but few private growers are selling seedlings in the local market day seasonally but little was sourced from private nurseries due to financial constraints. According to the respondents, seedlings from private nurseries were expensive too.

Also Forestry office contributed very little as sources of planting material due to reduced mobility of its staff in offering extension services and operational constraints. This reduced their ability to carry out their institutional mandate. Finally, as per our observation low yield levels and pests and diseases were also the major constraint that were observed in the field visit and open discussion with farmers.

Opportunities of Moringa production

There are many opportunities that smallholder growers can grab considering the difficult agro-ecological conditions that prevail to secure a better livelihood from Moringa farming.

Transformation of barren land: Most smallholder growers live in marginal areas with lots of barren land near their fields or homesteads. Moringa can utilize marginal land as it is resilient to harsh growing environments, including drought and poor soil quality. Competition for land with other food crops will be reduced and land will be utilized effectively for both livestock and human food requirements enhancing food security. This will promote climate change resilient agricultural systems and will be a solution to environmental problems where the administration is known for its arid and difficult climatic condition and mountainous land escape.

Increased livelihood security and diversification: The tree is very fast growing, with normal growth ranging from 3-5 meters per year if left uncut. Growers will quickly realize benefits from the tree in a very short period for both human and livestocks. With Moringa tree parts, retaining high percentages of vital nutrients throughout the year (Melesse *et al.*, 2012) it is an advantage for livestock production, which experiences great seasonal variations in quality and quantity of forage. Moringa thus can be used as source of inexpensive protein to supplement poor quality forage in the dry season. This will help sustain and enhance livestock production systems and boost livelihoods.

Linkage to markets and value addition:- If Developmental agents, and institutions that are aimed at reducing food insecurity or promote food self-sufficiency can work on value addition of Moringa products by organizing unemployed young people to work on degraded mountainous area of the administration. The government and development agents can help by opening up markets and also explore export opportunities for Moringa products as growers need an assured market for their products for them to produce Moringa as a cash crop as they did for *coffee.* Communication of market information should be done clearly to farmer so that they can plan and implement tree growing strategies that increase productivity.

Water purification: - Moringa seed can also be used as a water purifier both for the urban and rural inhabitants (Ali *et al.,* 2010) and the use of the seed can improve the availability of clean water to both rural and urban areas in a country which potentially will reduce exposure to waterborne diseases after using untreated water especially at household level.

***Industry raw materials*:** different studies shows that the plant can be used for production of oil, perfume, medicine and lubricant and these opportunities can be promoted on the area where the environment is suitable for production of the plant.

4.3. Secondary data analysis

Climate*: Dire Dawa has a hot semi-arid climate (Köppen climate classification BSh). It's a warm and dry climate with a relatively low level of precipitation. The mean annual temperature of Dire Dawa is about 25.9 °C (78.6 °F). The average maximum temperature of Dire Dawa is 32.8 °C (91.0 °F), while its average minimum temperature is about 19.0 °C (66.2 °F). The region has two rain seasons; that is, a small rain season from March to April, and a more pronounced rain season that extends from August to September. The aggregate average annual rainfall that the region gets from these two seasons is about 583 mm (22.9 inch).*

Table 4.6. Climate Data for Dire Dawa Administration

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Average high °C (°F)	29.4 (84.9)	31.5 (88.7)	34.1 (93.4)	32.7 (90.9)	34.8 (94.6)	35.9 (96.6)	34.3 (93.7)	32.9 (91.2)	33.6 (92.5)	33.6 (92.5)	31.6 (88.9)	29.6 (85.3)	32.83 (91.1)
Daily mean °C (°F)	22.0 (71.6)	24.1 (75.4)	26.6 (79.9)	26.5 (79.7)	28.4 (83.1)	29.5 (85.1)	27.9 (82.2)	26.5 (79.7)	27.1 (80.8)	26.2 (79.2)	24.0 (75.2)	22.1 (71.8)	25.91 (78.64)
Average low °C (°F)	15.5 (59.9)	16.6 (61.9)	19.1 (66.4)	20.4 (68.7)	22.3 (72.1)	22.8 (73)	21.2 (70.2)	20.2 (68.4)	20.7 (69.3)	18.7 (65.7)	15.9 (60.6)	15.0 (59)	19.03 (66.27)
Average rainfall mm (inches)	16.6 (0.654)	55.2 (2.173)	61.6 (2.425)	74.8 (2.945)	45.5 (1.791)	15.6(0.614)	83.9 (3.303)	87.7 (3.453)	39.8 (1.567)	24.8 (0.976)	59.9 (2.358)	17.8 (0.701)	583.2 (22.96)
Average relative humidity (%)	43.9	49.8	45.0	47.0	39.3	37.6	41.4	45.1	39.7	31.3	39.1	42.6	41.82
Mean monthly sunshine hours	294.5	265.6	257.3	246.0	244.9	204.0	220.1	244.9	234.0	248.0	282.0	300.7	3,042
Mean daily sunshine hours	9.5	9.4	8.3	8.2	7.9	6.8	7.1	7.9	7.8	8.0	9.4	9.7	8.33
Source #1: *Normales et records pour la période 2000-2016 à Dire Dawa* ,[22]													
Source #2: *Klimatafel von Dire Dawa (Diredaua), Provinz Harar / Äthiopien* for sunshine hours,													

Dire Dawa Administration with such a climatic condition supported with sandy soil, is conducive for the production of the moringa for both commercial and home consumption and also possible to use it for creating socio economic benefit such as for tackling youth unemployment.

5. Conclusions and recommendations

5.1. Conclusions

Despite the potential of Moringa, its production has remained limited due to, lack of awareness about its marketability potential and benefit, lack of efficient cultivation practices, seed supply, and marketing problems. It is of no doubt that Moringa may constitute great economic and strategic value to the smallholder farmers of Dire Dawa rural administration if they implement systematic tree management and marketing programmes. The current practices being used by the farmers need to be altered in order to promote their production. Moringa has a potential of becoming the lifeline of the small holder growers in Dire Dawa Administration given their history of failed crops and poor and mountainous land escape.

5.2. Recommendation

To fill those gaps stated in the discussion section based on the analysis, Small and medium enterprises, governmental and nongovernmental agencies need to work together to use the plant for socio economic development and to support the Climate Resilient Green Economy of Ethiopia. As the topography of the study area shows the soil is sandy, and the climate is semi-desert with degraded mountainous landscape where resources are intensively used by the residents if unemployed youths as well as rural dwellers engaged on cultivating of the plant, it will have a potential of creating job opportunities by selling the leaf through adding value, and honey production and animal husbandry. Finally, it can be used to cover deforested areas within the region.

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