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Research Article

Production and Utilization of Moringa by Farmers in Limpopo Province, South Africa

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Abstract

Background and Objective: *Moringa oleifera* (*M. oleifera*) is an important and fast growing tree, in the tropics, it is recognized for its medicinal, industrial, human and livestock nutritional values. In the Limpopo province of South Africa, Moringa is mainly grown by a limited number of farmers in the backyards and spaces around homesteads. This study is aimed at identifying Moringa growers in the province and to mass information on their perspective knowledge on production and management of the tree as well as the commercial's production potential. **Materials and Methods:** The survey was conducted from November, 2013-September, 2014 in five districts of the Limpopo province. Focus group discussion, questionnaires and field observations were used for data collection. A total of 150 Moringa growers formed part of the focus group and a questionnaire was administered to only 31 farmers producing Moringa within an area of 0.25 ha or more. Collected data were analyzed using the SPSS version 22. **Results:** Results from the survey indicated that there are potential Moringa farmers in all the districts of the province, with the intension to commercialize the tree. Majority of growers were found in Vhembe district (38.7%) and the least in Waterberg and Sekhukhune districts with 9.7%. Male growers were dominant by 64.5% producing mainly in mixed farming system. The highest percentage of farmers, grow Moringa in 0.25-1.0 ha and have been producing the crop for the past 2 years were found in Mopani and Vhembe districts. In general, most farmers grow Moringa for leaf processing into powder (96.8%) that is sold locally. **Conclusion:** This study revealed that most farmers are willing to expand the Moringa production, however, the major challenge of effective market access need to be addressed. This is critical if the crop is to be incorporated in the smallholder farming system for income generation and food security.

Key words: Survey, *Moringa oleifera*, commercialization, food security, smallholder farming system

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Moringa oleifera is an important fast growing tree species which can grow up to 6-7 m within a year under low rainfall of at least 400 mm/annum¹. The Moringa tree is also known for its resistance to drought and diseases, as well as the adaptation to harsh growing conditions which most trees cannot withstand². Moringa is a fairly new crop to farmers in the Limpopo province and is mainly grown at the backyards for household purposes. There is limited information on farmers' perceptions on production, utilization, processing and commercial production of this tree crop. Currently, many areas of South Africa, the Limpopo province in particular, experience significantly prolonged dry seasons which negatively impact the agricultural sector³. Limpopo province has an average annual rainfall of 500 mm and the threshold of average rainfall agriculture is 250 mm/annum³. The province also experiences extremely high temperatures with continuous records of exceeding 30°C during the growing season. During drought seasons, production of grain crops under dryland conditions becomes almost impossible. Food security is thus threatened, given the fact that majority of the farmers in the province produce these crops under rain fed conditions. As a result of unreliable rainfall over the past years, it is important for farmers in Limpopo province to diversify the crops they grow in order to counteract the challenge of drought across the province⁴. Cultivation of Moringa under harsh conditions, such as experienced in the Limpopo Province, is therefore recommended since it will serve as an important contributor to food quality due to its high nutritional value in the leaves and tender green pods. Moringa products have a high commercial value thus making its cultivation a potential cash earning opportunity that can enhance the livelihoods of the smallholder farmers in the province.

Moringa has been cultivated in many areas of the tropics mainly for medicinal, industrial and nutritional purposes. In many tropical areas, there are major nutritional limitations of feed for ruminants with natural feeds having poor quality and quantity, which can lead to deficiency of energy and protein^{5,6}. This challenge of feed shortages for ruminants is exacerbated during the dry seasons, when natural pastures are low in protein and energy. Several studies revealed that Moringa has a high nutritional content and can serve as a good source of feed supplement^{7,8}. Therefore, Moringa, as a source of protein, will improve the livestock performance and supplement the balance of other nutrients available⁹.

Moringa leaves contain high concentration of crude protein and other essential elements¹⁰. The seeds of Moringa

are also reported to be important for human consumption as an edible oil and seedcake for soil fertility amelioration. Seeds contain about 35-40% oil which can be used in many ways besides human consumption, including lubrication of delicate machinery, manufacture of perfume and hairdressing⁹. The oil has a high potential market value and could be a source of income for the producers¹¹. Seed cake is a good source of fertilizer, however it is not advisable to use the seed cake for livestock feed as it contains alkaloids and saponin¹².

Farmers in Limpopo province grow Moringa for various purposes and management strategies. The objectives of the study were to establish the extent of farmers involvement in growing Moringa in the five districts of the Limpopo province, and to establish the current status of the crop in the smallholder farming sector focusing on farmers knowledge on general production and uses, as well as the marketing of its products and its potential for income generation.

MATERIALS AND METHODS

Study sites: A survey was conducted from November, 2013-September, 2014 in all the five districts of the Limpopo province (23.4013°S, 29.4179°E), namely Capricorn, Sekhukhune, Waterberg, Mopani and Vhembe (Fig. 1). Limpopo province falls within the summer rainfall region of South Africa, with the Western part being semi-arid and the eastern part largely sub-tropical. Typical rainfall for the province ranges from 200 mm in the hot dry areas to more than 1500 mm in the high rainfall areas, with most of it happening between October and April¹³. The province experiences the highest temperature during the months of October-March. Temperatures peak in December and January at about an average of 25°C. The lowest temperatures occur in July with an average of 15°C with the average annual temperature being about 22°C¹⁴.

Participants and data collection: The study used both the quantitative and qualitative methods. A structured questionnaire was used to gather all the information required, by interviewing both the commercial and smallholder farmers who are growing Moringa in the Limpopo province. Focus group discussions and field observations were also made to validate the data obtained from the farmers and to assess the situation on the ground. Open ended questions were included in the questionnaire to enable discussions on production challenges that the farmers face.

Participating farmers were identified with the assistance of Limpopo Department of Agriculture and during the Moringa Development Association of South Africa (MDASA)

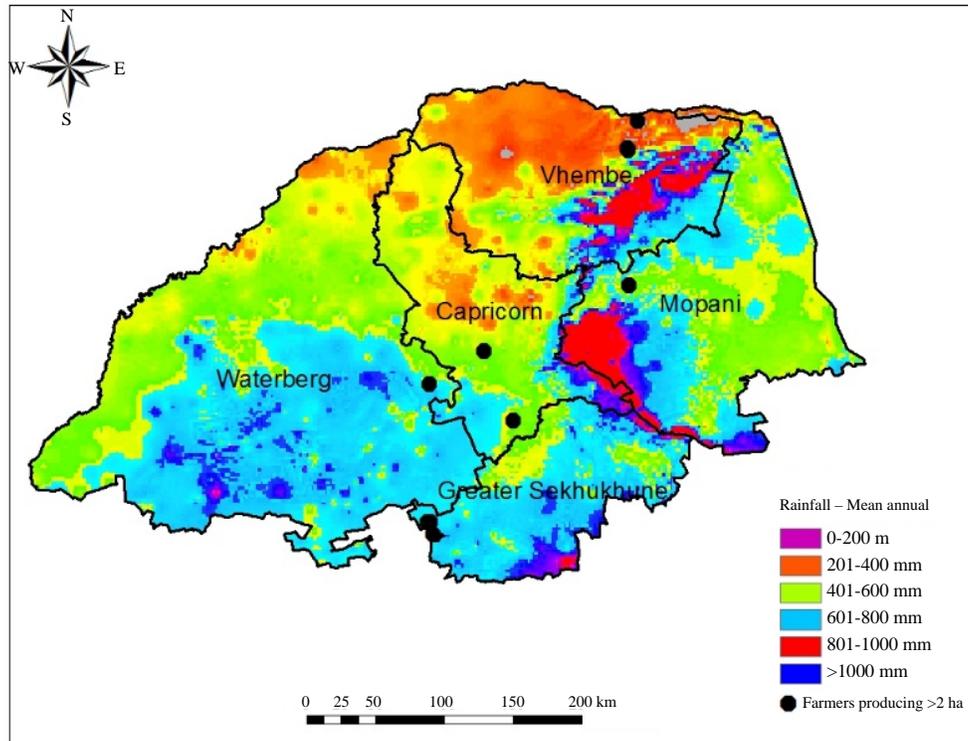


Fig. 1: Limpopo province map with legend showing districts, mean annual rainfall and locations of farmers who cultivate more than 2 ha of Moringa

launch, held on the 24th of February 2014 in Lebowakgomo. There were 150 farmers who attended the meeting. During that meeting it was realized that some farmers produced Moringa in very small areas as well as at the backyards. A purposive sampling technique was used to select the farmers who produce Moringa on at least 0.25 ha. A total of 31 farmers were identified and interviewed for the reporting purpose of this study. Data collected included gender, farm size, farming systems, management practices, leaf production, processing methods and marketing, as well as production constraints.

Statistical analysis: Data from the survey were analyzed statistically using the Statistical Package for Social Sciences (SPSS) version 22 (IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp)¹⁵. Descriptive statistics were used to achieve the study's objectives and to generate frequencies of response. The Pearson's chi-square test was conducted to determine the significance of associations at the probability level of <0.05. The locations where farmers produce Moringa on fields in excess of 2.0 ha and mean annual rainfall experienced from the locations as indicated by Fig 1.

RESULTS

Production of Moringa in Limpopo province: The chi-square test showed significant differences ($p = 0.001$) between the districts on the number of farmers growing Moringa in the Limpopo province. It was previously known that Moringa is widely grown in Sekhukhune district but contrary to that, the results of this study (Fig. 2) showed that most production takes place in Vhembe district with 38.7% of the smallholder farmers growing on at least 0.25 ha of the crop. Mopani and Capricorn districts follow with 22.6-19.4%. Sekhukhune and Waterberg have the least numbers of farmers producing Moringa on land areas exceeding 0.25 ha at 9.7% each. The majority of farmers in Sekhukhune produce at the household level where they have less than 5 trees in their backyards.

Gender influence on Moringa production in Limpopo province: Amongst the producers, this survey revealed that males are the dominant producers of Moringa in the Limpopo province accounting for 64.5% of the farmers ($p = 0.027$).

Farming systems: This study revealed that about 64.5% of farmers grow Moringa under mixed farming systems which

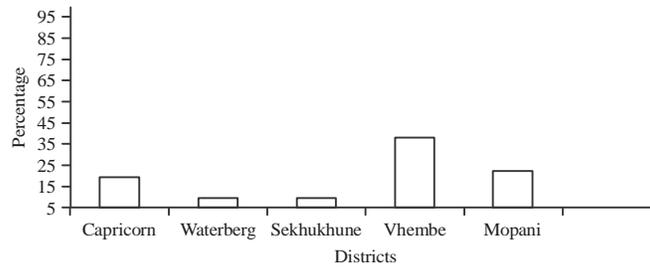


Fig. 2: Distribution of farmers who cultivate Moringa (>0.25 ha) in different districts of the Limpopo province

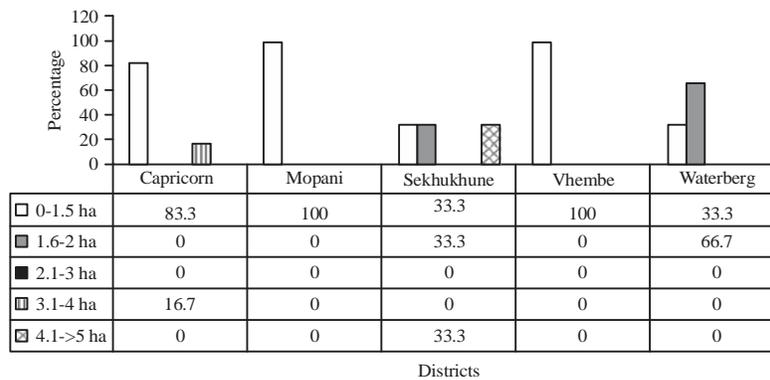


Fig. 3: Farmer land area devoted to Moringa production in the five districts of the Limpopo province

include Moringa, other crops and livestock. Approximately 26.0% grow the crop under polyculture and only 9.7% of farmers were found to produce Moringa in pure stands.

Size of landholdings of Moringa farmers: The study indicated that farmers who produce Moringa in the province own diverse land sizes ranging between 0.5-63.0 ha/farmer. There were significant differences ($p = 0.000$) between the total farm sizes owned by farmers and between the districts. The study further revealed that 38.9% of farmers own a small land area of 0.25-1.0 ha, followed by 12.9% who own between 1.5-3.0 ha, while the remaining 48.1% of farmers own bigger lands of between 3-63 ha. Among the 48.1% farmers with large lands, two farmers own 42 and 63 ha, respectively.

Total farm size devoted for production of Moringa: Analysis from this study showed a significant difference ($p = 0.000$) among the land devoted to Moringa in the different districts. The study revealed that the land area currently allocated to Moringa does not exceed 6.0 ha. Majority of farmers grow Moringa at an area in the range of 0.25-1.5 ha across all the districts. However, the Capricorn, Sekhukhune and Waterberg districts were found to have farmers who cultivate the tree on areas exceeding 1.5 ha (Fig. 3).

Farming experience in Moringa production: More Moringa farmers are new in the agro-enterprise having been on the production only for the last 2 years as shown in Fig. 4. Majority of these are in Sekhukhune district. However, the Mopani district, was found to have a large number of farmers who have been cultivating the crop for more than 6 years. More farmers started planting Moringa after realizing its nutritional and health benefits as well as possibilities of income generation from its products. These results (Fig. 4) show that the widespread production of Moringa in the Limpopo province is still at the developmental stage.

Farmers' knowledge on management practices of Moringa: The study revealed that 74.2% of farmers apply both organic and inorganic fertilizers to enhance the growth of Moringa while 25.8% grow the tree under the natural conditions. Among the farmers who apply fertilizers, 61.3% use organic fertilizer particularly livestock manure, 12.9% use inorganic fertilizer while the other 25.8% of farmers allow the trees to grow naturally. Approximately 39.0% of the inorganic fertilizer users indicated that they collect the fertilizer from their own animal barn. The other group of farmers (22.6%) acquired the organic fertilizer through donation from the surrounding villages. About 12.9% of those farmers who use the inorganic fertilizers obtain them through purchase.

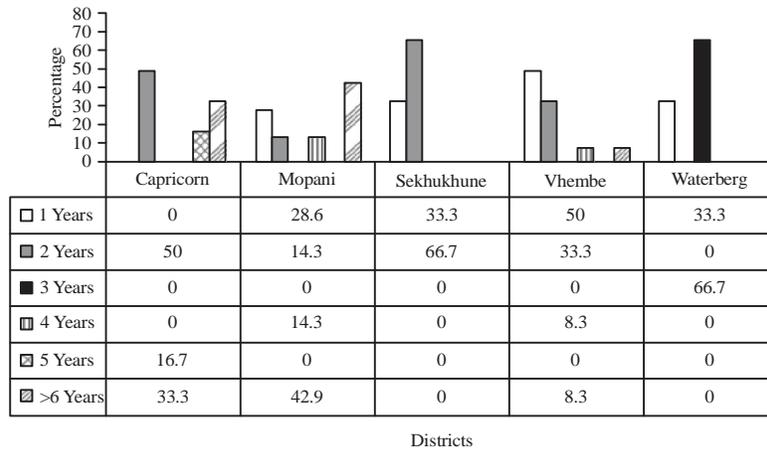


Fig. 4: Farmers' experiences in Moringa production in the five districts of the Limpopo province

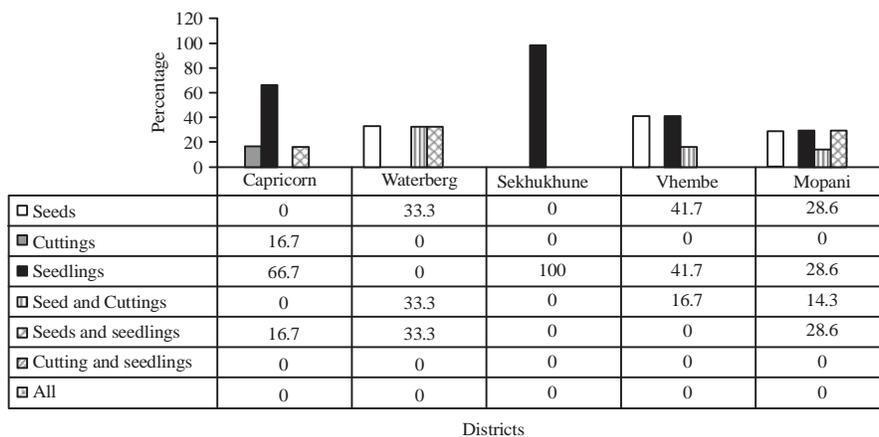


Fig. 5: Propagation methods preferred by farmers in the five districts of Limpopo province

Farmers in four districts prefer to use only seedling, Waterberg district uses seeds, a combination of cuttings and seedlings. The results showed a significant relationship ($p = 0.002$) between the districts and the propagation methods. Majority of farmers preferred to plant using the seedlings relative to other methods (Fig. 5).

Farmers' perceptions on management practices of Moringa cultivation across the five districts of Limpopo as shown in Table 1. The study indicated that generally 83.9% of farmers in the province preferred to plant the trees in rows whilst 16.1% of farmers plant at random without any spacing. It was observed that farmers who plant in rows used various inter-row spacing with majority (45.2%) maintaining 1-2 m between the rows (Table 1). Few farmers (6.5%) plant a high population of trees at a space of 0.5 m between the rows whereas 25.8% plant at low density with an inter-row spacing of 3-4 m.

All the farmers interviewed mentioned that they prune their trees when necessary in order to maintain the height that

eases leaf harvesting. Pruning height was significant with the highest proportion of farmers (45.2%) preferring to maintain the trees at 2.0 m height followed by 25.8% of farmers who maintained their trees at a 3.0 m height. Few farmers (16.1%) prune the trees at 1 m, while a lesser proportion of 6.5% each maintained the trees at 1.5-2.5 m (Table 1).

Planting season: Most farmers in the Limpopo province plant Moringa throughout the year except during winter. There were significant differences ($p = 0.000$) between the districts and planting seasons. Majority of farmers in Mopani district (71.4%) preferred to plant in spring while 75% of farmers from Capricorn district preferred to plant in summer. However, in general, the highest proportion of farmers (48.4%) plant Moringa during spring and 38.7% plant the tree in summer. At least 12.9% of farmers plant the tree in autumn.

Harvesting duration: Farmers indicated that they harvest the tree foliage when necessary, ranging from 3-12 months after

Table 1: Cultural practices used by farmers in Moringa production (N = 31)

Management practices	Frequency	Percentage (%)	Pearson chi-Square Value (χ^2)	
Planting spacing				
Random	5	16.1	6.01**	
In rows	26	83.9		
Spacing between the rows (m)				
Random	5	16.1	28.09**	
0.5	2	6.5		
1.0	7	22.6		
2.0	7	22.6		
2.5	1	3.2		
3.0	4	12.9		
4.0	4	12.9		
5.0	1	3.2		
Spacing between the plants (m)				
Random	5	16.1	19.01**	
0.5	2	6.5		
1.0	6	19.4		
2.0	6	19.4		
3.0	6	19.4		
4.0	5	16.1		
5.0	1	3.2		
Maintenance height				
1.0	5	16.1		15.27**
1.5	2	6.5		
2.0	14	45.2		
2.5	2	6.5		
3.0	8	25.8		
Total	31	100.0		

**Significant at 0.01 level, *Significant at 0.05 level

planting. The study further revealed that approximately 35.2 and 32.3% of farmers harvest the trees at 5 and 6 months after planting, respectively, whereas 26.0% of the farmers carry out harvesting when the trees are between 7-12 months after planting. A very strong relationship between the harvest duration and the districts ($p = 0.001$) was observed, whereby half of the farmers in Vhembe district (50%) commenced to harvest within 6 months after planting followed by Mopani district with the duration of 5 months after planting. Only a small proportion (6.4%) of farmers harvested the trees at an earlier stage of growth within 3-4 months after planting, but this occurs when favourable weather conditions prevails.

Seed and leaf yield production: The highest proportion of farmers preferred to harvest the leaves rather than harvesting the seeds. Overall, 55% of farmers in the Limpopo province harvest the leaves, while there are some farmers who grow the tree solely for the seeds (Fig. 6). There was no significant difference on the seed yield among the districts. Generally, the study revealed that 54.8% of farmers in the Limpopo province grow Moringa with the purpose of harvesting the leaves. With this objective, the trees are maintained at a vegetative stage and pruned frequently to avoid seed production. For the

farmers who grow the tree for seed production, 25.8% produce seed yield of less than 50 kg ha⁻¹, followed by 12.5% of farmers who produce between 50-100 kg ha⁻¹. The least proportion (6.5%) of farmers produce more than 100 kg ha⁻¹. Farmers have no idea of leaf yield except harvesting from their fields. It was indicated earlier that farmers harvest the crop when necessary. This could be the reason why farmers are unable to quantify their leaf yield production. Some farmers retain bulk seeds, that they have harvested from several seasons and combine them for storage. Access to weighing balances may be a formidable challenge, for farmers who belong to these groups.

Utilization: Farmers indicated that they use Moringa in several ways, such as: A source of income, a high nutritional supplement for good health, food security, immune booster, livestock feeding, water purification, medicinal purposes to prevent many diseases and energy booster.

Moringa processing: The study indicated that there are 96.8% farmers who produce Moringa in all the districts of the province with an aim of processing the leaves into powder primarily for marketing to a limited extend and other uses. A

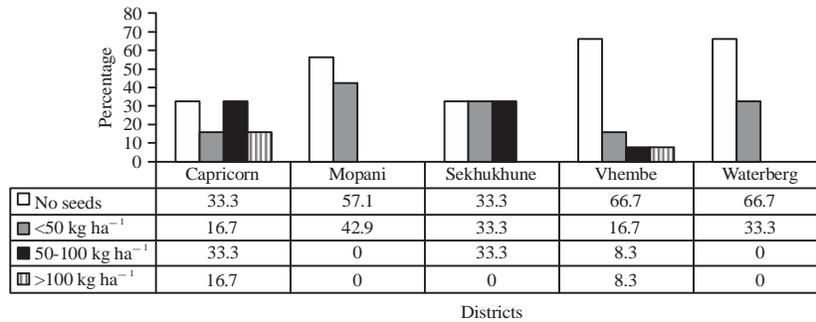


Fig. 6: Moringa seed yield produced by farmers in five districts of the Limpopo Province

Table 2: Marketing approaches of Moringa in Limpopo province (N = 31)

Marketing	Frequency	Percentage	Pearson chi-square value (χ^2)
Farmers sell their products			
Yes	30	96.8	9.65**
No	1	3.2	
Product marketed			
Not selling	1	3.2	15.89**
Dried leaves	1	3.2	
Powder	24	77.4	
Several products	5	16.1	
Quantity/unit (g)			
0	1	3.2	60.65**
20	2	6.5	
30	4	12.9	
50	12	38.7	
60	2	6.5	
100	1	3.2	
Different sizes	9	28.9	
Selling price (R/50 g ±)			
0	1	3.2	9.64**
20	4	12.9	
30	7	22.6	
45	1	3.2	
50	9	29.0	
65	2	6.5	
80	1	3.2	
100	1	3.2	
Different products	5	16.2	
Total	31	100.0	

‡: R = South African Rand (R15.00 is approx. 1.00 US Dollars during period of survey), **Significant at 0.01 level, *Significant at 0.05 level

lesser proportion (3.2%) processes other parts of the tree such as the seeds. From the large proportion of farmers who process the leaves, 83.9% process them into a powder form, whilst only 16.1% of the farmers process it into different products, such as dried leaves only and tea bags.

Overall marketing approaches of Moringa in Limpopo province: The marketing status of Moringa in the Limpopo Province as indicated by Table 2. This study revealed that majority of farmers (96.8%) produce Moringa with an intention of marketing their products. From the study, it was observed that 3.2% of the farmers from Waterberg district do not sell

their products, reason being that the trees are still young but the ultimate intention is to sell the leaves at a later stage.

The study further shows that 77.4% of the farmers who produce Moringa sell the leaf powder in all the five districts, while only 3.2% of these farmers sell the dried leaves only. Few farmers produce Moringa and sell it in various forms including, teabags, capsules, fresh leaves, seeds and seedlings (Table 2). Irrespective of the districts, it was found that farmers sell the leaf powder in diverse packaging sizes ranging from 20-100 g. Majority of these farmers preferred to package the powder in 50 g while others use different packaging sizes of 30 followed by a small proportion of farmers who package the Moringa

Table 3: Moringa enterprise budget: Income and expenditure for 2014/2015 season

Moringa powder financials				
Activity production of Moringa/annum	Unit	Qty	Price or cost/ Unit (Rand)	Value or cost/ Ha(Rand)
Total size of enterprise	ha	0.75		
Gross receipts				
Spring yield of Moringa ha ⁻¹	kg	72		
Summer yield of Moringa ha ⁻¹	kg	86		
Autumn yield of Moringa ha ⁻¹	kg	36		
Winter yield of Moringa ha ⁻¹	kg	7.2		
Total yield/0.75ha	kg	201.2		
Spring sales of Moringa at R950 kg ⁻¹	kg		950	68400
Summer sales of Moringa at R950 kg ⁻¹	kg		950	81700
Autumn sales of Moringa at R950 kg ⁻¹	kg		950	34200
Winter sales of Moringa at R950 kg ⁻¹	kg		950	6840
Gross Income				191140
Pre-harvest				
Seed at 2 kg ha ⁻¹ at R600 kg ⁻¹	kg	0.00	65.00	0
Compost making at 3 t ha ⁻¹	t	3.00	700.00	2100
Labour: 2 labourers at R3000.00/season	season	4	3000	12000
Total pre-harvest costs				14100
Marketing	month	12	400	4800
Packaging material cost	count	700	2	1400
Total harvesting costs				6200
Utility cost				
Electricity	month	12	700	8400
Communication	month	12	650	7800
Transport: 70km/day/15days/month/12 months at R5.00 km ⁻¹	km	12600	5	63000
Total utility cost				79200
Total cost shown excluding capital cost				99500
Contingency: Unknown (10%)				9950
Grand total cost				109450
Margin above cost shown				81690

Assumptions: Other labour comes from the company's permanent staff; the trees are established and are 2 years old; Utility cost will be lower for a smaller area than a larger one

powder in different sizes of 20, 60 and 100 g. In the Limpopo province, there were about 28.9% of farmers who packed and sold the different products of Moringa such as teabags, capsules, fresh leaves, seeds and seedlings (Table 2). Farmers, who produce teabags and capsules, are the ones who have established the markets and managed to purchase the processing machines. These farmers are located in the Capricorn, Sekhukhune, Waterberg and Mopani districts. Although a large number of farmers were found in Vhembe district, most of them preferred indigenous grinding methods to produce powder.

Majority of the farmers sell their products within their immediate community, while only a few of well-established producers sell to the supermarkets and pharmaceutical shops. The farmers also indicated that they sell Moringa products from their own produce and have not yet started sourcing from other farmers.

Due to the lack of formal market and no price control, the selling price of Moringa powder varies widely. It was observed that 29.0% of the farmers sell a 50 g powder for ₦ R50.00, followed by 22.6% and 12.9 % of farmers who sell the same quantity at R30.00 and 20.00, respectively. Other prices include R45.00, 65.0, 80.00 and 100.00 depending on the quantity. Due to the limited market access, farmers are compelled to sell their products on individual arrangements which further contribute to the inconsistency in pricing of Moringa powder.

Summarized representative enterprise budget from Moringa farmers: An annual enterprise budget from a case study of farmers who produce and market the Moringa tree is presented on Table 3. This information was generated from farmers who commercialize Moringa in Capricorn, Waterberg and Mopani districts. Information collected from their farms in

2015 was consolidated and summarized on Table 3. Farmers grow Moringa on an average area of 0.75 ha and assume to harvest the leaves in all the seasons. The budget shows a total income of R191140.00 and a total production cost of R99500.00 resulting in a gross margin of R81690.00.

Challenges faced by farmers: Farmers indicated that the challenges they face in Moringa production extend to: Unreliable access to market, the shortage of funding to enhance production, limited land for large area production, shortage of processing infrastructure, shortage of water to irrigate the trees in times of extreme drought, theft by community members, shortage of fencing to protect the trees against free roaming livestock and game animals, lack of training for production awareness, lack of knowledge on control of termites and formation of spider webs on the trees. Farmers further indicated that, although they have a good land suitable for production of Moringa, market access still remains the main challenge. Therefore, expansion of production is restricted by limited access to the market.

DISCUSSION

The study revealed that Moringa can grow in all the districts of Limpopo province under diverse climatic conditions. Moringa has the potential to contribute towards human and livestock dietary needs and foster rural development, due to its considerable benefits¹⁶. A study by Lekgau¹⁷ indicated that, in South Africa, Moringa is produced in provinces such as Kwa-Zulu Natal, Mpumalanga, as well as the Limpopo Province mainly for household purposes. The households have trees in their backyards for leaf and pod production¹⁷. The leaves are dried and ground into a powder form which is sprinkled on food whereas the young pods are consumed directly as vegetable after cooking. Packaged Moringa powder is now sold by several farmer groups and industrially produced Moringa juice is sold in some supermarkets.

Moringa in the Limpopo province is dominantly produced by male farmers. This is contrary to the general opinion that the majority of smallholder farmers in Limpopo province are women^{18,19}. However, it is also known that male farmers mostly feature on production of commercial crops. A study by Odeyinka and Ademosun⁶ on awareness and knowledge of Moringa in Nigeria also indicated a higher proportion of male farmers (59.7%) compared to females (40.3%). Furthermore, another study conducted by Thamaga-Chitja²⁰ on the consumption of Moringa reported that most of the respondents (69%) consuming Moringa products in Nigeria were males. The possible reason for woman to be less involved

in Moringa farming might be that large sizes of farms are owned by men while woman are focusing on household activities and production in the backyards, in order to stabilize home food supplies²⁰. This trend of production may also suggest a strong commercial potential of the plant, hence the clear interest by male farmers.

Mixed cropping system is dominating in the Limpopo province, whereby farmers produce Moringa, other crops as well as the livestock. Few farmers in the Limpopo province plant Moringa mainly as a sole crop, hence majority grow Moringa under the mixed farming system because, the subtropical conditions of the province ease the cultivation of many tropical fruits and field crops as well as livestock farming²¹.

A study conducted in Zimbabwe indicated that, the majority of smallholder farmers only grow Moringa around homesteads instead of larger farm areas²². Such production probably caters for domestic consumption of the Moringa products. In Limpopo province, the distribution of land sizes allocated to Moringa strongly suggest that either the farmers or some agencies are promoting Moringa for commercial purposes. This notion can be supported by the existence of an organization called Moringa Development Association of South Africa (MDASA).

Farmers producing Moringa in Limpopo province, apply both organic and inorganic fertilizers to enhance the tree growth. A study conducted by Dania *et al.*²³ on comparative effect of different fertilizer sources on growth of Moringa revealed that, the application of organic fertilizer such as poultry manure, significantly increased the vegetative growth of Moringa relative to NKP. However, this study revealed that farmers in Limpopo province prefer to use organic fertilizer such as the compost and livestock manure compared to inorganic fertilizer due to its enormous advantages as well as the minimum or no cost in acquiring it.

This study revealed that farmers in Limpopo Province use various methods of propagation such as seeds, seedlings and cuttings to establish Moringa. Results from this study concur with the findings by Gadzirayi *et al.*²², where the study indicated that seedling propagation is the most popular method for establishing Moringa plantations, the reason being that most farmers plant Moringa during the rainy and warm seasons to encourage establishment. Using the direct planting may assist in reducing the transplanting shock of seedlings, which affects the crops' performance during the early developmental stages. Utilization of stem cuttings has an advantage in terms of uniformity, however, establishment takes time and restricts the establishment period due to the slow growth rate.

Therefore, the study reveals that temperature and moisture are the main factors considered for establishing the crop. In a similar study Gadzirayi *et al.*²², indicated that farmers in Zimbabwe prefer to plant the crop during rainy seasons. Such timing is likely to achieve easier plant establishment and avoid the labour of manual irrigation of the seedlings. The danger of animal damage is also eliminated as all rural livestock are either paddocked or herded during the cropping season.

Moringa leaves can be harvested as early as 3 months after planting in some areas of the Limpopo province. Factors influencing the time of harvesting vary considerably among the farmers. It was revealed that, farmers only harvest the leaves when they want to sell or use them. Similar findings were reported by Maroyi¹¹ and Gadzirayi *et al.*²², where farmers harvested the leaves with a purpose of selling or consuming them. This study indicated that farmers in Limpopo province harvest Moringa at different times and this might be due to the varying temperature conditions, since low temperatures slow the growth of the crop. Moringa grows well under humid tropics or hot dryland and thus conditions favour the growth of Moringa and lead to early harvesting.

Several studies concur with the information obtained from the farmers in the Limpopo province on utilization of Moringa. Majority of farmers, perceptions knowledge on utilization of Moringa are almost similar. Besides what farmers have responded to, on the utilization of Moringa, other uses include oil for industrial use, biogas and ornamental plant^{2,8,11,22,24-27}.

The study further revealed various methods which farmers use when drying and grinding Moringa leaves. Majority of the farmers use traditional method of grinding followed by sieving to produce a fine powder. Few farmers use grinding machine for processing the leaf powder.

Drying leaves assists in the concentration of nutrients and facilitates long term storage thus⁸ suggested that Moringa should be consumed in powder forms. The high nutritional content found in the dried leaves is an important indicator of the usefulness of the plant as a likely feed source^{8,11}.

The demand for Moringa product is high in the Limpopo province and on the South Africa context, however, majority of the farmers do not meet the market requirements due to low standards of processing and storage facilities that the farmers use. This study revealed that, there is a need for proper and organized market structures, so that Moringa farmers can be able to market their products and generate substantial income from the enterprise. This could have a positive economic contribution towards the provincial GDP, create job and wealth and also improve the general livelihood

of the farmers. In addition, it will contribute to the achievement of Millennium Development Goal Number 1: Eradication of extreme poverty and hunger²⁸.

The summarized enterprise budget indicated that Moringa can be a good source of income and livelihood to farmers who grow the trees on a larger scale.

Farmers producing Moringa in the Limpopo province also encounter production challenges such as: Skills in terms of good management practices for sustainable Moringa production. A study by Gadzirayi *et al.*²² on the other hand reported that red spider mites, aphids, caterpillar and termites are the most troublesome pests in Moringa production. The study further indicated that Moringa does not have a challenge of being attacked by diseases. The issue of markets require further probing to establish the possible demands from the organizations selling packaged Moringa powder and juice. The level of local trading in Moringa powder also needs further research.

CONCLUSION

The study concludes that Moringa is produced in all the districts of Limpopo province with its utilization being variable, although production for nutritional and medicinal purposes seems to dominate. The tree is mainly grown by male farmers and majority of them grow on such a relatively small area ranging from 0.25-1 ha, using different management practices. Farmers produce Moringa with the purpose of processing the leaves into a powder that is sold in the local communities, however, due to underdeveloped market, there is wide variability on the pricing of Moringa products. Moringa has strong potential to generate income in Limpopo province but the marketing of the crop needs to be improved, since this crop offers a significant opportunity for the poorest people to enhance their livelihoods without requiring large capital and sophisticated management. Therefore, there is a need to promote Moringa production with the aim of sustaining its commercialization. Further research is recommended on Moringa as a potential crop in agroforestry, conception of stabilized marketing and pricing.

SIGNIFICANCE STATEMENTS

This study discovered the potential of production of Moringa that can be beneficial for commercialization, combating food insecurity and livelihoods of rural communities in the Limpopo Province of South Africa. This study will help the researcher to uncover the critical areas of producing Moringa on a larger scale and formulation of

various products that researchers could explore in future. Thus a new theory will be generated on commercialized production and processing of Moringa for income generation as well as food and nutrition security.

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