

USES AND POPULATION DYNAMICS OF *Sclerocarya birrea* HOCHST. subsp. *caffra*
(SOND) KOKWARO IN MUTALE, LIMPOPO PROVINCE, SOUTH AFRICA

By

Mabala Mulalo Grace

(11582201)



USES AND POPULATION DYNAMICS OF *Sclerocarya birrea* HOCHST. subsp. *caffra*
(SOND) KOKWARO IN MUTALE, LIMPOPO PROVINCE, SOUTH AFRICA

By

Mabala Mulalo Grace

(11582201)

Dissertation submitted in fulfilment of the requirement of

Master of Science Degree in Botany

School of Mathematical and Natural Science

University of Venda

Thohoyandou, Limpopo

South Africa

Supervisor: Prof. M.P. Tshisikhawe

Co-supervisor: Mr. M.H. Ligavha Mbelengwa

ABSTRACT

Understanding the uses of indigenous plants that are of economic importance to local communities is very much important in rural development strategies. The Marula (*Sclerocarya birrea*) Anacardiaceae family is widely used.

More information on this tree species would enhance its value in agricultural landscapes, by helping farmers improve their livelihoods and ensuring environmental sustainability. Understanding how a community uses a resource and what influences the level of its use is crucial for developing a framework for its sustainable use based on local demands. *Sclerocarya birrea* is a species with multiple uses, which is recognized as commercially, medicinally and culturally important in Africa. Almost all parts of this species are useful.

The study presented the findings of a survey of the indigenous knowledge, uses and management of *S. birrea* in Matshena village, Limpopo Province, South Africa. Different people of various ages were interviewed using a semi-structured questionnaire. Thirty percent of respondents indicated that they utilize the marula for beer and juice-making, the highest use category. In the sampled area the population of *S. birrea* is dominated by larger trees with no seedlings and juveniles. This is a sign of a population that will not be viable, since there are no younger individuals to replace the older trees when they die.

Keywords: *Sclerocarya birrea*, rural development, indigenous knowledge, management, environmental sustainability, Matshena village.

DECLARATION

I, Mulalo Grace Mabala, declare that this research is my work and has not been submitted for any degree at any other university or institution. The dissertation does not contain other persons' writing unless specifically acknowledged and referenced accordingly.

Signed (Student):..... Date:.....

ACKNOWLEDGEMENT

I thank Almighty God for giving me the strength, wisdom and courage. I have achieved all this because of his grace. To God be the glory.

Without the support, encouragement and time given patiently by my supervisor, Prof. M.P. Tshisikhawe, this study would not be completed. I give him my sincere and grateful thanks. My Co- supervisor Mr. Ligavha Mbelengwa is acknowledged for his encouragements and support. I also thank the University of Venda for giving the platform to pursue my studies.

Special thanks to my colleagues Mokgadi Rasekgala, Xirhilo Happy Vuma, and Tendani Sadiki for their field work assistance. I also give thanks to my foster daughter Mashudu Lalumbe who has been my pillar of strength and is thanked for her endless support.

I thank the Matshena, and Masea royal families for allowing me to work in their *Sclerocarya birrea* (Mafula) population.

Finally, a special thanks to my husband, Ruphus Mabala for giving me his blessing to further my studies and his support.

DEDICATION

THIS MASTERS DISSERTATION IS DEDICATED TO THE FOLLOWING PEOPLE:

- ❖ My late supervisor Prof. R.B. Bhat. I shall never forget the support he gave me during the initial stage of my research. I wish he was here to share this moment with me.
- ❖ My three lovely sons Phathutshedzo, Takalani and Akonaho for their support.

TABLE OF CONTENT

ABSTRACT.....	i
DECLARATION.....	ii
ACKNOWLEDGEMENT.....	iii
DEDICATION.....	iv

CHAPTER 1

INTRODUCTION

1.1 Background.....	1
1.2 Rationale for the study.....	4
1.3 Research questions.....	5
1.4 Aim and objectives of the study.....	5
1.5 Hypothesis.....	6
1.6 Structure of dissertation.....	6
References.....	7

CHAPTER 2

LITERATURE REVIEW

2.1 Utilization of <i>Sclerocarya birrea</i>	9
--	---

2.2 Population structure.....12

References.....14

CHAPTER 3

ETHNOBOTANICAL INVENTORY OF *Sclerocarya birrea* UTILIZATION IN MATSHENA VILLAGE, LIMPOPO PROVINCE

3.1 Introduction.....19

3.2 Materials and methods.....21

3.2.1 Study area.....21

3.2.2 Methodology.....23

3.3 Results and discussion.....23

3.3.1 Informants profile.....23

3.3.2 Plant part/s used.....24

3.3.3 Utilisation categories.....26

3.4 Conclusions and recommendations.....29

References.....31

CHAPTER 4

POPULATION STRUCTURE OF *Sclerocarya birrea* IN COMMUNAL AREA OF MASEA VILLAGE, LIMPOPO PROVINCE

4.1 Introduction.....	36
4.2 Materials and methods.....	37
4.2.1 Study area.....	37
4.2.2 Methodology.....	38
4.3 Results and discussion.....	40
4.3.1 Population structure.....	40
4.3.2 Size class distribution.....	41
4.3.3 Plant height measurement.....	42
4.3.4 Crown health.....	43
4.4 Conclusions.....	45
References.....	46
CHAPTER 5	
GENERAL CONCLUSIONS AND RECOMMENDATIONS	
5.1 Conclusions.....	49
5.2 Recommendations.....	51
References.....	53
APPENDIX I: Ethnobotanical knowledge questionnaire.....	55

CHAPTER ONE

INTRODUCTION

1.1 Background

Sclerocarya birrea. (A.Rich) Hochst. subsp. *caffra* (Sond.) Kokwaro, commonly known as Marula, is a member of the Anacardiaceae family. Some of Anacardiaceae diagnostic characters displayed by the species include resin ducts in the bark, dioeciousness, and production of fleshy fruits by female trees. *Sclerocarya birrea* is a deciduous tree up to 18 m tall with a round to spreading crown (Van Wyk and Van Wyk, 1997). Marula is a medium-sized tree, indigenous to the Miombo woodlands of Southern Africa. It is a dominant species in communities where it is found, and a keystone species in plant and animal ecology and productivity. It is adapted to the poor soils, and hot and dry climate.

The species has the ability to grow fast and can survive without water if it has been planted during the rainy season. It can grow big enough after some years to create a big canopy which can cast a shade in which other crops can grow. The soil below the Marula shade usually becomes fertile due to the presence of organic matter. The species enjoys great respect amongst the rural communities and therefore, form an integral part of such communities' livelihoods, culture and spirituality (Shackleton *et al.*, 2002).

This species is mostly used by rural populations, (Palmer and Pitman, 1974; Shone, 1979; Walker, 1989; Shackleton and Shackleton, 2000). In South Africa it is mostly found in Mpumalanga, Limpopo Province and KwaZulu- Natal. The rough bark is flaky with a mottled appearance because of its grey and pale brown patches colour (Van Wyk and Van Wyk, 1997). Flowers are 50 - 80 mm long sprays, with sexes on separate trees, with yellow-tinged red colours.

Fruits have a green colour before they are ripe. When ripe, the fruits have yellow skin with white flesh and a large stone. Since it is regarded as an important species in most parts of Africa, the species is protected in communal areas under jurisdictions of the local chief. Due to its highly foliated canopy the species is popular as a meeting spot for local communities. Because of its importance to communities the species is usually avoided during clearing of agricultural land, and is often found left standing in ploughed fields (Shackleton *et al.*, 2002).

Leaves are browsed by animals and the bark stripped by elephants. Elephants will travel for long distances in order to gorge themselves on it, and it is said that monkeys become drunk by eating fermented fruits. Its drought resistance ability makes it ideally suited to be found in abundance from bushveld to woodlands (Van Wyk *et al.*, 1997). The tree will only be felled if it is damaged by natural causes, as it is respected and revered in the community (Palmer and Pitman, 1974).

Because of its multiple uses the species is regarded as important. Balick (1990) suggests that Marula could be regarded as a 'power plant'. For example, the plant is mostly used for

nourishment, but additional uses, including medicinal and fuel wood. According to Wynberg *et al.* (2002), all parts of the tree are useful including fruits, kernels, roots, bark, leaves and wood. Because of these multiple parts uses, and its importance in the landscape, some African cultures have their beliefs and ceremonies associated with this species (Walker, 1989). The ripe fruit can be eaten while fresh or after it has been prepared as a juice, jelly or alcoholic drink (Shackleton and Shackleton, 2002).

The intact stone seeds are very hard and difficult to crack and contain two or three edible nutritious seed kernels (Van Wyk and Van Wyk, 1997). The delicious Marula nut is rich in protein and contain certain percentage of oil. The nuts (kernels) also form an important food supplement, and the oil extracted from them has many uses like to treat ear, nose and throat conditions. According to Mabogo (1990), the nut can also be used as condiments in vegetables.

The tree also attracts a range of edible caterpillars and larvae as well as parasitic mistletoes, which produce outgrowths known as wood roses that are developed and sold in the curio market (Walker, 1989; Holtzhausen, 1991; Van Wyk and Van Wyk, 1997; Wynberg *et al.*, 2002; Shackleton *et al.*, 2002). The high amount of vitamin C in the fruit makes it an important contributor to the diet of many people in rural communities. Jelly and jam can be made from the fruits (Shackleton and Shackleton, 2002). It produces a good quality semi-sweet and sweet wine, beer and juice.

Sclerocary birrea remains without fruits for a certain period during the year (Watt and Breyer-Brandwijk, 1962). Its importance and multiple uses the species is gaining a lot of attention for

the purposes of commercializing, and increasingly a number of Marula based products are entering the markets either through the work of local people themselves or by private sector companies, or through development projects aimed at improving the lives of rural communities (Shackleton and Shackleton, 2000; Shackleton *et al.*, 2002). According to Grant and Thomas (2000), the bark tends to be dark and swell around the main trunk because of insect infection.

Sclerocarya birrea is well distributed in Africa and being known by various vernacular names according to their different countries like Maroela (Afrikaans), Marula (English), Mufula (Venda), Morula (Pedi), Nkanyi (Shangaan), Mufura, Mapfura and Mushomo (Shona), Umganu (Zulu and Ndebele) and Mfula (Chichewa) (Von Teichman,1983; Shackleton *et al.*, 2002).

1.2 Rationale for the study

Sclerocarya birrea is one of the most important useful indigenous plant species in the Limpopo Province. This species provides a number of benefits at subsistence level, and it is producing traded and increasingly commercialized commodities. Most of the people in rural areas rely on its production for income. Indigenous people have significant traditional knowledge about this species related to its uses, management and its population. Their knowledge about *S. birrea* needs to be documented, as African culture is an oral-based society, without a long history of written documentation.

The species is well distributed in Africa, including South Africa. However, the dynamics within its population needs to be understood in order to aid in its sustainability. Thus entical to undertake a population census of the different stages of *S. birrea* in order to develop proper management recommendations.

1.3 Research questions

The following research questions were investigated in this study:

- (a) What are the use categories of *Sclerocarya birrea*?
- (b) What are the *Sclerocarya birrea* utilization perceptions?
- (c) How is *Sclerocarya birrea* population managed?

1.4 Aim and objectives of the study

The aim of this study was to investigate the indigenous knowledge, uses and management of Marula (*Sclerocarya birrea*) in Matshena village, Vhembe District Municipality. To achieve the aim the following objectives were investigated:

- (a) Documentation of the indigenous knowledge inventory of *S. birrea* utilization:
- (b) Assessing the community perceptions on the availability of *S. birrea*
- (c) Assessment of population structure of *S. birrea* in a communal area.

1.5 Hypothesis

The hypothesis is that *Sclerocarya birrea* is still one of the most respected, useful, and multipurpose indigenous species around the communities in which they grow.

1.6 Structure of dissertation

This dissertation has been written in stand- alone chapters on several aspects on the indigenous knowledge, uses and management of *Sclerocarya birrea*. Repetition of certain aspects will therefore be unavoidable in certain sections of the dissertation. Chapter 1 provides the introduction and background to the research. Chapter 2 provides a review of available literature. Chapter 3 provides the ethnobotanical inventory of *Sclerocarya birrea* utilization in Matshena village, Limpopo Province, South Africa. Chapter 4 deals with the population ecology of *Sclerocarya birrea* in communal area of Masea village in Mutale, Limpopo Province, South Africa. Chapter 5 is general conclusion and recommendations.

References

- Balick, M.J. 1990. Ethnobotany and the identification of therapeutic agents from the rainforest. In: Chadwick, D.J., Marsh, J. (Editors). *Bioactive Compounds from Plants*. Wiley, Chichester, United Kingdom.
- Grant, R. and Thomas, V. 2000. *SAPPI Tree spotting- Bushveld: Tree identification maculeas*. Jacana Education (Pty) Ltd. Johannesburg, South Africa.
- Holtzhausen, L.C. 1993. Ennobling and domestication of the indigenous African Marula. *The Indigenous Plant Use Newsletter* 1: 1-3.
- Mabogo, D.E.N. 1990. The ethnobotany of the Vhavenda. MSc Dissertation, University of Pretoria. Pretoria, South Africa.
- Palmer, E. and Pitman, N. 1974. *Trees of Southern Africa*. Balkema Publishers. Cape Town, South Africa.
- Shackleton, S.E., Shackleton, C.M., Cunningham, A.B., Lombard, C., Sullivan, C.A. and Netshiluvhi, T.R. 2002. Knowledge on *Sclerocarya birrea* subsp. *caffra* emphasis on its importance as a non-timber forest product in South and Southern Africa: A summary. Part 1, Taxonomy, ecology and role in rural livelihoods. *Southern African Forestry Journal* 194: 27-41.
- Shackleton, C.M. and Shackleton, S.E. 2000. Direct use values of Savanna resources harvested from communal Savanna in the Bushbuckridge Lowveld, South Africa. *Journal of Tropical Forest Products* 6: 21-40.

- Shackleton, S. and Shackleton C. 2002. Use of Marula products for domestic and commercial purpose by households in the Bushbuckridge district, Limpopo Province, South Africa. Rhodes University, Grahamstown, South Africa.
- Shone, A.K. 1979. Notes on the Marula. *Department of Water Affairs & Forestry Bulletin*, 58: 1-89.
- Van Wyk, A.E. and van Wyk, P. 1997. Field guide to Trees of Southern Africa. Struik Publishers. Cape Town, South Africa.
- Van Wyk, B- E., Van Oudshoorn, B. and Gericke, N. 1997. Medicinal Plants of South Africa. Briza Publications. Pretoria, South Africa.
- Walker, N.J. 1989. King of foods: Marula economics in the Matabos. *African Wildlife* 43: 281-285.
- Watt, J.M. and Breyer-Brandwijk, M.G. 1962. Anacardiaceae. In: Medicinal and Poisonous Plants of Southern and Eastern Africa. E. & S. Livingstone Ltd. Publishers. Edinburgh & London, United Kingdom.
- Wynberg, R.P., Laird, S.A., Botha, J., Den Adel, S. and Mchardy, T. 2002. The management, use and commercialisation of marula: policy issues. Centre for Ecology and Hydrology, Wallingford. Available from <http://www.nwl.ac.uk/research/winners/index.html>. Accessed 4 April, 2016.

CHAPTER TWO

LITERATURE REVIEW

2.1 Utilization of *Sclerocarya birrea*

According to Van Wyk (2002), most of the available literature focusses on a single region, culture or category of plant use. These include medicinal plant use in the Bredasdorp/Elim region of the Southern Overberg area in the Western Cape Province of South Africa (Thring and Weitz, 2005). Helm *et al.* (2009) on the other hand studied mortality and utilization of *S. birrea* in the Kruger National Park. According to Gouwakinnou *et al.* (2009), the species has been recorded to be utilized in four defined use categories namely food, medicine, firewood and carving. It is estimated that over one third of the world's population lacks regular access to modern medicine, and therefore most of the people in rural areas can afford traditional medicine for health care (Zhang, 2004).

The uses of plant resources represent an important shared heritage, preserved in a number of countries. This heritage must be exploited in order to provide a new and useful body of ethnobotanical knowledge (Maroyi and Rasethe, 2015). Indigenous fruit trees are important traditional sources of nuts, fruits, vegetables, spices, edible oil and beverages (Okafor, 1985). According to Street and Prinsloo (2013), most of the South African population are using traditional medicines to meet the demand of their primary health care needs.

However, only a few South African medicinal plants have been exploited to their full potential in terms of commercialization. *S. birrea* is considered to be ‘tree of life’, because it provides important human needs in the form of food and medicine (Maroyi, 2013).

In protected areas the species is utilized by wild animals for its leaves, bark, fruit and roots. Humans in communal areas utilized it for its fruits, wood used in carving, and its wonderful shade (Hall *et al.*, 2002; Shackleton *et al.*, 2002). According to Peters (1988), the fruit is the most valuable part of this tree. The large numbers of fruits are eaten by wild animals such as elephants, monkeys and baboons (Shackleton *et al.*, 2002). Marula contributes to various forms of livelihood in Bushbuckridge ranging from subsistence purposes to commercialisation of resources (Shackleton and Shackleton 2002). Data from Bushbuckridge in South Africa indicate that *S. birrea* is amongst the most commonly used wild fruit species with 59 - 77% of households reporting consuming Marula fruit between four and five times per week during fruiting season (Shackleton *et al.*, 2002).

The most useful part in Namibia is leaves where it is believed that the medicinal powers of male trees are greater than those of female trees (Street and Prinsloo, 2013). The leaves are cooked as relish (Mojeremane and Tshwenyane, 2004). According to Dimo *et al.* (2007), in Ghana the leaves are used to treat snakebite. According to Kokwaro (1986), Taylor and Kwerepe (1995), as well as Van Wyk and Van Wyk (1997), during drought seasons the livestock owners cut down the branches to use leaves as fodder for their livestock.

According to Galvez *et al.* (1991), Kokwaro (1993), Iwu (1993), and Van Wyk *et al.* (2000), the most useful part for medicinal purpose is bark that treats a variety of ailments such as fever, diarrhoea and blood circulation problems. According to Mabogo (1990), Vhavenda women use soft porridge with root bark to strengthen their babies. The Vhavenda traditional healers use powdered stem bark of a male Marula tree in medication to select a male child and stem bark from a female tree for selection of girl. Bark can also be useful when mixed with other medicinal plants in treatment of different infections like syphilis, dysentery, hepatitis, diarrhoea, rheumatism, insect bites and burns (Dalziel, 1948; Watt and Breyer-Brandwijk, 1962; Kokwaro, 1993; Lombard *et al.*, 2000).

In most of African countries, the roots, stem-bark and leaves of *Sclerocarya birrea* are used medicinally in treatment of malaria and fevers, diarrhoea and dysentery, stomach ailments headaches, sore eyes, toothache, backache and body pains, infertility, constipation, abdominal cramps, swollen gums, cough, hypertension, arthritis, epilepsy, diabetes mellitus, sores and other bacterial infections (Watt and Breyer-Brandwijk, 1962; Van Wyk and Van Wyk, 1997; Ojewole, 2003).

Shone (1979) indicates that *S. birrea* has been used from the earliest of times. Fresh fruit is widely consumed particularly by children and provide vitamin C. According to Shackleton *et al.* (2002), collected fruits are also processed into juice, alcoholic drinks and jam. Shone (1979) reported that Marula beer can be stored for a period of up to three years sealed in containers and buried underground. Almost all parts of the species are useful. The species is widely used by rural populations in most countries in which it is growing (Palmer and Pitman, 1974; Shone,

1979; Walker, 1989; Shackleton and Shackleton, 2002). The fruits and leaves also provide nutritious fodder for livestock (Holtzhausen, 1993).

Marula wood has been traditionally used for carving pestles and mortars, bowls, drums, beehives and stools (Dalziel, 1948). According to Grundy *et al.* (1993), wood is also used for making musical instrument in Mutanda Resettlement Area, Zimbabwe. The trees are harvested to carve wide ranging figures (Steenkamp, 1999). Immelman *et al.* (1973) elaborated on other uses for *S. birrea* wood such as furniture, flooring, laminating products, box shooks, and manufactured articles like shoe heels. In some other areas like Malawi, wood is used for making canoes (Coates Palgrave, 1956).

The Marula nuts shells are used as good sources for fuel (Lombard *et al.*, 2000).

2.2 Population structure

Population structure which is defined as the composition of a given population, can be used to categorize a population into different subsections. According to Klimas *et al.* (2007), size class or stem diameter are used to determine the population structure in forestry and ecological studies. *S. birrea* usually grows up to 18 m tall, with a taproot and sturdy lateral roots. Bark is pale silvery or purplish-grey on small individuals, with flat roundish scales, a rounded crown with dense leaves, spreading widely in large old trees (Hall *et al.*, 2002).

Most of the trees are under increasing pressure as more and more areas are modified or transformed. Direct causes of population decline include fuel wood harvesting, burning and conversion to cultivated field and plantations with the human population growth as the ultimate cause (Ingvar *et al.*, 2006). Population decline is also due to reactions to different kinds of disturbance but also long term dynamics and climate change. The concern over forest conservation lies on the activities that lead to depletion of forest resources.

Marula populations are influenced by resprouting and by seed dispersal by animals (Shackleton *et al.*, 2002; Helm *et al.*, 2011). *S. birrea* is resistant to fire and herbivory.

References

- Coates Palgrave, O. 1956. Trees of Central Africa. National Publications. Trust Publishers. Glasgow, Scotland.
- Dalziel, J.M. 1948. The useful plants of West Tropical Africa. An appendix to the Flora of the West Tropical Africa by Hutchinson J.M. and Dalziel, Crown agents for the colonies. London.
- Dimo, T., Rakotonirina, S.V., Tan, P.V., Azay, J., Dongo, E., Komtchouing, P. and Cros, G. 2007. Effect of *Sclerocarya birrea* (Anacardiaceae) stem bark methylene chloride/methanol extract on streptozotocin-diabetic rats. *Journal of Ethnopharmacology* 110 (3): 434 – 438.
- Galvez, J., Zarzuelo, A., Crespo, M.E., Ultrilla, M.P., Jimenez, J., Spiessens, C. and de Witte, P. 1991. Antidiarrhoeic activity of *Sclerocarya birrea* extract and its active tannin constituents in Rats. *Phytotherapy Research* 5: 276-278.
- Gouwakinnou, G.N., Kindomihou, V., Assogbadjo, A.E. and Sinsin, B. 2009. Population structure and abundance of *Sclerocarya birrea* (A. Rich) Hochst subsp. *birrea* in two contrasting land- use systems in Benin. *International Journal of Biodiversity and Conservation* 1(6): 194-201.
- Grundy, I.M., Compbel, B.M., Balebereho, S., Cunliff, R., Tafangenyasha, C., Fergusson, R. and Parry, D. 1993. Availability and uses of trees in Mutanda Resettlement area, Zimbabwe. *Forest Ecology and Management*, 56: 243 – 266.

- Hall, J.B., O'Brien, E.M. and Sinclair, F.L. 2002. *Sclerocarya birrea*: A monograph. School of Agriculture and Forest Sciences Publication No. 19, University of Wales. Bangor, United Kingdom.
- Helm, C.V., Scott, S.L., Witkowski, E.T.F. 2011. Reproductive potential and seed fate of *Sclerocarya birrea* subsp. *caffra* (Marula) in the low altitude savanna of South Africa. *African Journal of Botany* 77: 650-664.
- Helm, C.V., Witkowski, E.T.F., Kruger, L. Hofmeyr, M. and Owen-Smith, N. 2009. Mortality and utilisation of *Sclerocarya birrea* subsp. *caffra* between 2001 and 2008 in the Kruger National Park. *South Africa Journal of Botany* 75: 475-484.
- Holtzhausen, L.C., 1993. Ennobling and domestication of the indigenous Africa Marula. *The Indigenous Plant Use Newsletter* 1: 1-3.
- Immelman, W.F.E., Wicht, C.L. and Ackerman, P.P. 1973. Our Green Heritage. A book about indigenous and exotic trees in South Africa, about trees and timber in our cultural history and about our extensive Silvicultural and timber industries. Tafel Publishers. Cape Town, South Africa.
- Ingvarg, B., Borge, P., Lennart, S. and Ruffo, C. 2006. Tree communities and structural dynamics in Miombo (*Brachystegia-Julbernadia*) woodland, Tanzania. *Forest Ecology and Management* 230: 171-178.
- Iwu, M.M. 1993. Handbook of African Medicinal Plants. C.R.C. Press, Inc. Boca Laton, Florida.
- Klimas, C.A., Kainer, K.A. and Wadt, L.H.O. 2007. Population structure of *Carapa guianensis* in two forest types in the South Western Brazil. *Amazon Forest Ecology and Management* 250: 256-265.

- Kokwaro, J.O. 1986. Flora of Tropical East Africa. A.A., Balkema.
- Kokwaro, J.O. 1993. Medicinal plants of East Africa. Kenya, Literature Bureau. Nairobi.
- Lombard, C., Allanic, B. and Shilote, B. 2000. Potential for the development of Marula products in the Bushbuckridge area. DANCED - Community forestry project in the Bushbuckridge area, Department of Water Affairs and Forestry, Nelspruit 71 p.
- Lukheli, S. 1998. Children's food of medicinal value. B.Sc. Honours Report. University of Venda. Thohoyandou, South Africa.
- Mabogo, D.E.N. 1990. The ethnobotany of the Vhavenda MSc thesis. University of Pretoria, Pretoria. South Africa.
- Maroyi, A. 2013. Local knowledge and use of Marula [*Sclerocarya birrea* (A. Rich.) Hochst.] in South- central Zimbabwe. *Indian Journal of Traditional Knowledge* 12(3): 398-403.
- Maroyi, A. and Rasethe, M.T. 2015. Comparative use patterns of plant resources in rural areas of South Africa and Zimbabwe. *PHYTON: International Journal of Experimental Botany* 84(2): 288-297.
- Mojeremane, W. and Tshwenyane, S.O. 2004. The resource role of Marula (*Sclerocarya birrea*): A multipurpose indigenous fruit tree of Botswana. *Journal of Biological Sciences* 4: 771-775.
- Ojewole, J.A. 2003. Evaluation of the anti-inflammatory properties of *Sclerocarya birrea* (A.Rich.) Hochst (Family: Anacardiaceae) stem-bark aqueous extract in rats. *Journal of Ethnopharmacology* 85 (2-3): 217 – 220.
- Okafor, J.C. 1985. Selection and improvement of indigenous tropical trees. *Journal of Tropical Resources*. 1: 87-95.

- Palmer, E. and Pitman N. 1974. *Trees of Southern Africa*. A.A., Balkema Publishers. Cape Town, South Africa.
- Peters, C.R. 1988. Notes on the distribution and relative abundance of *Sclerocarya birrea* (A.Rich.) Hochst. (Anacardiaceae). *Monograph in Systematic Botany of the Missouri Botanical Garden* 25: 403-410.
- Shackleton, S.E. and Shackleton, C.M. 2002. Use of Marula products for domestic and commercial purpose by household, in the Bushbuckridge district, Limpopo province, South Africa, Unpublished report Environmental Science Department, Rhodes University Grahamstown.
- Shackleton, S.E., Shackleton, C.M., Cunningham, T., Lombard, C., Sullivan, A.A. and Netshiluvhi, T.R. 2002. Knowledge on *Sclerocarya birrea* subsp. *caffra* with emphasis on its importance as a non-timber forest product in Southern Africa: A summary part: taxonomy, ecology and role in rural livelihoods. *Southern Africa Forestry Journal* 194: 27-41.
- Shone, A.K. 1979. Notes on the Marula. *Department of Water Affairs & Forestry Bulletin*, 58: 1-89.
- Steenkamp, C. 1999. Analysis of the woodcarving industry in the Bushbuckridge area. DANCED - Community forestry project in the Bushbuckridge area. Department of Water Affairs and Forestry. Nelspruit, South Africa.
- Sreet, R.A. and Prinsloo, G. 2013. Commercially important medicinal plants of South Africa. *Journal of Chemistry* 2013: 1-16.
- Taylor, F. and Kwerep, B. 1995. Towards the domestication of some Indigenous Fruit Trees in Botswana: In Maghembe, J.A., Ntupanyania, Y. and Chirwa P.W. (Editors):

- Improvement of Indigenous trees of miombo woodlands of Southern Africa. ICRAF. Nairobi, Kenya.
- Thring, T.S.A. and Weitz, F.M. 2005. Medicinal Plant use in the Bredasdorp / Elim region of the Southern Overberg in the Western Cape Province of South Africa. *Journal of Ethnopharmacology* 103: 261 – 275.
- Van Wyk, B. and Van Wyk, P. 1997. The Guide to Trees of Southern Africa. Struik Publishers. Cape Town, South Africa.
- Van Wyk, B.E. 2002. A review of ethnobotanical research of Southern Africa. *South Africa Journal of Botany* 68: 1-13.
- Van Wyk, B.E., Van Oudshoorn, B., Gericke N. 2000. Medicinal Plants of South Africa. 2nd Edition. Briza Publishers. Pretoria, South Africa
- Walker, N.J. 1989. King of foods: Marula economics in the Matobos. *African Wildlife* 43: 281- 285.
- Watt, J.M. and Breyer- Brandwijk, M.G. 1962. The Medical and Poisonous Plants of Southern and Eastern Africa. 2nd edition. Livingstone Publishers. London, United Kingdom.
- Zhang, X. 2004 Traditional medicine: Its importance and protection. The role of traditional knowledge in health care and agriculture. In: Twarong S. and Kapoor, P. (Editors) Protecting and promoting traditional knowledge. Systems, National experiences and International dimensions United Nations Conference on Trade and Development, United Nations, New York and Geneva.

CHAPTER THREE

ETHNOBOTANICAL INVENTORY OF *Sclerocarya birrea* UTILIZATION IN MATSHENA VILLAGE, LIMPOPO PROVINCE

3.1 Introduction

Marula tree (*Sclerocarya birrea* subspecies *caffra*) forms a major component of the diet, tradition and culture of rural communities in most parts of Southern Africa (Wynberg *et al.*, 2002). According to Xaba (2011), the African Marula (*Sclerocarya birrea*) is one of the world's most highly-prized indigenous fruit trees. The tree is regarded as one of Africa's botanical treasures. There are thousands of different indigenous fruit trees in Africa, but only a few produce "food for all seasons" (Petje, 2008). Botanists and other researchers have started recording the local uses of plants (Van Wyk, 2002). Some valuable wild plants are still utilised as medicinal and food sources from their natural habitats. Due to the increasing human population and further expansion of land for agriculture, all these continue to reduce the natural habitats. This leads to extinction of some plant species, and threatening the existence of others (Moyo, 2009).

Indigenous plant use is declining in other areas. Only elderly people use the indigenous plants for various purposes like medicine, crafting, wood, fodder for animals, building and fencing wood. Marula provides benefits at subsistence level and yields treated and increasingly

commercialised commodities. The main product is fruit. The edible fruits and the multiple uses associated with almost all parts of the species, makes it one of Southern Africa's most valued tree. The fruit may be eaten either fresh or made into juice. It also makes alcoholic beverage known as Mukumbi by Vhavenda people. According to Runyaro (2005), in Zimbabwe they also make same product and also call it Mukumbi.

People consumed raw fruits and kernels extracted from the fruits are also eaten raw. The kernels are crushed and used as an ingredient in vegetables. Marula wood has been used for carving drums, wooden spoons and bowls. Herbal remedies and Traditional Medical Practitioners play an important role in the primary health care of people in an under developed countries. The bark of *S. birrea* has medicinal properties and is used widely in treating dysentery and diarrhoea, insect bites and other different ailments. The inner layer of bark makes ropes.

Across Africa, many wild plants are utilized as food resources in addition to the most commonly available agricultural foods (Mojeremane, 2004). They are a source of vitamins, minerals, amino acids and trace elements. They also improve development in rural areas, job creation and improved quality life. In Matshena village the species is protected by local people. Local farmers select and retain the species when clearing the area for agriculture (Malunga, 2015). Research has proved that Marula species play an important role in the livelihood of the rural population. They can also make a living by selling the Marula products to other people.

Sclerocarya birrea like other indigenous food plants is always present during drought and non-drought years and therefore its domestication and use is important for food security

(Mojeremane *et al.*, 2004). According to Den Adel (2011), the multipurpose Marula tree has a long history of traditional use and the importance of Marula stretches from the social, to the cultural, the economical and the nutritional aspects of people's lives, and its value makes a significant contribution to local livelihoods. The species is also gaining economic importance as products are marketed more widely (Gadd, 2002; Shackleton *et al.* 2002a). Hall *et al.* (2002) also state that Marula is a fruit bearer, which plays a very significant role in the lives of many people in Southern Africa. According to Shackleton (1996) and Shackleton *et al.* (2002a), *S. birrea* is one of the species that provides job opportunities to the communities around Tzaneen and also economic growth in South Africa. In most rural societies it is a taboo to cut down Marula tree.

The current study is therefore aimed at ethnobotanical inventory or *Sclerocarya birrea* utilization in Matshena village, Limpopo Province South Africa.

3.2 Materials and methods

3.2.1 Study area

The study was performed in Matshena village, Vhembe District Municipality, Limpopo Province, South Africa. Limpopo Province is located in the north most part of South Africa. The province shares its borders with countries like Zimbabwe, Botswana and Mozambique. Limpopo is one of the two Provinces, which enjoy a close proximity to the Kruger National Park. The province is named after the long, winding Limpopo river that makes its way through the province thereby providing nourishment to the surrounding flora. Limpopo is a land of

legends and myths and of ancient civilization. Vhembe District Municipality is located in the northern part of the Limpopo Province. <http://www.southafrica.com/limpopo/climate/>

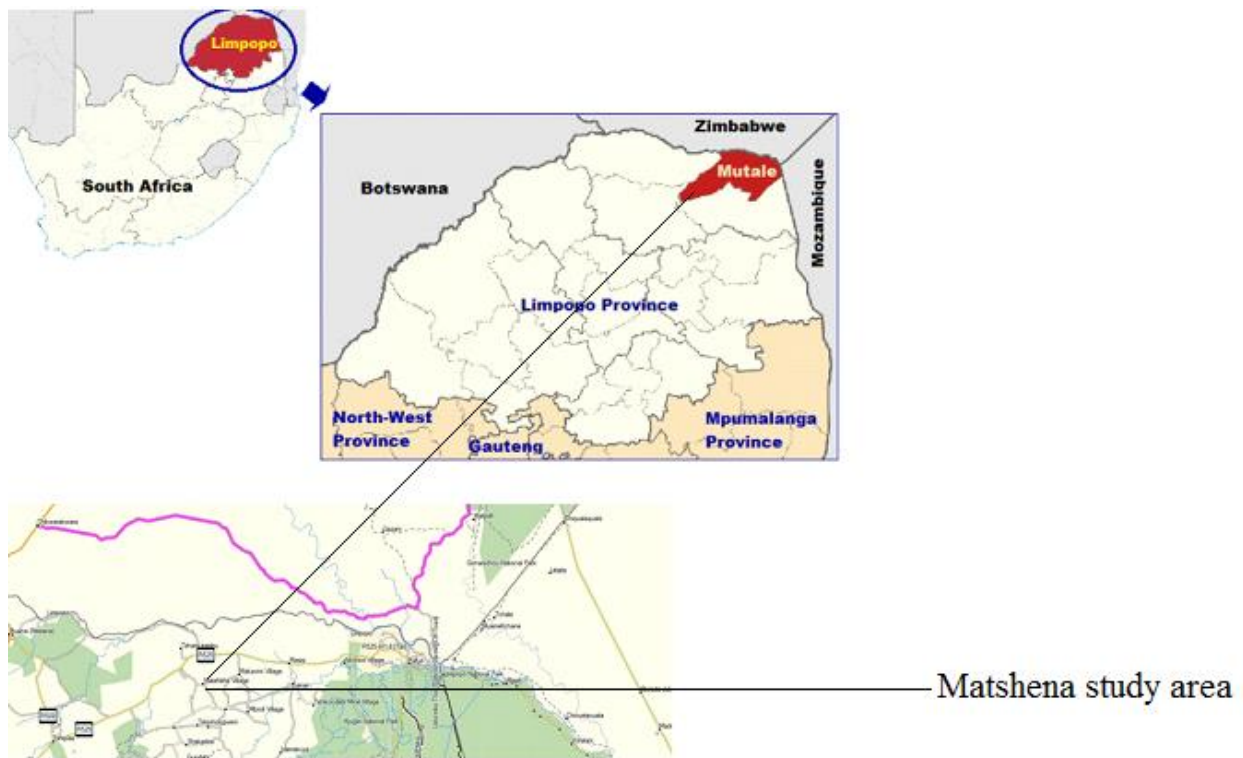


Figure 3.1: Map of South Africa showing the position of Mutale Local Municipality in Limpopo Province and the Matshena village study site.

The climate in the Limpopo Province is usually hot since the area is bisected by the tropic of Capricorn. During the summer months the heat is often interrupted by short thunderstorms, which are usually accepted despite the sometimes extreme heat of the day. Visitors of Limpopo province can anticipate sunshine, long summer afternoons and dry days for most of their stays. They can expect temperatures of around 27 - 45°C.

Visitors from cooler countries mostly prefer to visit in winter when the province experiences cool temperature. During this time of the year, the days usually start with a chill in the air to a warm midday and cool, dry afternoon.

3.2.2 Methodology

Thirty informants were interviewed in Matshena village former, Mutale Municipality in Limpopo Province, South Africa. Convenient sampling method was used to select informants to be interviewed. Informants found available and willing to be interviewed when moving from house to house were interviewed on the uses of Marula, most parts used and management. Interviews were conducted using a semi-structured open-ended questionnaire. Time assigned for an interview was dependant on the understanding of the questions. For those who were illiterate questionnaires were conducted in the vernacular Tshivenda, local language after obtaining prior consent from them. Prior informed consent was sought with informants before interviewing them. They were made aware that the interviews were done voluntarily and they could stop if ever they feel they do not want to continue with such interviews.

3.3 Results and discussions

3.3.1 Informants profile

A total of 30 informants were interviewed which included 23 females and 7 males (Table 3.1). Data on information given by informants revealed that females were the ones who were willing to participate, and that they had more information on the uses of *Sclerocarya birrea* than males.

Convenient sampling method used did not take into consideration the proportionality of the population in the village since people were interviewed on the basis of availability and willingness to participate.

Table 3.1: Age and gender profile of informants interviewed

Gender	Age (years)			Total
	20 – 40	41 – 60	61 – 80	
Female	05	08	10	23
Male	04	02	01	07

These results on the dominance of females in information sharing are in agreement with what has been stated by Shackleton *et al.* (2000) and Shackleton *et al.* (2002b) that women are mainly involved in trading Marula products. They are therefore at a better position to know and be willing to share information on the uses of *S. birrea*. Educational levels were not considered for analysis in this study that focused on indigenous knowledge generated through years of experience. Its effects were assumed to be minimal.

3.3.2 Plant part/s used

Figure 3.1 showed that fruits (35%) and kernels (nuts) (28%) contributed the highest percentages in terms of plant parts used, followed by bark (24%), leaves (10%) and whole plant (3%).

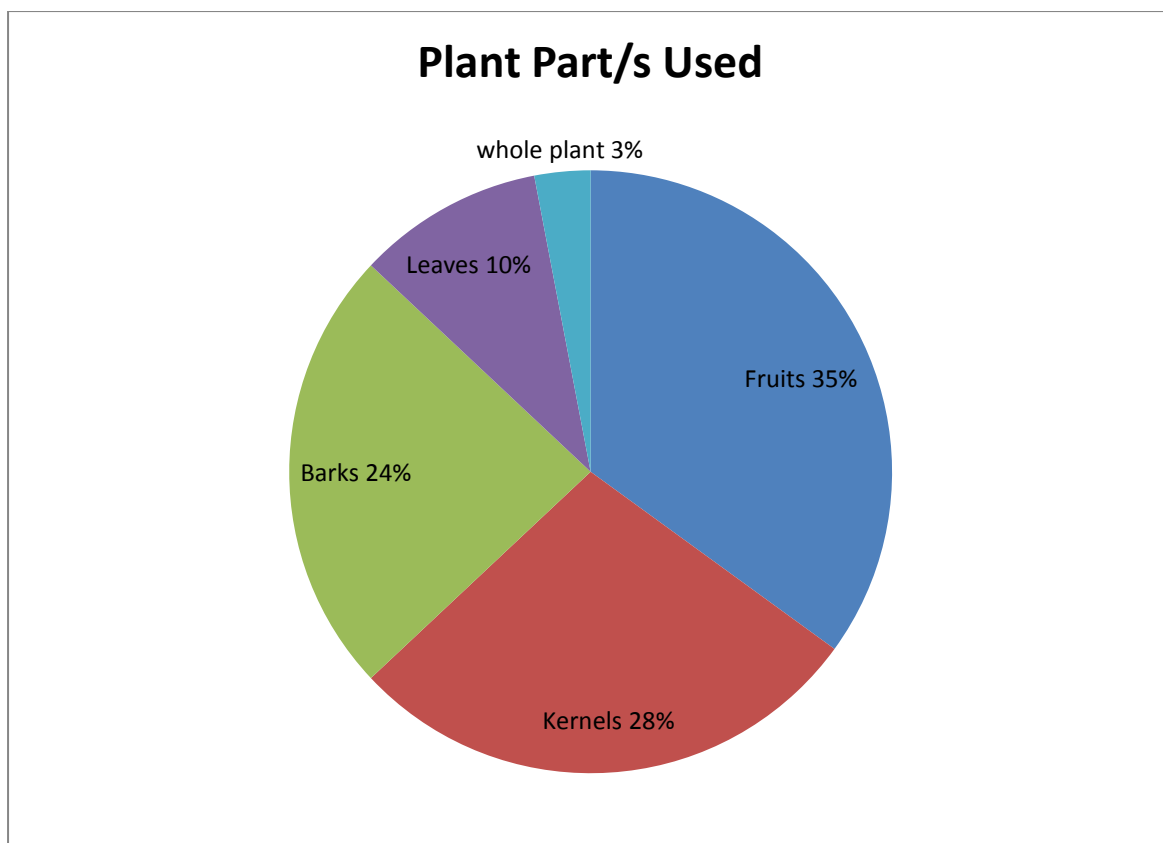


Figure 3.1: Plant parts utilization of *Sclerocarya birrea* in Matshena village.

The dominance of the utilization of fruits was also observed by Shackleton *et al.* (2002b) on a study done in Bushbuckridge area of South Africa. Van Wyk *et al.* (1997) also indicate this species as a commercial fruit crop and the fruit pulp being used to produce a jelly and flavoured liquor. According to Shackleton (2002), the data collected from Bushbuckridge, also showed that *S. birrea* is one of the most commonly used wild fruit species, with 59 - 77% of households reporting consuming Marula fruits between four to five times per week during fruiting season (Shackleton, 1996; Shackleton *et al.*, 2000).

Shackleton and Shackleton (2002), also elaborate the uses of fruit for eating (94, 4%) in the use of Marula products for domestic and commercial purposes by households in Bushbuckridge

Mopani District, Limpopo Province, South Africa. Shackleton *et al.* (2002b) in their study in Bushbuckridge showed that over 81% of households indicated that family members consume a handful of Marula fruit every couple of days.

Sclerocarya birrea fruit and kernels form an important component of the diet of rural people (Cunningham, 1988; Shackleton *et al.*, 2000). Fresh fruits are widely consumed when they ripe, particularly by children (Cunningham, 1988; McGregor, 1995; Cavendish, 1999).

3.3.3 Utilization categories

Members of community in Matshena village consume fruits while they are fresh. They also collect fruits and prepare juice, jelly and an alcoholic drink called Mukumbi in Tshivenda (Figure 3.2).



Figure 3.2: Use of Marula in making of traditional Marula wine (Mukumbi).

The kernels are also consumed being raw sometimes used as an ingredient as it is being added to green vegetables when cooking. Other uses of the kernels include as a meat preservative (Palmer and Pitman, 1972; Peters, 1988; Holtzhausen, 1993). Fruits are eaten by variety of domestic and wild animals. Leaves are used as fodder for animals during dry periods.

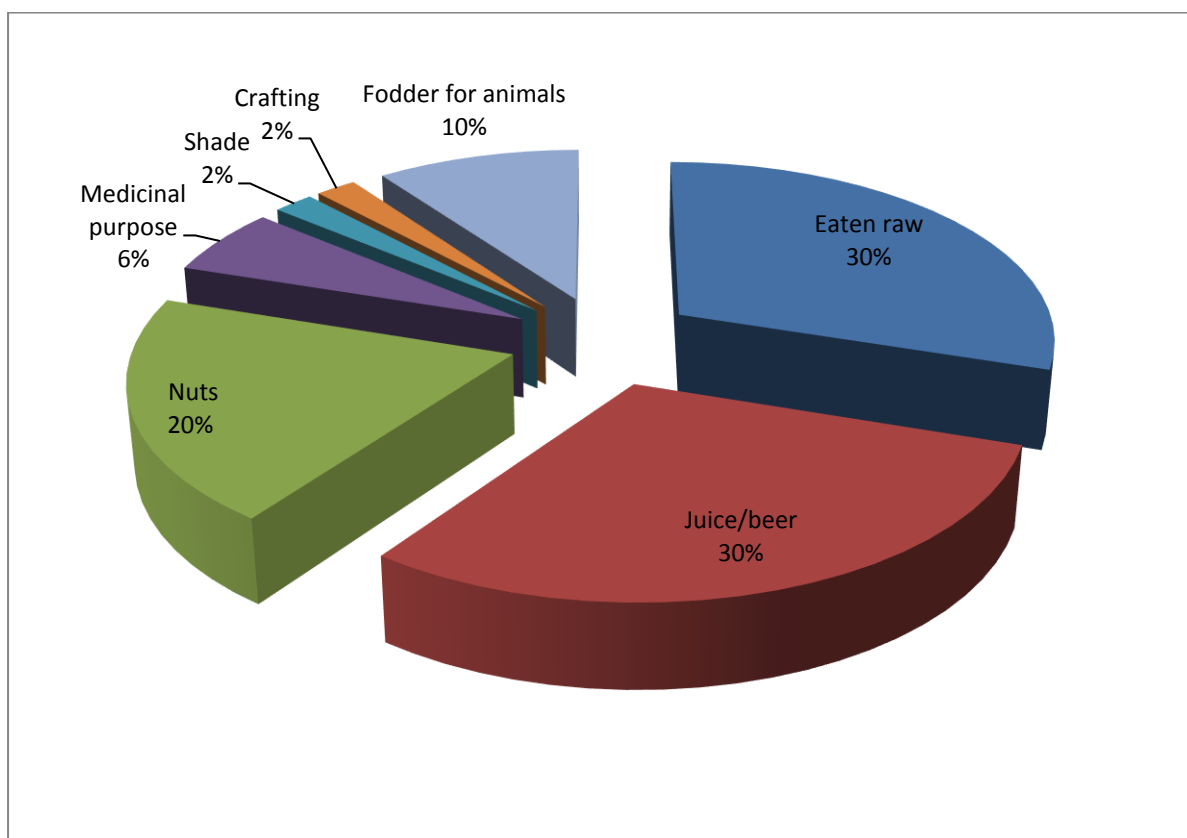


Figure 3.3: Utilization categories of *Sclerocarya birrea* in Matshena village.

The bark collected as shown in Figure 3.4 is used in treating various stomach ailments, liver diseases, sore throat, skin eruptions and malaria and to ease labour pain. These uses were also stated by Oliver-Bever (1986), Ellof (2001), Ojewole (2003, 2004), and Dimo *et al.* (2007). Amongst Vhavenda traditionalists in South Africa, powdered stem bark from male Marula trees

is used to “select” a male child and stem bark from a female tree for a girl (Shone, 1979; Mabogo, 1990).



Figure 3.4: Evidence of bark removal on one of the *S. birrea* individuals recorded at Matshena village.

The stony seed covers are used to make cooking soda that is used when cooking green vegetables. According to Hall *et al.* (2002), leaves are also mixed with bark in a variety of medical treatments. According to Galvez *et al.* (1993), leaves are used as medicine to treat muscular systems. Gelfand *et al.* (1985) and Shackleton *et al.* (2002b) indicated the uses of roots in the treatment of heavy menstruation, bilharzias, coughs, weakness, sore eyes and heart pains.

According to Shone (1979) the wood is used for carving drums, stools, kitchen utensils like forks, plates and wooden spoons. *S. birrea* was used for manufacturing tomato boxes and toilet seats (Shone, 1979). Other uses for the wood include furniture, panelling, flooring, laminated products, box shooks, and manufactured articles such as shoe heels (Immelman *et al.*, 1973). The canopy provides habitat for various insects and bird species and some parasitic plants.

3.4 Conclusions and recommendations

There is no doubt that Marula is important to rural communities for a variety of reasons. It is important that its role in the lives of many is not underestimated. It is a drought resistant species therefore it is important in times of hardship and it is available in communal lands for human survival. People who live in communal areas rely on indigenous woodland for most of their fuel, graze and browse for animals, food, medicine and other benefits (Bradley and Dewees, 1993).

The study has revealed that people from Matshena village situated in the former Mutale Municipality which are mostly women, possess a sound knowledge related to the uses of *Sclerocarya birrea*. The practice is mostly influenced by its population. The study showed that male people are not interested in the uses of *S. birrea*. Much of the knowledge on the use of *Sclerocarya birrea* is lost due to not being passed on from one generation to the next.

The fact that the mostly used part of *S. birrea* is fruit is good because this will increase the availability of the species if the seed kernels are not removed after using the pulp of the fruit. The negative impact in terms of sustaining the population through germination by seeds may only be posed by excessive use of seed kernels, since it may affect recruitment.

It is recommended that communities should be encouraged to use Marula efficiently for their own benefits and for commercial reasons.

References

- Bradley, P.N. and Dewees, P. 1993. Indigenous woodlands, agricultural production and household economy in the Communal Areas. In: P.N. Bradley and K. McNamara (Editors). Living with trees: Policies for Forestry Management in Zimbabwe. World Bank Technical Paper 210. Washington, United States of America.
- Cavendish, W. 1999. Empirical regularities in the poverty-environment relationship of African rural households. WPS 99-21.
- Cunningham, A.B. 1988. Collection of wild plants in Themba Thonga society: A guide to Iron Age gathering activities? *Annals of the Natal Museum* 29: 433-446.
- Den Adel, S. 2011. The National Forest Programme Facility, CRIAASA-DC, Namibia.
- Dimo, T., Rakotonirina, S.V., Tan, P.V., Azay, J., Dongo, E., Kamtchouing, P. and Cros, G. 2007. Effect of *Sclerocarya birrea* (Anacardiaceae) stem bark methylene chloride/methanol extract on streptozotocin in diabetic rats. *Journal of Ethnopharmacology* 110(3): 434-438.
- Ellof, J.N. 2001. Antibacterial activity of Marula (*Sclerocarya birrea*) (A.Rich) Hochst. subsp. *caffra* (Sond) Kokwaro (Anacardiaceae) bark and leaves. *Journal of Ethnopharmacology* 76(3): 305-308.
- Gelfand, M., Mavi, S., Drummond, R.B. and Ndemera, B. 1985. The traditional medical practitioner in Zimbabwe. His principles of practice and pharmacopoeia. Mambo Press, Gweru.

- Gadd, M.E. 2002. The impact of elephants on the Marula tree. *Sclerocarya birrea*. *African Journal of Ecology* 40: 328-336.
- Galvez, J., Crespo, M.E., Zarzuelo, A., Witte, P.D. and Spiessens, C. 1993. Pharmacological activity of a procyanidin isolated from *Sclerocarya birrea* bark: Antidiarrhoeal activity and effects on isolated guinea-pig ileum. *Phytotherapy Research* 17(1): 25-28.
- Hall, J.B., O'Brien, E.M. and Sinclair, F.L. 2002. *Sclerocarya birrea*. *Monograph*. School of Agricultural Forest Sciences Publication no 19. University of Wales. Bangor, United Kingdom.
- Holtzhausen, L.C. 1993. Ennobling and domestication of the indigenous African Marula. *Indigenous Plant Use Newsletter* 1: 1-3.
- Immelman, W.F.E., Wicht, C.L. and Ackerman, P.P. 1973. Our Green Heritage. A book about indigenous and exotic trees in South Africa, about trees and timber in our cultural history and about our extensive silvicultural and timber industries. Tafel Publishers. Cape Town, South Africa.
- Mabogo, D.E.N. 1990. The ethnobotany of the Vhavenda. MSc Thesis, University of Pretoria. Pretoria, South Africa.
- Malunga, G. 2015. Ethnobotanical profile of indigenous tree species protected within agricultural farming system of Mutale Local Municipality, Limpopo Province, South Africa. B.Sc Honours Report. University of Venda. Thohoyandou, South Africa.
- McGregor, J. 1995. Gathered produce in Zimbabwe's communal areas. Changing resource availability and use. *Ecology of Food and Nutrition* 33: 161-193.

- Mojeremane, W. and Tshwenyane, S.O. 2004. The Resource Role of Morula (*Sclerocarya birrea*). A Multipurpose Indigenous Fruit Tree of Botswana. *Journal of Biological Science* 4(6): 771-775.
- Moyo, M. 2009. Micropropagation and secondary metabolites of *Sclerocarya birrea*. MSc Dissertation, University of KwaZulu- Natal. Pietermaritzburg, South Africa.
- Ojewole, J.A. 2003. Evaluation of the anti-inflammatory properties of *Sclerocarya birrea* (A.Rich) Hochst. (Family: Anacardiaceae) stem-bark extracts in rats. *Journal of Ethnopharmacology* 85(2-3): 217-220.
- Ojawole, J.A. 2004. Evaluation of the analgesic anti-inflammatory and anti-diabetic properties of *Sclerocarya birrea* (A.Rich) Hochst. stem-bark aqueous extract in mice and rats. *Phytotherapy Research* 18(8): 601-608.
- Oliver-Bever, B. 1986. Anti-infective activity of higher plants. In: Medicinal Plants in Tropical West Africa. Cambridge University Press. Cambridge, United Kingdom.
- Palmer, E. and Pitman, N. 1972. Trees of Southern Africa. Volume 2. Struik Publisher. Cape Town, South Africa.
- Peters, C.R. 1988. Notes on the distribution and relative abundance of *Sclerocarya birrea* (A.Rich.) Hochst. (Anacardiaceae). *Monograph in Systematic Botany of the Missouri Botanical Garden* 25: 403-410.
- Petje, K.F. 2008. Determination of fruit yield and fruit quality in Marula (*Sclerocarya birrea* subsp. *caffra*) selections. University of Pretoria, South Africa.
- Runyaro, M. 2005. Population dynamics of Marula, *Sclerocarya birrea* subsp. *caffra* in Mwenezi, Zimbabwe. MSc Dissertation. University of Zimbabwe. Harare, Zimbabwe.

Shackleton, S.E., Shackleton, C.M., Cunningham, T.B., Sullivan, C.A. and Netshiluvhi, T.R. 2002a. Knowledge of *Sclerocarya birrea* subsp. *caffra* with emphasis on its importance as a non-timber forest product in South and Southern Africa Part 1. Taxonomy, ecology, traditional uses and role in rural livelihoods. *Southern African Forestry Journal* 194: 27-41.

Shackleton, C.M. 1996. Potential stimulation of local rural economies by harvesting secondary products: A case study of the central Transvaal Lowveld, South Africa. *Ambio* 25: 33-38.

Shackleton, C.M. 2002. Growth and fruit production of *Sclerocarya birrea* in the South African lowveld *Agroforestry Systems* 55: 175-180.

Shackleton, C.M., Botha, J., Emmanuel, P.L., Ndlovu, S. 2002b. Inventory of Marula (*Sclerocarya birrea* subsp. *caffra*) stocks and fruit yields in communal and protected areas of the Bushbuckridge Lowveld, Limpopo Province, South Africa. Department of Environmental Science. Rhodes University. Grahamstown, South Africa.

Shackleton, C.M., Dzerefos, C.M., Shackleton, S.E. and Mathabela, F.R. 2000. The use and trade in indigenous edible fruits in the Bushbuckridge savanna region, South Africa. *Ecology of Food and Nutrition* 39: 225-245.

Shone, A.K. 1979. Notes on the Marula. *Department of Water Affairs & Forestry Bulletin* 58: 1-89.

South Africa Channel. The Climate of Limpopo Province.

<http://www.southafrica.com/limpopo/climate/>

- Van Wyk, B.E. 2002. A review of ethnobotanical research of Southern Africa. *South Africa Journal of Botany* 68: 1-13.
- Van Wyk, J.A., Malan, F.S. and Randles, J.L. 1997. How long before resistance makes it possible to control some field strains of *Haemonchus contortus* in South Africa with any of the modern anthelmintics? *Veterinary Parasitology* 70(1-3): 111-122.
- Wynberg, R.P., Laird, S.A., Botha, J., Den Adel, S. and Mchardy, T. 2002. The management, use and commercialisation of marula: Policy issues. Centre for Ecology and Hydrology, Wallingford. Available from <http://www.nwl.ac.uk/research/winners/index.html>. Accessed 4 April, 2016.
- Xaba, P. 2011. Marula: Gardening with traditional useful indigenous plants. *Veld and Flora* 97 (2): 76-77.

CHAPTER FOUR

POPULATION STRUCTURE OF *Sclerocarya birrea* IN COMMUNAL AREA OF MASEA VILLAGE, LIMPOPO PROVINCE

4.1 Introduction

Most of the trees are under increasing pressure as more and more areas are modified or transformed. Direct causes of population decline include fuel wood harvesting, burning and conversion to cultivated field and plantation with the human population growth as the ultimate cause (Ingvar *et al.*, 2006). Population decline is also due to reaction to different kinds of disturbance but also long term dynamics and climate change.

Sclerocarya birrea (Marula) is a common and widespread species throughout the semi-arid, deciduous savanna of much of sub-Saharan Africa (Peters, 1988). It is a species that is usually found dominant in communities and it is also a keystone indigenous species in plant and animal community ecology and productivity. *S. birrea* is found growing in a wide variety of soils, i.e. from deep sands on granite to basaltic clays even though they prefer a well-drained soil (Lewis, 1987). The species is not well distributed in areas where there is frost (Palmer and Pitman, 1972; Johnson and Johnson, 1993).

When bark, fruit, wood and other parts of a species are harvested for the processing of various products (at household and or commercial levels), it has an important impact on the population structure and the distribution of species due to the nature of harvesting (Peters, 1995). There are some external factors that influence the performance of plants on how they are distributed to different life- cycle stages (Runyaro, 2005). Some factors are removal of bark by humans and by herbivory (Ehrlen, 1995). Farmers in Matshena village always select and retain the species when clearing the woodland for arable agriculture. According to local informants, the Marula trees have never appeared to decline in density.

Differences in size can affect the population of the same age that they can respond differently to the stimulus (Desmet *et al.* 1996). The population size structure reflects the past of demographic structure and also shows the future demographic structure (Bullock *et al.* 1996). Basal diameter, tree height and canopy cover are important characteristic of a tree (Avsar, 2004).

4.2 Materials and methods

4.2.1 Study area

The study area was located at Masea village in Mutale Local Municipality within the Vhembe District Municipality of Limpopo Province, South Africa. It is situated in the north eastern part of Thohoyandou town. The vegetation of the area is a Savanna biome on sandy soil. The study area receives approximately 650 - 1000 mm of annual rainfall in summer. The area is extremely hot in summer and mild in winter.

4.2.2 Methodology

Transects method was used to sample the population of *Sclerocarya birrea* using a 100 m measuring tape which, was laid down and all the individuals of *S. birrea* within the 5 m distance on both sides of the 100 m tape were sampled. Ecological data on the population of *S. birrea* was collected from an open communal veld area where people collect its resources. It was a subjective approach which selected an area that was having *S. birrea* individuals. Therefore, open communal areas in the village that did not have representative of *S. birrea* individuals were avoided.



Figure 4.1: Research assistant recording basal stem circumference on *S. birrea* individual.

Hundred and thirty individuals were sampled within 100 m x 10 m transects. The following parameters were recorded:

- i. Basal stem circumference in centimetres. Stem circumference measurements were taken at the base of the individuals using a measuring tape (Figure 4.1). In cases where an individual is multi-stemmed, all stems were measured and added in order to have an average.
- ii. Plant height in metres. Plant height measurements were recorded in meters (m) with an 8m digital reading measuring pole (Figure 4.2).
- iii. Crown health estimates on a sliding scale of 0 - 5. The assessment was interpreted as follows 0 - 100% crown mortality, 1- severe crown damage, 2 - moderate crown damage, 3 - light crown damage, 4 - trace of crown damage and 5 - healthy crown.



Figure 4.2: A research assistant measuring height of *S. birrea* individual using a measuring rod.

4.3 Results and discussion

4.3.1 Population structure

The population structure of *S. birrea* was expressed through stem diameter size class distribution and plant height size class distribution.

4.3.2 Size class distribution

The 130 individuals measured were divided into six size class based on their stem diameter. Size class ranges and distribution of individuals within them are presented in Figure 4.3.

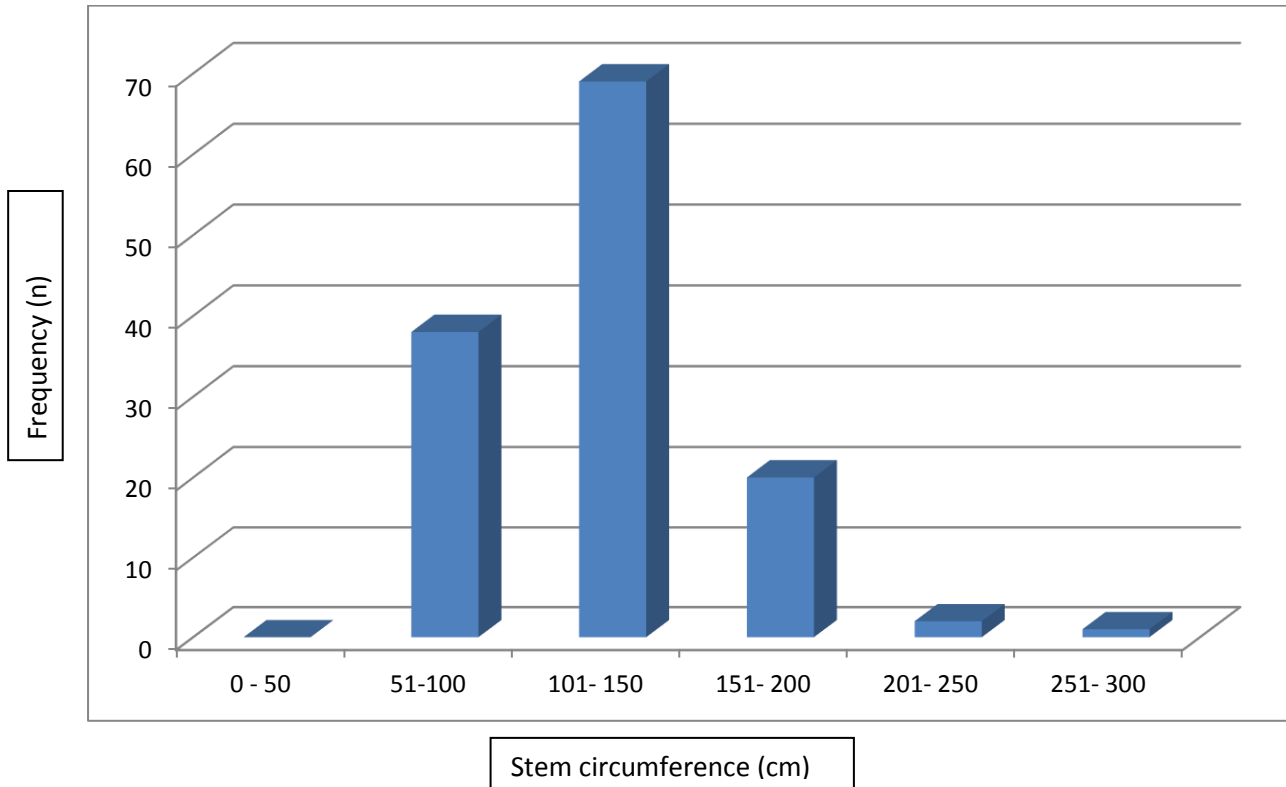


Figure 4.3: Size class distribution of *Sclerocarya birrea* population of Masea communal area in 2016.

The graph has bell-shaped size class 0 - 50 cm showing that there is no *S. birrea* in this size ($n = 0$) and extreme increase in number of individuals in the size class of 51 – 100 cm ($n = 38$) and 101 – 150 cm ($n = 69$). This population face difficulties in regenerating smaller trees. This is due to human activities like picking up all the fruits (seeds).

4.3.3 Plant height measurements

Table 4.1 shows 130 individuals that were categorised into nine classes as per height. The percentages were also calculated.

Table 4.1: Frequencies of *Sclerocarya birrea* individuals within different height classes

Plant height (m)	Frequency (n)	Percentage %
0 - 1.0	0	0%
1.1 - 2.0	0	0%
2.1 - 3.0	0	0%
3.1 - 4.0	6	5%
4.1 - 5.0	11	8%
5.1 - 6.0	24	18%
6.1 - 7.0	49	38%
7.1 - 8.0	35	27%
8.1 - 9.0	5	4%

The height class of 6.1 - 7.0 m has high number of individuals and there is a huge decrease in individuals from this class to 7.1 - 8.0 m this is from thirty eight percent (38%) to twenty seven percent (27%) and eighteen percent individuals respectively. Very few individuals recruited into small scale and large scale plant height classes, i.e. 3.1 - 4 m, 4.1 - 5 m and 8.1 - 9 m. In this study on the population of *S. birrea* is stable with only mature trees and no little or no evidence of successful regeneration or recruitment. This finding has also been reported by Gouwakinnou *et al.* (2009) in that the largest trees are available in agroforestry area as

compared to protected areas. The height classes of 0 - 1.0 m, 1.1 - 2.0, and 2.1 - 3.0 m had no individuals (0%). Severe browsing of Marula fruit by goat was also noted. The decline in seedling establishment was also due to human activities like harvesting of Marula fruit by removing the seeds from the population. Furthermore, it reduces recruitment of the population size class structure. An optional harvesting system should consider the regeneration potential of the species (Orbiri *et al.*, 2002).

Harvesting intensity and technique may therefore determine the magnitude of these impacts (Sinha and Bawa, 2002). It is therefore important to understand the population dynamics of each and every species. According to Klimas *et al.* (2007), population structure in forestry and ecological studies has been defined in terms of the size class or stem diameter.

4.3.4 Crown health

Crown health is regarded as an indication of a healthy tree (Sunderland and Tako, 1999). The population of *S. birrea* is dominated by individuals with healthy crown totalling seventy nine percent (79%), (n = 102), followed by eighteen percent (18%), (n = 24) individuals with trace of crown damage. However two percent (2%), (n = 3) had light crown damage. Only one percent (1%), (n = 1) was severely damaged.

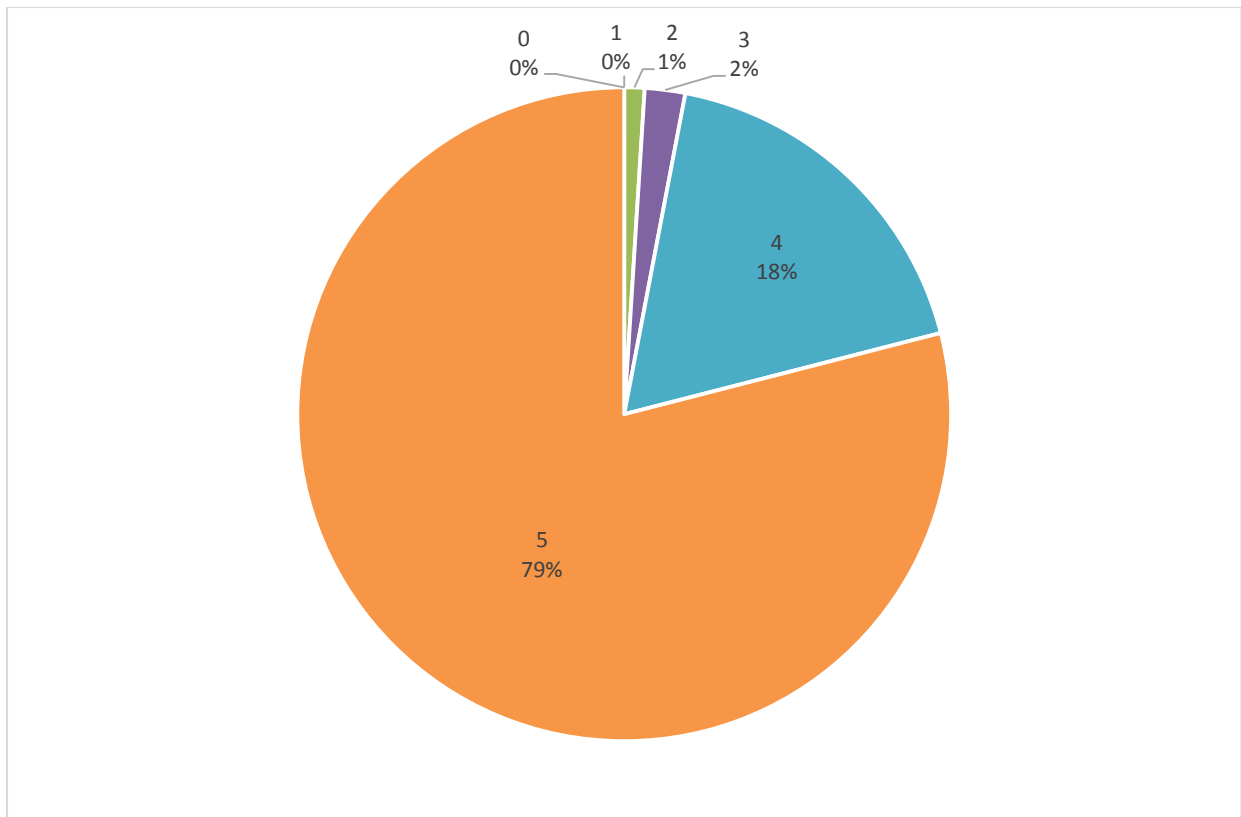


Figure 4.2: Crown health estimates of *Sclerocarya birrea* in percentages as per sliding of 0 - 5 on data collected from Masea communal area in 2016.

Seasonal condition may also play a role in the estimation of crown health status. During winter season numerous plants shed their leaves, but since data was collected during summer month (13-19th February), most of the trees were having healthy crown. However, Stravinskiene *et al.* (2015), reported old age as a contributing factor to severe crown defoliation in *Tilia cordata* tree species.

4.4 Conclusions

Most of *Sclerocarya birrea* trees are large in size and also make the crown of the tree an important habitat for some animals and plants. Some animals also benefit from this species i.e. from the fruits and foliage. According to Shackleton *et al.* (2002), even mosquitos benefit from the water-filled holes in the trunk of *S. birrea*. When harvesting Marula fruits it implies the removal of seed from population (Bernal, 1998). Harvesting of fruits at Masea also affect the recruitment of *S. birrea*, and the population is therefore dominated by larger trees. Other work on population characteristics of Marula also showed population structures with no seedling and no evidence of regeneration and recruitment as a result (Walker *et al.*, 1996; Lewis, 1987). Severe browsing of Marula seedlings by goat was also noted at Masea.

Harvesting method used in fruit of Marula does not show any direct environmental risk (Lombard *et al.*, 2000). There are things to be considered like collection for human use that may increase due to demand resulting from population growth. However, Peters (1999) also indicate the decline in recruitment and altered size structures on other species as a result of increased harvesting.

As a recommendation the protection of the remaining population should therefore be considered in order to save it.

References

- Avsar, M.D. 2004. The relationship between diameter at breast height, tree height, and crown diameter in Calabrian Pines (*Pinus brutia* Ten.) of Baskonus Mountain, Kahramanmaras, Turkey. *Journal of Biological Sciences* 4: 437 - 440.
- Bernal, R. 1998. Demography of the vegetable ivory palm *Phytelephas seemannii* in Colombia, and the impact of seed harvesting. *Journal of Applied Ecology*, 35: 64 - 74.
- Bullock, J.M., Silverton, J. and Hill, C.B. 1996. Plant demographic responses to environmental variation distinguishing between effects on age structure and effect on age specific vital rates. *Journal of Ecology* 84: 733 - 743.
- Desmet, P.G., Shackleton, C.M. and Robinson, E.R. 1996. The population dynamics of the life history attributes of a *Pterocarpus angolensis* D.C. population in the Northern Province, South Africa. *South African Journal of Botany* 62(3): 160 - 166.
- Ehrlen, J. 1995. Demography of the perennial herb *Lathyrus vernus* ii Herbivory and population dynamics. *Journal of Ecology* 83: 297 - 308.
- Gouwakinnou, G.N., Kindomihou, V., Assogbadjo, A.E. and Sinsin, B. 2009. Population structure and abundance of *Sclerocarya birrea* (A. Rich) Hochst subsp. *birrea* in two contrasting land- use systems in Benin. *International Journal of Biodiversity and Conservation* 1(6): 194 - 201.
- Ingvar, B., Borge, P., Lennart, S. and Ruffo, C. 2006. Tree communities and structural dynamics in miombo (*Brachystegia-Julbernadia* woodland), Tanzania. *Forest Ecology and Management* 230: 171 - 178.

- Johnson, D. and Johnson, S. 1993. Gardening with indigenous trees and shrubs. Southern Book Publishers. Halfway House, South Africa.
- Klimas, C.A., Kainer, K.A. and Wadt, L.H.O. 2007. Population structure of *Carapa guianensis* in two forest types in the South Western Brazil. *Amazon Forest Ecology and Management* 250: 256 - 265.
- Lewis, D.M. 1987. Fruiting patterns, seed germinating and distribution of *Sclerocarya birrea* in an elephant- inhibited woodland. *Biotropica* 19: 50 - 56.
- Lombard, C., Allanic, B. and Shilote, B. 2000. Potential for the development of Marula products in the Bushbuckridge area. DANCED - Community forestry project in the Bushbuckridge area. Department of Water Affairs and Forestry. Nelspruit, South Africa.
- Obiri, J., Lawes, M. and Mukolwe, M. 2002. The dynamics and sustainable use of high-value tree species of the Coastal Pondoland Forests of the Eastern Cape Province, South Africa. *Forest Ecology and Management* 168: 289 - 300.
- Palmer, E. and Pitman, N. 1972. Trees of South Africa. Balkema, Publishers. Cape Town, South Africa.
- Peters, C.M. 1995. Observations on the sustainable exploitation of non- timber topical forest products. An ecologist's perspective. In: Ruiz Perez M. and Arnold, J.E.M. 1995. Current issues in non- timber forest products research, CIFO, Bogor Indonesia.
- Peters, C.R. 1988. Notes on the distribution and relative abundance of *Sclerocarya birrea* (A.Rich.) Hochst. (Anacardiaceae). Monograph in Systematic Botanical Garden, 25: 403 - 410.

- Peters, C.M. 1999. Ecological research for sustainable non-wood forest product exploitation an overview In: Non- wood forest products of central Africa: Current research issues and prospects for conservation and development. Sunderland, T.C., Clark, L.E. and Vantomme, P. (Editors). FAO. Rome, Italy.
- Runyaro, M. 2005. Population dynamics of Marula, *Sclerocarya birrea* subsp. *caffra* in Mwenezi, Zimbabwe. MSc Dissertaton. University of Zimbabwe. Harare, Zimbabwe.
- Sinha, A. and Bawa, K.S. 2002. Harvesting techniques, hemiparasites and fruit production in two non-timber forest tree species in South India. *Forest Ecology and Management* 166: 289 - 300.
- Shackleton, S.E., Shackleton, C.M., Cunningham, B., Siluvan, C.A. and Netshiluvhi, T.R. 2002. Knowledge of *Sclerocarya birrea* subsp. *caffra* with emphasis on its importance as a non-timber forest product in South and Southern Arica Part 1 Taxonomy, ecology and role in rural livelihoods. *Southern African Forest Journal* 194: 27 - 41.
- Walker, B.H., Stone, L., Henderson, L. and Vened, M. 1996. Size structure analysis of the dominant trees in a South African Savanna. *South African Journal of Botany* 52: 397 - 402.

CHAPTER FIVE

GENERAL CONCLUSIONS AND RECOMENDATIONS

5.1 Conclusions

This is the chapter that summarizes the whole project. Chapter 1 was the introduction of the whole projects. It also includes the research questions, aims and objectives of the study, hypothesis and the structure of the dissertation.

Chapter 2 gave a thorough account on the literature review on *Sclerocarya birrea*. It is apparently clear that the species occupied an important space in the utilization profile of natural resources by members of communities around the globe, Africa as well as South Africa. Its utilization potential has also been documented amongst the Vhavenda of Limpopo Province.

Chapter 3 was about the utilization of *Sclerocarya birrea* in Matshena village. In this chapter thirty informants of different age groups were interviewed based on their knowledge of *S. birrea* from plant parts used, uses, management and availability. People from Matshena seem to have same knowledge on the uses of *S. birrea*. Most of them mentioned same uses like making beer (Mukumbi), jam, and they use nuts when cooking green vegetables. Very few of them mention medicinal use and the part used to treat various diseases.

In conclusion, it was found that people of Matshena village are not using this species for commercialisation like people from Bushbuckridge and Phalaborwa (Shackleton *et al.* 2000). They did not know about the oil extracted from the nuts. The use of kernels is high in other countries like on Inhaca Island where in 40 people were interviewed and indicated that they extract and consume Marula kernels (Shackleton *et al.* 2002). According to Grundy *et al.* (1993) similar levels of using kernels were also observed in Owambo (Namibia) and Mbengarewa (Zimbabwe).

The rural population can sell Marula products to the urban areas for generating income. *Sclerocarya birrea* is always present even during drought years therefore it can be useful as food security (Mojeremane *et al.*, 2004).

Chapter 4 was about population structure in communal area, wherein data was collected in Masea village, Mutale, Limpopo Province. Hundred and thirty individuals were sampled within sixteen 100 m x 10 m transects. Plant height was measured with an 8 m height rod, Basal stem diameter with tape measure and crown health were estimated on a sliding scale of 0 - 5. Crown health of almost all *S. birrea* have a good canopy, and it plays an important role in an ecological value as some species will grow beneath it.

According to Gouwakinnou *et al.* (2009), there were plenty of seedlings in agroforestry systems beneath adult trees that germinate during farming activities. This happened because the fruits will fall down on the ground and there will not be harvested by people or eaten by animals. If

protected areas lack seedlings it could be due to fire or drought (Zida *et al.*, 2007). Most of the savanna tree species experience long period of death at juvenile stage (Luoga *et al.*, 2004).

This findings on population ecology of *S. birrea* in communal area of using size-class distribution, height and crown health cannot alone conclude or predict the future of the population. It needs to be done during drought season also. According to Condit *et al.* (1998), it needs time to predict the future population of a species. An increased rate of rural population and agricultural activities have a negative impact on various species (Gouwakinnou *et al.*, 2009).

5.2 Recommendations

This area should be protected and people should be educated on how to harvest the fruits. There should be a time frame for harvesting the fruits and after such time people should no longer be allowed to harvest. So that the remaining fruits will fall down and regenerate as they will not be harvested.

Concerning fire wood, carvings and bark removal for medicines, communities should be empowered with required knowledge for effective management and to use this population in a sustainable manner. There should be a policy that should be followed when collecting indigenous fire wood. This species is dioecious and people can therefore be able to differentiate the sexes. It is therefore advisable that people should use male trees rather than female trees.

Knowledge of these plants is important not only for medicinal value but also for conservation point of view. This is because if a certain species is under threat for any reason certain measures can be implemented to main sustainability of that species. According to Luseba and Tshisikhawe (2012), indigenous knowledge should be recorded and not transmitted to younger generation by word of mouth only.

It is important to document the knowledge so that it can be useful to the next generation who may need this information in future. Some cultural influence and urbanisation lead to loss of traditional knowledge in South Africa. Some people from Matshena village indicated that they no longer use Marula tree for anything as they are Christians. Young scientists should be encouraged to use what has been found by the researchers concerning indigenous medicinal plants.

References

- Condit, R., Sukumar, R., Hubbell, S.P. and Foster R.B. 1998. Predicting population trends from size distribution: A direct test in tropical tree community. *American Naturalist* 152: 495-509.
- Gouwakinnou, G.N., Kindomihou, V., Assogbadjo, A.E. and Sinsin, B. 2009. Population structure and abundance of *Sclerocarya birrea* (A.Rich) Hochst subsp. *birrea* in two contrasting land-use systems in Benin. *International Journal of Biodiversity and Conservation* 1(6): 194-201.
- Grundy, I.M., Campbell, B.M., Balebereho, S., Cunliffe, R., Tafangenyasha, C., Fergusson, R. and Parry, D. 1993. Availability and use of trees in Mutanda Resettlement Area, Zimbabwe. *Forest Ecology and Management* 56: 243- 266.
- Luoga, E.J., Witkowski, E.T.F. and Balkwill, K. 2004. Regeneration by coppicing (resprouting) of miombo (African savanna) trees in relation to land use. *Forest Ecological Management* 189: 23-35.
- Luseba, D. and Tshisikhawe, M.P. 2013. Medicinal plants used in the treatment of livestock diseases in Vhembe region, Limpopo Province, South Africa. *Journal of Medicinal Plants Research* 7(10): 593-601.
- Mojeremane, W. and Tshwenyane, S.O. 2004. The resource role of morula (*Sclerocarya birrea*) - A multipurpose indigenous fruit tree of Botswana. *Journal of Biological Sciences* 4(6): 771-775
- Shackleton, S.E., Shackleton, C.M., Cunningham, T.B., Sullivan, C.A. and Netshiluvhi, T.R. 2002. Knowledge of *Sclerocarya birrea* subsp. *caffra* with emphasis on its importance

as a non-timber forest product in South and Southern. Africa Part 1. Taxonomy, ecology and role in rural livelihoods. *Southern African Forest Journal* 194: 27-51.

Shackleton, C.M., Dzerefos, C.M., Shackleton, S.E. and Mathabela, F.R. 2000. The use and trade in indigenous edible fruits in the Bushbuckridge savanna region, South Africa. *Ecology of Food and Nutrition* 39: 225-245.

Zida, D., Sawadogo, L., Tigabu, M., Tiveau, D. and Oden, P.C. 2007. Dynamics of sampling population in savanna woodlands of Burkina Faso subjected to grazing, early fire and selective tree cutting to a decade. *Forest Ecological Management* 243:102-115.

APPENDIX I: Ethnobotanical knowledge questionnaire.

UNIVERSITY OF VENDA

DEPARTMENT OF BOTANY

QUESTIONNAIRE FOR SCLEROCARYA BIRREA

NB: Informants were interviewed with their prior informed consent.

Age: Youth Middle – aged Elder

Gender: Male Female

Locality _____

Local name of the plant: _____

Plant parts used: Roots Leaves Others

Stem Whole

Fruits Barks

Uses: _____

Management

Availability: Very high High Moderate Low
Very low

How do you maintain the above status for continuous availability of the species:

