ADDIS ABABA UNIVERSITY

SCHOOL OF GRADUATE STUDIES

DIVERSITY, DISTRIBUTION AND POTENTIAL VALUES OF VEGETABLES IN MGORI DIVISION, SINGIDA-TANZANIA

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JULY 2004

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Diversity, Distribution and Potential values of Vegetables in Mgori Division, Singida-Tanzania

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A Thesis Submitted to the School of Graduate Studies of Addis Ababa University in Partial Fulfilment of the Requirements for the award of the Degree of Master of Science in Dryland Biodiversity under the Biology Department, Faculty of Science

July 2004

DEDICATION

This work is dedicated to:

My father, the late Mwl. John Salanga, who built the foundation of my education and who I wish could have lived to read this work. The grace of the Lord is sufficient. Dad, may God the Almighty rest your soul in eternal peace, Amen!

To my mother Colleta Leonce who brought me up and made a great effort to educate me. Mom, accept my utmost gratitude. May God the Almighty bless you!

ACKNOWLEDGEMENTS

I received a lot of assistance and support both materially and morally from quite a number of people in Ethiopia, Kenya and Tanzania. It is difficult to mention all of them by names in these pages. I would, however wish to express my heartiest felt gratitude to the following: My supervisors: Dr. Zemede Asfaw and Prof. Zerihun Woldu for their untiring work from supervision and material support. Prof. Zerihun Woldu, your assistance in vegetation data analysis is cordially acknowledged. Thanks to Dr. Amon P. Maerere, the co-supervisor of SUA, Department of Crop Science & Production-Morogoro in Tanzania, for his assistance with the computer and his guidance in the field during data collection. Thanks to Mr. T. Msogoya, for your interest on this study and for visiting me in the site during data collection. Thanks for the discussions we have had, encouragements and material support. Thanks to Prof. Hamza J. Kiko, Dr. Munishi K.T. Pantaleo and Dr. E.J. Luoga of Faculty of Forest and Nature Conservation-SUA for the invaluable discussions we have had and for moral and material support. I am also greatly indebted to my friends Alfred Sife, of SNAL-Morogoro in Tanzania, for his immense support in search of materials and Vendeline Tairo who introduced me to the SPSS computer programme. Thanks to all the staff members of the SNAL for the cooperation availed to me in search of literatures.

This study would not have been possible without the financial support of Sida-SAREC through RPSUD, which granted me with the scholarship to pursue this postgraduate program. In line with this I must thank the RPSUD Executive Committee members-to name a few: Prof. A. M. Nikundiwe and Dr. F. Urassa of UDSM, Dr. Jeff Odera

and M/s Joyce Kinyanjui of NMK-Nairobi and Dr. Tamrat Bekele- Course coordinator AAU, or their coordinating work. My gratitude is also due to my employer MOEC, for granting me an extended study leave. My thanks are due to the District Council of Singida as a whole and especially Orgut (LAMP), for accepting me; logistics support and facilitating my research work in Mgori Division. Most grateful to Mr. Charles Thomas for his enormous contribution in data collection - your enthusiasm and knowledge on the ground was crucial. I would like to express my appreciation to Mr. Suleiman Haji, the technician from the Herbarium of the Botany Department-USDM, for participating in the fieldwork and in the identification of plants. I wish to extend my sincere gratitude to all the Key informants consulted during this study. All the elders consulted, without forgetting a great contribution by a famous traditional healer in the area, Mzee Mungwe Majengo, whose knowledge on plants and their various uses is highly appreciated. Many thanks are also due to my classmates: Agnes Lusweti, Edward Njagi, Eyassu Chama, Hussein Adal, Leonard Jones, Meshack Malo, Omary Issango, Phillista Athiambo, Peter Angaine, Kinfemichael Geressu and Yassin Chumburo, whose good company and encouragements gave me a memorable stay in Ethiopia.

Lastly, but certainly not least, my family: My dearest wife, Dr. Consolata Salanga for bearing the burden of taking care of the family during my absence and for enduring the torture of separation. Her great support and prayers were prerequisites for getting this over with smoothly. Connie, sorry for keeping myself in books and in the field longer than expected...Thanks to our lovely daughter Yvonne, for her understanding and persevering the absence of the fatherly love and care. Both of you have always been a constant inspiration and source of strength to my work. Thanks to the rest of my family members for their prayers and support to my family during my absence.

Table of Contents

List of Tables

List of Figures

List of Appendices

List of Plates

ABREVIATIONS/ACRONYMS

FAO	Food and Agriculture Organisation of the United Nations
HORT-Tengeru	Horticulture Training Institute
IBPGR	International Board for Plant Genetic Resources
LAMP - Singida	Land Management Programme in Singida Region
m.a.s.l	Meters above sea level
MFR	Mgori Forest Reserve
MOEC	Ministry of Education and Culture
NGO	Non-Governmental Organisations
NMK	National Museums of Kenya
NORAD	Norwegian Agency for Development
RPSUD	Research Programme on Sustainable Use of Dryland Biodiversity
SAREC	Swedish Agency for Research and Extension Corporation
Sida	Swedish International Development Corporation Agency
SNAL	Sokoine National Agricultural Library
SUA	Sokoine University of Agriculture
UDSM	University of Dar es Salaam
UNDP	United Nations Development Programme
UNEP	United Nations Environmental Programme

ABSTRACT

This study employed both ecological and ethnobotanical approaches to document information about the diversity, distribution and potential values of vegetable plant species at Mgori Division of Singida Rural District, in Central Tanzania. The plant species diversity and distribution in Mgori Forest Reserve (MGF) have been described. A total of 304 plant species were collected and identified representing 53 families. Of these 56 species belonging to 21 families were identified by the local people important for use as vegetables. This accounts for 18.4% of all the identified plant species in the area. About 35.7% of the plant species recognised as vegetables having medicinal values. Such plants with both food and medicinal values are called nutraceutical plants. It was therefore found out that, 90% % of these nutraceuticals are used as remedies of human ailments and only 5.3% are used for the treatment of animal diseases. *Adansonia digitata, Solanum nigrum* and *Mukia maderaspatana* are used for the treatment of both human and livestock ailments. Amaranthaceae, Euphorbiaceae and Tiliaceae each contributed 4% to the total vegetables. Of the identified vegetable plant species, 3.6% were trees, 8.9% were shrubs, 32% were climbers and 53.6% were herbs. Further analysis revealed that, plant species belonging to the Family Cucurbitaceae contributed more species for use as vegetables by the indigenous people accounting for 17.9% of the vegetable species in the area. Environmental factors such as % slope, altitude, and fire (the most prominent disturbance in the area, especially during the dry season) were collected. Plant species for both dry and wet seasons were classified into 4 and 5 community types respectively, using SYNTAX computer program. The vegetation results revealed instability of plant communities. Fire incidences in the area and the effect of climate were responsible for manifestation of two sets of communities. Thus, the dry season

community types are the vegetation types of Mgori Forest Reserve. The distribution of plant species and sample plots in relation to environmental variables were subjected into analysis of variance (ANOVA). Species diversity, richness and evenness were generally found to be high in sample plots belonging to wet season community types and generally low in dry season community types. Plant species diversity and richness decreased with distance from the homesteads. The woodlands and shrublands had high plant species than the grasslands. Drought and over-harvesting are reported to be the main cause for the scarcity of some vegetable plant species. However, no vegetable plant species in the IUCN red list of threatened species was identified. A number of indigenous practices used by the local people have been documented. Most wild and cultivated vegetables were found to grow more on disturbed lands, such as farmlands, fallow lands and less in the natural forest. Only 39% of the identified vegetables in the area were found to grow in the natural forest. Their density and cover abundance values recorded higher during the wet season community types and lower in dry season, which means more of these vegetables are annuals. Their density and cover abundance values also decreased as one moved from the villages towards the forest. Recommendations towards the conservation of vegetable plant species in the area are put forward.

1 INTRODUCTION

1.1 Background

Many developing countries are endowed with rich and diverse biological resources provided by the biological diversity found in their territories. Biodiversity is the total variability between and within all living organisms (Friis-Hansen and Sthapit, 2000). Biodiversity or genetic variability is vital to well-being of the living things on earth. It secures food supply, provides a source of medicine and helps regulate global climate. Today much of the world's biodiversity is concentrated in remote areas, where it furnishes life's necessities to local communities and indigenous peoples (GoT, 2002). Biodiversity is disappearing at an ever-quick rate because of varied forces of environmental destruction and globalization, reducing the wealth of nations (FAO, 1996b).

Wild and cultivated vegetables constitute an important and unexplored biological resource in many countries. Before the introduction of exotic species to Africa, the traditional species of vegetables were widely consumed, particularly during famine or natural disasters (FAO, 1988). While most of them are gathered or are grown in home gardens as intercrops with staples, they may find their way to urban markets (Mnzava, 1997). The diversity in traditional vegetables offers varieties in family diet and helps ensure household food security (Mingochi and Luchen, 1997).

Throughout the world, at least 75,000 plant species are believed to be edible, yet humans depend on just a few species as our major sources of food and more than 90% of the world's nutritional needs are provided by a mere 30 plant species, and only about 150 species are commercially cultivated (FAO, 1996a & b; FAO, 2003). Based on this information, Bukenya (1997) argued that the human plant food base is limited to a few plant species and thus does not offer adequate food security.

Public institutions and seed companies in African countries tend to spend more funds and efforts in the introduction of international exotic vegetable species and cultivars thereby neglecting the use of local vegetables (Gruben & Almekinders, 1997). Indigenous vegetables serve many people as famine food, as it takes much less time for the leaves and young shoots of these plants to become ready for eating compared to grains (Zemede Asfaw, 1997). According to this source, vegetable consumption also serves as a means of coping. Generally, indigenous vegetables are usually cheaper than exotic ones. Therefore, they are especially important for people with low income in both rural and urban communities (FAO, 1990).

Vegetables play a very vital part in supplementing the diet of the people of Tanzania (GoT, 1998). The degree of dependence on indigenous vegetables has gradually decreased as vegetables that are more exotic are being introduced (Mnzava, 1997; Swai, 1997). Although the use of indigenous vegetables has recently decreased, many people in rural areas still use them extensively as a supplement to their basic food requirements. Some are preserved for use during periods of scarcity and they are sometimes sold in the urban markets and in competition with

crops of exotic origin (Manyafu, 1971). Although the popularity of these indigenous vegetables has declined, it is considered that special attention should be paid to them in order to maintain and improve this important food source (Manyafu, 1971). The botanical, nutritional and social science literature document the use of such plants in providing important micronutrients and energy under a broad range of conditions (Chweya, 1997; Mnzava, 1997; Swai, 1997). Still researchers and health professionals interested in traditional medicines frequently neglect the important roles of indigenous foods in traditional health-care systems and focus only on bioactive industrial substances. This approach is all inappropriate since many species are both medicine and food.

Literature has continued to stress the importance of edible traditional plants as part of human diet in many African countries, yet indigenous vegetables are commonly dismissed by agricultural planners, who stress on the production of more domesticated field crops (Okigbo, 1977). What is needed is better understanding of traditional farming practices especially customs that protect and manage indigenous food resources since farmers regularly diversify their diets by using such plants.

The manner in which certain traditional vegetable species are exploited makes them vulnerable to extinction. This is especially true of the root and fruit vegetable species whose harvesting involves destroying the entire plant by uprooting. There are threats of extinction due to land clearing for agriculture, population growth, urbanization and overgrazing, unfavourable weather conditions such as droughts, and extreme temperatures have been experienced in recent

years. In Zambia, for example, the association of these vegetables in people's minds with backwardness and feeding habits has been undermining their use in favour of exotic vegetables (Mingochi and Luchen, 1997). Similar trend also exists in Tanzania. There is generally inadequate knowledge on the nutritional importance of indigenous vegetables leading to neglect (Mnzava, 1997). Most traditional vegetables are specific to areas and ethnic groups and are highly seasonal (Mingochi & Luchen, 1997). All these attributes discourage their development and conservation.

Information on both wild and cultivated vegetables in Tanzania is scanty and dispersed (Mnzava, 1993). Early studies by Manyafu (1971), Fleuret (1979b) and Gerson (1989), are exploratory in nature. Despite the wide range of indigenous vegetables found in Tanzania, a few have been scientifically documented (Swai, 1997). On the other hand, indigenous knowledge of their nutritive values, methods of production, preservation and utilization of indigenous vegetables is disappearing with the young people moving to urban centres and as systematic transmission of the information from the old generation breaks down (Swai, 1997; Ruffo *et al.*, 2000). There is a need to mobilize staff and financial resources at the national level to strengthen the activities of inventory, collection, characterization, evaluation and documentation of traditional vegetables.

Indigenous vegetables have been largely by-passed by formal research development and conservation efforts; hence, local communities are holding much of the expertise about these plant genetic resources in the form of indigenous knowledge (Okigbo, 1977; Guarino, 1997). Gaining access to that knowledge and using it in a fair and equitable way so that communities receive the appropriate recognition and benefits from the use of their knowledge is an important issue to address. There is a need to document and support aspects of indigenous knowledge and traditional practices that promote the conservation of genetic diversity of vegetables and to study the vegetation types in the area, in order to determine the distribution of both wild and cultivated vegetables in different vegetation community types.

1.2 OBJECTIVES OF THE STUDY

1.2.1 General objective

The main objective was to study the diversity, distribution and potential values of vegetables at Mgori Division of Singida Region in Tanzania.

1.2.2 Specific objectives

(i) To conduct an inventory and compile a list of the important plants used as vegetables by the Nyaturu tribe.

(ii) To collect, prepare and document botanical voucher specimens of both wild and cultivated vegetables of the study area.

iii) To assess the extent of household dependency on indigenous vegetables and to see how the dependency varies with season.

(iv) To identify threats to the diversity and availability of vegetables and explore pre-requisites for domestication of wild vegetables.

(v) To identify and examine indigenous knowledge / practices used by the Nyaturu people to conserve vegetable plants in the study area.

(vi) To examine the distribution of wild and cultivated vegetables in both local land use categories and vegetation types.

2 LITERATURE REVIEW

2.1 Wild and cultivated plants

The term "wild" when applied to plants or plant species refers to those that grow spontaneously in self-maintaining populations in natural or semi natural ecosystems and exist independently of direct human action (FAO, 2003). The term is contrasted with "cultivated" or "domesticated" plants or plants species that have arisen through human action, such as selection or breeding and that depend on management for their continued existence (FAO, 2003).

In practice, the distinction is not an easy one to make, as there is a complete spectrum between completely wild and completely domesticated species depending on the degree of human intervention or management involved. Zemede Asfaw and Mesfin Tadesse (2001) discussed on this wild-semi-wild–domesticated continuum and pointed out that, wild plants that are more commonly found in human managed landscapes are regarded as semi wild. These authors indicated that in Ethiopia, species such as *Opuntia ficus-indica* are in the pipeline of being domesticated crops due to their sporadic use, occasional purposeful planting and harvesting, crop fields, and proximal growth with gardens and living quarters. They further elaborated that these species are consumed regularly in small quantities when food is sufficiently available, but in large quantities when food is scarce and are tolerated around cultivated areas, home gardens and margins. They are either encouraged or tolerated to grow on fences and fallow lands. Some social anthropologists insist that, terms such as "wild" and "domesticated" are culturally specific and would, for example, have quite different meanings to a European farmer and an African farmer (Posey, 1992). In conclusion, it is therefore difficult to maintain a strict separation

between "wild" and "cultivated" plants.

2.2 Wild plants and biodiversity

Throughout the world, thousands of plant species are used by humans and can be considered resources. About 5,000 have been cultivated at one time or another, but of the 250,000 to 300,000 known higher plant species, only a few hundred species have been fully domesticated and enter world trade (FAO, 1996a).

In Tropical countries, only 103 species of food plants contribute to 90 % of national per capita supplies, while 20 to 30 of these species are regarded as the staples that supply most of human nutrition needs (FAO, 2003). On the other hand, thousands of species grown locally are scarcely or only partially domesticated and thousands more are gathered from the wild. Not surprisingly, most of the partially domesticated or wild collected species are found in the tropics. For example, the Plant Resources of South East Asia (PROSEA) project records nearly 6,000 species in its basic list of species (some of them exotic) used by humankind in that region, and assuming similar levels in other tropical regions, a figure of 18,000 to 25,000 species can be extrapolated for the tropics as a whole (FAO, 1996b). In addition, several thousands plant species are used in human activities in the Mediterranean and temperate regions of the world. These figures exclude most of the 25,000 species that are estimated to have been used or are still in use as herbal medicines in various parts of the world, especially China, Tropical Asia, the Indian subcontinent, Africa and Central and South America, and the many thousands of species grown as ornamentals in parks and in public and private gardens and in the horticultural trade (FAO, 2003).

2.3 Defining vegetables and their classification

The word vegetable is used to designate an edible, mostly herbaceous plant species, or a relatively tender part of it, that is consumed fresh, steamed or boiled, salted or unsalted, alone or in combination with other foodstuffs and sometimes as an ingredient in soups or stews (Okigbo, 1980).

Several criteria are used for classifying vegetables depending on their usefulness. These include, botanical criteria, optimum growing temperature, edible part of the plant used for food, salt tolerance and tolerance to soil infertility (Berinyuy *et al.*, 1997). According to the edible part criterion (which is of much interest to consumers), vegetables can be divided into leafy vegetables, fruit vegetables, seed vegetables and root vegetables; grown respectively mainly for their green leaves, fresh fruits, dried seeds, and fresh roots or petioles (Tindall, 1974). Wild vegetables, for example, are all categories of plants whose leaves, fruits or roots are acceptable and used as vegetables by rural and urban communities through custom, habit and tradition (FAO, 1988). To define what is and what is not a vegetable was found to be far from easy, so that rather than attempting to redefine the meaning of the word, reliance is made on what local people considered to be vegetables (Schippers, 2002). According to this source, several leguminous crops that are mainly used for their roots or for their seeds rather than their green pods or leaves do not qualify as vegetables. Generally, the term vegetable is applied for those horticultural food crops, which do not fall into the category of fruits, dry pulses, nuts, spices or large starchy roots (Schippers, 2002).

2.3.1 Leafy vegetables

These are vegetables that consist of edible leaves of plants such as the African spinach (*Amarathus hybridus var. cruentus*), *Amaranthus spinosus*, *Celocia argentia*, vegetable jute (Corhorus *olitorius*), Lettuce (*Lactuca sativa*), cabbage (*Brassica oleracea var.capitata*) and *Ceratotheca sesamoides* (Okigbo, 1978). Most vegetables include not just the leaf blade but also their petioles (leaf stalks).

2.3.2 Fruit vegetables

These are plants whose fresh edible parts consist mainly of fruits or similar reproductive structures. Within this group are okra (*Abelmoschus esculentus*), tomatoes (*Lycopersicon esculentus*), the pumpkins and squashes (*Curcubita spp.*), the eggplant (*Solanum melongena*), the sweet pepper (*Capsicum anuum* var. *frutescens*) and many others (Tindall, 1968).

2.3.3 Flower vegetables

This is a group of vegetables whose flowers or flowering structures constitute the edible part of the plant. Included here are cauliflower (*Brassica oleraceae var. italica*) and the cocoyam (*Colocasia esculenta*) (Okigbo, 1990).

2.3.4 Root and tuber vegetables

These consist of plants that produce underground edible swollen storage organs, which are either anatomically, formed from stems, for example yams (*Dioscorea spp.*), Irish potato (*Solanum tuberosum*), carrot (*Daucus carrota*), or from roots such as beetroot (*Beta vulgaris*), cassava (*Manihot esculenta*), and sweet potatoes (*Ipomoea batatas*)(Tindall, 1974; Mnzava, 1990a; Okigbo, 1990).

2.3.5 Stem or shoot vegetables

These are vegetables that consist of edible portions of stems, vines or twigs made up of succulent or young leaves, petioles and the tender apical portions of the shoot to which some leaves are attached. Examples of vegetables in this group include asparagus (*Asparagus officinalis*), pig weeds (*Amaranthus spp.*), tips of vines of sweet potato, fluted pumpkin and pumpkin (Tindall, 1974; Okigbo, 1990).

2.3.6 Other plant parts

Other plant parts that are used as vegetables include bulbs as in onions and leeks and petioles as in celery and rhubarb. In many vegetables, more than one part of the plant may be used as food. In the cowpea, the leaves, tender pods and seeds are used; in okra, the fruits and young leaves; in peas, the seeds and pods are used as vegetables; in lima beans, it is mainly the young seeds; in onions, the bulb is the main vegetable while in spring onions, the leaves and not much of the bulbs (Tindall, 1974; Okigbo, 1990).

2.4 Comparing indigenous and exotic vegetables

Indigenous vegetables are comparable to their exotic counterparts in many ways. Many of the local vegetables are often far more nutritious than exotics (Mnzava, 1997). Indigenous vegetables, both wild and cultivated are already adapted to local environmental conditions. They are therefore tolerant to abiotic and biotic stresses found locally (Chweya, 1997; Gruben & Amelkinders, 1997). They are already known and popular, hence promoting their consumption in both rural and urban areas is logical than promoting the use of exotic types (Chweya, 1997). On the other hand, exotic types are expensive to grow or buy, as they require advanced and expensive agro techniques. Rural communities are therefore, unable to buy and use the exotic vegetables and this may lead to under nourishment (Chweya, 1997). It has been reported from many African countries that exotic vegetables are more widely cultivated than indigenous species in terms of use and management (Chweya, 1997; Maundu, 1997; Mnzava, 1997). Apart from their traditional use as food in many parts of Tanzania, these indigenous vegetables have many potential advantages over the exotic types: They are already adapted to the local environment; they are often immune to disease; they are less adversely affected by insect than exotic types and they are adapted to withstand competition with other plants and weeds (Chweya, 1997; Mnzava, 1997; Swai, 1997).

2.5 Nutritional value of vegetables

Vegetables remain the cheapest source of important proteins, vitamins, minerals and essential amino acids in the diet of many rural communities in Tanzania (Fleuret, 1979a) and in Africa at large. In their diversity of species, forms and texture, vegetables can supplement the diet with

nutrients in a way that cannot be achieved with any other major energy-providing food (Attere, 1990). However, it should be noted that the nutritional value of indigenous vegetables is comparable to that of the exotic vegetables (Chweya, 1985; Mnzava, 1997). Unlike the past, present researches are carried out on some nutritional values of indigenous vegetables (Tables 1&2). In Tanzania, wild food plants have been analysed for their nutritional contents and available data indicate that many local vegetables have a higher nutrivive value than the exotic vegetables commonly sold in markerts (Mnzava, 1990a & b; Ruffo *et al.*, 2002). For example, *Amaranthus spinosus*, *Bidens pilosa* and *Sesamum angolense* are the local vegetables that are high in protein, fats and minerals (calcium and iron). Other local vegetables have calcium contents of 1.5-3.2 times higher than those of the cabbage family species whose calcium content is the highest of all the exotic vegetables (Ruffo *et al.*, 2002). There have also been some comparative studies on the nutritive value of indigenous wild vegetables to those of exotic vegetables (Table 3).

Table 1: Dry matter, protein, and total ash, vitamin A and vitamin C contents of vegetables

Vegetables	Dry mater %	Crude protein %	Total ash %	Vitamin A (mg/100g)	Vitamin C (mg/100g)
Amaranthus spp.	14.2	4.3	3.3	5.3	102
Cleome gynandra (Gynandropsis gynandra)	15.3	5.7	2.1	10.8	139
Corchorus olitorius	16.3	4.7	2.6	9.2	125
Vigna unguiculata	12.6	4.6	2.0	5.5	87
Solanum nigrum	13.6	4.4	1.4	4.9	112
Curcubita spp.	15.3	5.1	2.0	7.1	172
Crotalaria brevidens	13.5	4.9	1.4	4.3	190
African kale	11.7	4.5	1.8	4.6	122

Source: Attere (1990)

Table 2: Fatty acid composition (% of total fatty acids) in seeds of cleome (*Cleome gynandra*) selections

Fatty acids	Selections				
	Purple stem	NIRS-2	NIRS-3	Green stem	Mean
Palmitic (16:1)	11.5	10.7	11.2	11.7	11.2
Palmitoteic (18:0)	0.3	0.4	0.3	0.3	0.3
Stearic (18:1)	6.4	7.6	6.1	6.1	6.6
Oleic (18:1)	19.6	23.9	21.5	22.2	21.8
Linoneic (18:3)	61.1	59.3	59.7	58.6	58.9
Arachidic (20:0)	0.1	0.2	0.2	0.2	0.2
Eicosenoic (20:1)	0.1	0.1	0.1	0.1	0.1

Source: Mnzava (1990a, b)

Indigenous vegetable species are therefore, known to contain varying concentrations of nutrients, according to variety, stage of maturity, conditions of storage, methods of processing and sometimes origin (Attere, 1990).

Table 3: Nutrient content of some Kenyan indigenous and exotic vegetables (Per 100g edible portions)

Vegetable (English) name	Vitamin A (mg carotene) RDA)	Vitamin C (mg) RDA	Protein (g) RDA	Calcium (mg) RDA	Iron (mg) RDA
Cleome gynandra (Cat's whiskers)	6.7 - 18.9	127 - 177	5.4 - 7.7	434	11
Solanum nigrum	2.7 - 7.9	37 - 141	3.2 - 4.6	215	4.2
Amaranthus spp. (Pig weed)	5.3 - 8.7	92 - 159	4.0 - 4.3	800	4.1
Crotalaria brevidens	2.9 - 8.7	115 - 129	4.2 - 4.9	270	7.7
Corchorus olitorious	3.9 - 5.4	170 - 204	4.5 - 5.5	270	3.8
Curcubita spp.	2.4 - 5.3	170 - 172	3.1 - 4.2	40	2.1
African kale	3.7 - 5.7	102 - 142	3.6 - 3.8	520	6
Spinach	2.8 - 7.4	1 - 59	2.3 - 3.1	60 - 595	0.8 - 4.5
Cabbage (white)	Trace - -4.8	20 - 220	1.4 - 3.3	30 - 204	0.5 - 1.9
Cauliflower	Trace - -0.4	8 - 114	1.8 - 3.4	13 - 43	0.2 - 1.9
Lettuce	0.15 - 7.8	3 - 33	0.8 - 1.6	17 - 107	0.5 - 4.0
French beans	0.02 - 0.6	5 - 28	1.1 - 2.4	30 - 65	0.5 - 3.2

Source: Awino (1989)

It can be observed in Table 3 that most indigenous vegetables such as cucurbits and *Solanum nigrum* contain ascorbic acid as high as about 160mg/100g and 240mg/100g. Some of the exotic vegetables such as kale and spinach contain about 190mg/100g and 50mg/100g respectively (Awino, 1989).

2.6 Role of vegetables in food security and income generation

The virtue and need for vegetables for human nutrition and food security points of view is well known. In addition, vegetables can add varicty and nutritive value of diets. The contribution of vegetables to household income and creation of employment needs not be further emphasized. In most developing countries, there are excellent examples of individual farmers and farming communities who are successfully engaged in vegetable production, distribution and processing. Because of the higher incomes obtained from vegetables, farmers tend to be more prosperous than those who grow cereals and other staples. In contrast to the conventional vegetables that can be raised or purchased from the local markets, the wild vegetable plants involve no cash outlay and little efforts to gather. However, some of these are found in the markets when they have been gathered for sale. In this case, the potential of indigenous vegetables in income generation is realized. Parts of these plants can be made into many palatable dishes such as stews and salads. The leaves can make a material contribution to the vitamin intake when they are eaten. The vitamin content in some exotic and indigenous vegetables is given in Table 3. This food preference has increased the emphasis of growing exotic vegetable species at the expense of local or indigenous species.

2.7 Concept of species diversity

A biological community has an attribute that we call species diversity and many different ways have been suggested for measuring it. Recent interest in conservation has generated a strong focus on how to measure species diversity in both plant and animal communities by using different diversity indices. Magurran (1988) provided a unified framework for the study of species diversity. Although biodiversity has a broader meaning than species diversity as it includes genetic, ecosystem and cultural diversity, species diversity is still a large part of the focus of biodiversity at the local and regional scale (Kent & Coker, 1992; Krebs, 1998). Early naturalists observed more species of both plants and animals in tropical areas than in temperate regions. According to Krebs (1998), as ecological ideas matured and ideas of quantitative measurement were introduced it became clear that the idea of diversity involved two distinct components, i.e. species richness and evenness.

2.7.1 Species richness

This is the oldest, simplest and the basic measure of species diversity (Whittaker, 1970; Krebs, 1998). It refers to the number of species in the community. The term "species richness" was coined by McIntosh (1967) to describe this concept. However, the basic measurement problem of this concept as observed by Krebs (1998) is that, it is often impossible to enumerate all the species in a natural community. Whittaker (1970), described this measure as a number of species "S", in a sample of standard size, which can be called "richness in species" or "species density" in distinction from population density and expressed it as follows:

$d = S / \log A$, or $S / \log N$. Where:

S is the number of species in a sample (of standard size),

A is the sample area (usually in square metres),

N is the total number of individuals in the sample.

The numbers of species in different-sized-samples from a given community are approximately proportional to the logarithms of the areas of the samples. Hence, in this mathematical relation, the measure "d" can be used to compare diversities of samples that differ in size, but are not too widely different in size (Whittaker, 1975).

2.7.2 Evenness

Lloyd and Ghelardi (1964) were the first to suggest this concept. Since heterogeneity contains two separate ideas-species richness and evenness, then they tried to measure the evenness component separately. Whittaker (1973), on the other hand considers this concept as equitability. Its base is on the fact that most communities of plants and animals contain a few dominant species and many species that are relatively uncommon. Evenness measure attempts to quantify this unique representation against a hypothetical community in which all species are equally common, such that when all species have equal abundances in the community, evenness is maximal.

Many different measures of evenness or equitability have been proposed. The literature is more confusing about which measure is the best. Smith and Wilson (1996) have recently reviewed 14 indices of evenness with respect to the criterion that evenness measures must be independent of species richness. According to Krebs (1998), the most common approach has been to scale one of

the heterogeneity measures relative to its maximal value when each species in the sample is represented by the same number of individuals. In this case, two formulations are available:

Evenness = D/Dmax

Evenness = D-Dmin / Dmax- Dmin,

Where: D = Observed index of species diversity.

Dmax= Maximum possible index of diversity, given "S" species and "N" individuals.

Many evenness measures should range from 0 to 1 (Krebs, 1998).

Equitability can also be given by Simpson's measure of Evenness. For Simpson's measure of heterogeneity, maximum diversity is obtained when all abundances are equal to (P=1/S), so in a very large population: DMAX=1/ S where: DMAX= Maximum possible value for Simpson's index,

S= Number of species in the sample.

It follows from this that; the maximum possible value for the reciprocal of Simpson's index (1/D) is always equal to the number of species observed in the sample. This leads to a simple definition of Simpson's index of evenness:

$E_{1/D}$= 1/D/S where:

$E_{1/D}$= Simpson's measure of Evenness,

D= Simpson index,

S= Number of species in the sample. Again the index ranges from 0 to 1 and is relatively unaffected by the rare species in the sample (Krebs, 1998).

Species diversity is a dual concept that includes the number of species in the community and

evenness with which the individuals are divided in among the species. Many ways of measuring species diversity exist to date, and there is much controversy about which indices of diversity are best.

2.8 Heterogeneity

This concept was brought up by Simpson (1949), who proposed a second measure of species diversity that combines two separate ideas: "specics richness" and "evenness". The term heterogeneity was first applied by (Good, 1953; cited in Krebs, 1998), which many ecologists consider synonymous with diversity (Hurbert, 1971; cited in Krebs, 1998). Heterogeneity remains a popular concept in ecology partly because it is relatively easy to measure (Krebs, 1998).

2.9 Species richness measures

Some communities are simple enough to permit complete count of the number of species present. Species richness is easy to determine only in easily censured communities with few species (Oösting, 1965). In all other cases, the larger the sample size the longer the species list.

2.10 Heterogeneity measures

Heterogeneity measures confound species richness and evenness in a single index of diversity. Two statistical distributions have been fitted to species-abundance data: the logarithmic series and the lognormal distribution. Peet (1974), recognised two categories of diversity indices i.e. Type I indices and II. Type I indices are most sensitive to changes in the rare species in the

community sample. The Shannon-Wiener index is an example of Type I index. Type II indices are most sensitive to changes in the more abundant species. Simpson index is an example of Type II index. The choice of what heterogeneity measure to use should be made on this basis: whether the interest is to emphasize the dominant or the rare species of the community in question. However, in most community works both data types I & II are obtained. In the present study, Shannon-Wiener index was adopted (Shannon & Wiener, 1949). This is because, Shannon-Wiener function stands the most popular measure of species diversity, which combines species richness and evenness, yet not affected by sample size (Kent and Coker, 1992). It is given by the Shannon-Wiener equation: $H' = \sum (Pi) \log 2 Pi$), where: H'= Information content of sample (individuals) or Index of species diversity,

S= Number of species and Pi = Proportion of total sample belonging to i^{th} species.

Based on this relationship, two types of data can be collected: The number of species and the number of individuals in each place.

Margalef (1958) argued that, the Shannon-Wiener function enables one to escape some of the difficulties of the lognormal curves and the logarithmic series. Information content is a measure of the amount of uncertainty so that the larger the value of H' the greater the uncertainty. The Shannon-Wiener measure H', increases with the number of species in the community and in practice, H' does not exceed 5.0 (Washington, 1984).

3 DESCRIPTION OF STUDY AREA

3.1 Geographical location

Mgori Division, covering over 50,000 ha is situated in Singida District, which is one of the three districts in Singida Region. The Division, which is mainly covered by Mgori Forest Reserve is situated approximately 50km east of Singida town. Geographically, the Division is located between longitudes 35^0 05' E and 35^O 22'E and 4^0 45' S and 4^0 58' S (Fig. 1). It borders Kondoa and Hanang Districts to the eastern and northern parts respectively. Within the Division is a forest reserve managed by five villages. These are Mughunga (7,270 ha); Unyampanda (7250 ha); Nduamughanga (16,709 ha); Pohama (10,856 ha) and Ngimu (1,966). Pohama and Nduamughanga Wards cover more than three–quarters of the total area and Ngimu has the smallest coverage (Ikakukidua, 2002).

3.2 Topography

The major part of the Mgori Division is a plateau with gentle slopes having non-specific directions of inclination. There are occasional outcrops. Altitude ranges between 1400-1600 m a.s.l (Ikakukidua, 2002). Geologically, the area has a number of rocky outcrops forming hilly formations, which are spectacularly looking. Two such areas, one is in the north and another in the south, form easily identifiable points for tracing the forest reserve borderline. Some elevated parts of the forest reserve provide spectacular scenes into the rift valley, which are not far away (Water Source Ltd, 1996). There are no permanent rivers in the Division. However, the area has a number of seasonal streams, such as Masiriva and Lyongwambindo, which do not have water

during the dry seasons. Occasional small marshes and swamps locally known as "Mbuga" are also apparent (e.g. at Mbuga ya Daa, Kinyampimbi, Handa, Kwa Tingatinga, etc.). These serve as sources for drinking water for both wildlife and livestock (Water Source Ltd, 1996).

3.3 Geology and soils

The Geology of the study area is typical of the whole Singida Region. The dominant rock is granite batholith, which occasionally has been modified by basalt flows from old volcanoes (Water Source Ltd, 1996). The tops of the volcanic plateau comprise sandy loam soils of a fair fertility status and adequate depth for plant growth. In the valleys and lowlands, there are deposits of clays and loams (De Pauw, 1984 cited in Water Source Ltd, 1996). Erosion is pronounced on slopes and gullies are eminent where the vegetation cover is poor.

In respect to hydrology, most of Mgori Division falls within the Mgori forest catchments and has an optimal value as rainwater sink (Water Source Ltd, 1996). Due to the presence of dense woodland thicket canopies, little of rainwater is being lost as run-off in most of the forest area. However, in areas where sandy loams are the dominating soil types, little of the precipitation is dispersing and percolating to paretic and intermediary water tables as standing water available for both humans and animals (Water Source Ltd, 1996).

3.4 Climate

A large part of Singida Region is arid and semi arid. The average annual rainfall ranges between 500-800 (Opole, 1994 cited in Ikakukidua, 2002). However, the rainfall data collected by the meteorological station located at Nduamughanga Primary School near Mgori Forest Reserve shows that the study area receives an average annual rainfall of 790mm (Ikakukidua, 2002). The wet season is from December to the end of April, with a dry spell in January. The dry season is from May to October. Temperatures vary within a range of 15^0 C to 30^0 C depending on the season and altitude (Fig. 2). The coldest month in the year is July while the hottest period is in October and November. On the other hand, the relative humidity (R.H) at noon rises from 36% in the driest months to 58% during the wet season. The higher rainfall amount of Mgori Forest Reserve and the nearby areas relative to that of Singida Region may be attributed to the presence of the forest. The forest may have influenced a favourable microclimate within the area, consequently increasing the amount of rainfall. Evaporation in the study area is almost the same to that of the whole Region and averages close to 200mm annually. It is lowest in April where it goes down to zero mm and highest in October reaching 2200mm. Wind speed is usually high during the dry season, which is between may and October.

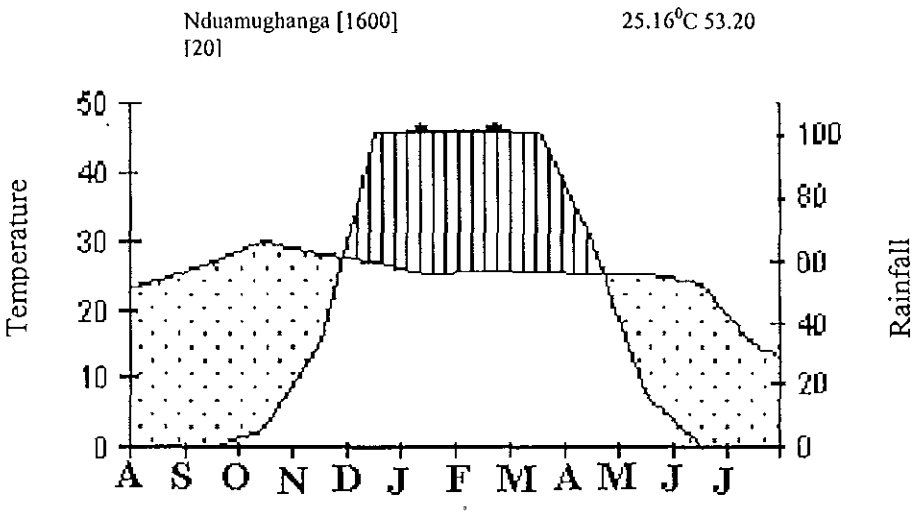


Fig. 2: Climatic diagram showing mean annual temperature and mean annual rainfall for the last 20 years (1980-2000) of Singida Rural District.

Constructed following Walter (1985).

Source: Data obtained from Tanzania Meteorological Agency compiled for the station at Nduamughanga Primary School.

3.5 The people

The Nyaturu people or Arimi are the main inhabitants in Mgori Division. They also occupy a large part of the Singida District and the northern portion of the Manyoni District. They belong to Bantu group of tribes and are supposedly a mixture of various people who entered this area some 250 years ago (Jerald, 1936; Moffett, 1958). Many elders in the area claim to have migrated from Ethiopia (Personal communications with the elders, 2004). The area was by then

sparsely populated by the Taturu ("wild dwellers") a nomadic or Semi-nomadic branch of the Tatoga tribe (Moffett, 1958). A few of the Taturu people still exist in Mgori forest reserve. There are two explanations of the origin of the name Singida. One is that it comes from the local vernacular name of tree, "*Msingida*" used for the blocks of wood, locally known as "*singida*" that were traditionally inserted in the ears of the people of the area (Mungwe Majengo-the elder: Personal communication, 2004). Another explanation is that, the place was named after "*Singieda*", a Barbaig war chief who once lived there. This name in the Barbaig vernacular, means "zebra" and was given to the chief because on the day he was born, a zebra was killed to provide particular medicines to her mother (Moffett, 1958). The Arimi may be described as cattle keeping agriculturists.

3.6 Population

There has been a significant increase in the human populations of the Division in the past. For instance, in 1988 the Wards of Ngimu, Nduamughanga, Pohama, Unyampanda and Mughunga had a total population of 3200, 1089, 2531, 1345 and 1140 people respectively (Opole, 1994 cited in Ikakukidua, 2002). According to the survey conducted by Singida Water Source Ltd (1996), the population size was estimated to 3738, 2991, 1663, 1362, and 1382 people for Ngimu, Nduamughanga, Pohama, Unyampanda and Mughunga wards respectively.

3.7 Land use and economy

Cropping in combination with livestock rearing is a major land use in the Division. The forest reserve in the area covering about 45,000ha is relied upon for fuel wood, building materials and a

number of other forest products, all largely at a subsistence level (Ikakukidua, 2002). The major food crops grown are sorghum, sweet potatoes, millet and maize. Cash crops include: sunflower and groundnut. Cotton used to be one of the most important cash crops but recently has lost ground due to a number of reasons, the major one being low market prices. In the villages, women are involved in basketry and pottery. However, marketing of these and other products remain a problem, particularly for remote areas like Nduamughanga. In these areas, roads are inaccessible especially during the rainy season (see Plate 1).

Plate 1: Inaccessible road toward Nduamughanga Village.

3.8 Vegetation

Physiognomically, the whole area is typical of savannah woodland. Based on its location and its vegetation type, it lies entirely within the Somalia-Maasai Regional Centre of Endemism (White, 1983). According to Attebring (1995; cited in Water Source Limited 1996), the vegetation cover and distribution is mainly composed of *Jubernardia globiflora* (69.3%), *Brachystegia speciformis* (10.3), *Combretum zeyheri* (3.7), *Lannea schimperi* (2.2%), *Commiphora mossambicensis* (1.6%), *Pretocarpus angolensis* (1.5%), *Combretum molle* (1.5%) and *Lonchocarpus bussei* (1.4%). The commercial forest species are few and far between with only about 70 trees/ha and a total of standing volume of less than $20m^3$/ha (Attebring, 1995; cited in Water Source Limited, 1996). According to the above source, the valuable tree species found in the forest include *Pretocarpus angolensis*, *Alfenzia quaensis, Dalbergia melanoxylon* and *Brachystegia* species. During this study, late fires seriously affected the dry season vegetation and most herbaceous and under storey plant species were burnt (see plate 2).

Plate 1: Burning of vegetation: A common practice in the area

4 MATERIALS AND METHODS

During Participatory Rural Appraisal (PRA), data were obtained through field inventory, interviews using both structured and semi-structured questionnaires (Appendix 5). The study sites for the social survey were the 5 villages, which surround the forest reserve in the Division. These are Unyampanda, Mughunga, Nduamughanga, Ngimu and Pohama villages (see Fig. 2 and Appendix 6).

4.1 Informants selection

183 informants with general ethnobotanical knowledge on both wild and cultivated vegetables were interviewed in the present study. Of these, 50 (ten from each village) with specific knowlegde were identified as key informants (see Appendix 9). Selection was done using systematic sampling procedures from all the five villages, which surround the forest area in collaboration with the local administrators, elders and other community members. Each village constituted a minimum of five sub-villages; hence, about 8 informants were selected from each sub-village. The respondents from each village who were reached were: Unyampanda 41 (22.4%), Mughunga 31 (6.9%), Nduamuhanga 35 (19.1%), Ngimu 34 (18.6%) and Pohama 42 (23%). The response rate was generally good despite the serious problem of food crises that existed in the area. All these were informed about the study objectives and aims to make them more open and co-operative.

In this study more women (70%) were involved because of the cultural division of labour of the Nyaturu women that makes them more responsible in the collection, production, marketing and

preparation (cooking) of vegetables. The assumption here was that, women were more knowledgeable on food plants than men.

4.2 Ethnobotanical data collection

Ethnobotanical data collection was based on Participatory Rural Appraisal (PRA) techniques, as described by Maundu (1995), Grenier (1998) and Coe *et al.* (1999). The PRA techniques employed are presented below:

4.2.1 Participant observation

This involved direct observation in the field during the study period. The principal researcher stayed with the people in the study area for about five months that is from 1st September to 16th February and shared with them the many facets of their life from subsistence activities such as farming or gathering of vegetables to attending their ritual occasions such as marriages, burial ceremonies, religious celebrations or initiation rites.

4.2.2 Semi-structured interviews and listening techniques

This was the main method of data collection. Semi-structured interviews were administered to the selected respondents with general ethnobotanical knowledge on vegetables based on the description by Martin (1995) and Cotton (1996). 50 key informants (about 10 from each village) with outstanding knowledge on vegetable plant species responded to key questions. A checklist of topics or main questions was prepared before hand as per the attached schedule in Appendix 5. Most of the interviews and discussions were conducted in Swahili as the national language and

occasionally in Nyaturu as the vernacular language of the local people in the study area. There was no need of translation because the principal researcher was quite familiar with both languages. During the interview, information sets concerning gathering, preparation and use of vegetables were recorded. Data about diversity (abundance), number of species (density), cultivation practices, status and marketability of the vegetables in the area were also collected. Each informant was visited for at least three times in order to crosscheck on the validity and reliability of the information given. Repeated visits also helped to get information that might have been left out during the previous interviews.

4.2.3 Informant consensus and group discussions

The value or the relative importance of each plant was evaluated based on the proportion of informants who independently reported its use as a vegetable in accordance to the approach used by Adu-Tulu *et al.*, (1979) and Trolter and Logan (1986). According to these authors, the frequency of usage of each plant species, as reported by informants indicated the use value (popularity) of the species. Responses from the interviewees were recorded in a field notebook. Some photographs were taken to supplement the written and the recorded information. Group discussions were done for reaching an agreement among the respondents on the various aspects of the collected plants such as names and physical variations. Meetings of a few selected respondents from each village were convened. These were so helpful in the discussion and thereafter consensus on the use and the associated indigenous knowledge on the plants.

4.2.4 Open-ended conversation and unstructured interviews

The open-ended conversation techniques as described by Martin (1995) and Cotton (1996) were used to gather indigenous knowledge of Nyaturu people related to conservation and use of vegetables including their habitats. Using these techniques, respondents gave extensive responses to a series of general questions, some of which were prepared in advance (Appendix 5), and some of which raised naturally in the cause of the conversation. These techniques were followed to ensure successful data collection. Unstructured interviews were made to collect information in places such as markets. Through this, information related to plants used as vegetables was collected.

4.2.5 Guided field walks

Guided field walks (Maundu, 1995) were used to supplement the information obtained through semi-structured interviews. A group of selected key informants; 3 women and 1 man from each village accompanied the researcher to the field to document important plant species used as vegetables and their habitats along the laid down belt transect. As the key informants identified the plants, they explained how it was being used, harvested and eventually prepared. Information was considered valid and reliable if at least three or more key informants/interviewees at different sessions gave the same information. During this approach, specimens of plants identified as vegetables were collected for identification purposes as described in section 4.3.

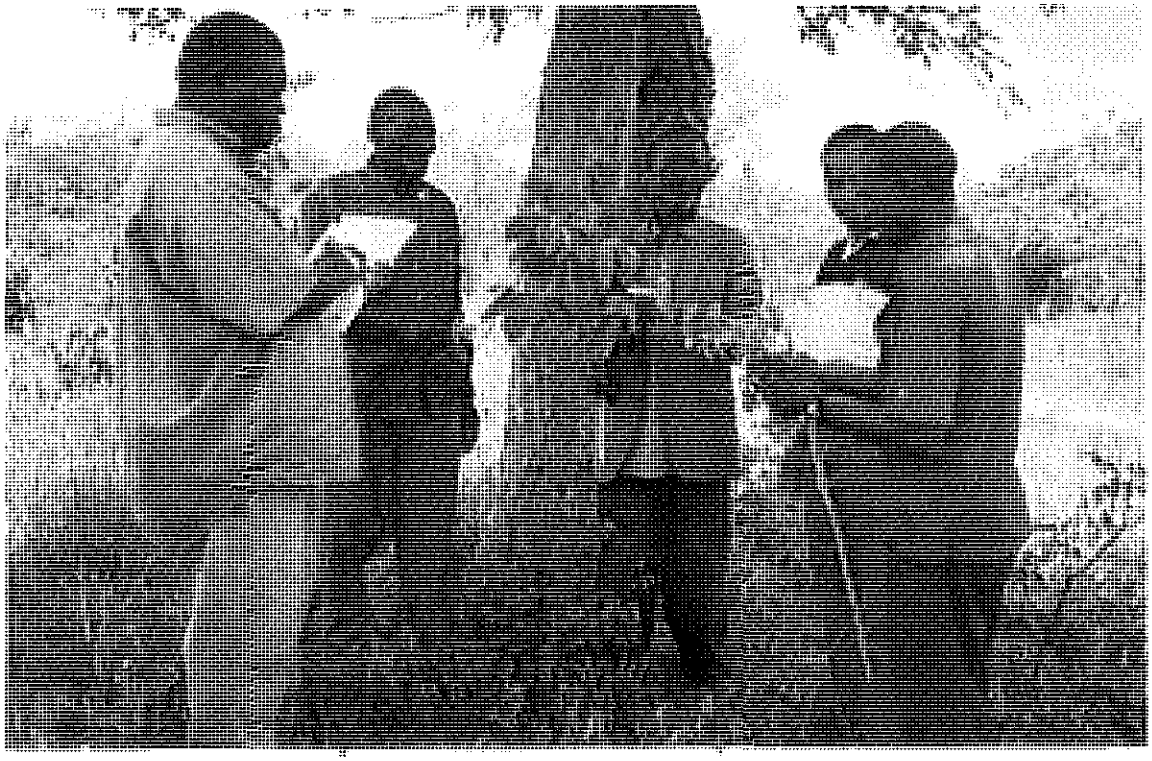


Plate 3: Research team at one of the sample plots in Pohama village forest reserve

4.2.6 Preference ranking

The preference ranking technique was used to rank some selected vegetable plants according to the degree of preference and scarcity. Preference ranking is one of the analytical tools that involve asking people to think of some five to ten items and arrange them according to a given criterion (Martin, 1995). In the course of this study, vegetable plants were ranked according to the degree of preference and scarcity. In a group of five items, each rank was given an integer value of 1 to 5, whereas in a group of ten items each rank was given an integer value of 1 to 10. In this case, the most preferred and or the scarcest vegetable plant species, was given the highest value, while the least important (the least preferred and or the less scarce vegetable plant species),

was assigned the least value (i.e. 1). Figures for all the respondents were summed up to obtain the overall ranking for the items by the selected group of the respondents. For this purpose, 10 individuals were randomly selected among the key informants. Each of these was provided with fresh specimens of 10 indigenous vegetable species, reported as being most liked and was asked to rank them using the above-mentioned criterion. The same procedure was carried out for the scarce species. The selected species for this purpose was based on the information that was obtained from the key informants, vegetation study, species and family use reports, observations and other attributes. The most valuable and commonly used vegetable plant species were also determined by this technique.

4.3 Botanical data

Specimens were collected based on ethnobotanical information that was provided by the informants. The voucher specimens for wild, cultivated vegetables and other plant species were collected and identified, first on site and later the identification was confirmed using taxonomic keys and botanically authentified specimens in the herbarium in collaboration with the plant taxonomists from the Herbarium of the University of Dar es Salaam. Plants collected were numbered, pressed, dried and mounted for identification. The identification was based on the works of Haines and Lyke (1983), Brummitt (1992) and Kokwaro (1994). Collected and identified specimens were kept at the Herbarium of the University of Dar es Salaam for future reference (see Appendix 1).

4.4 Vegetation data

Data on vegetation types and distribution were collected. The landscape was stratified based on measurable parameters such as, cultivated lands, natural forest, slope and disturbance that existed in the area such as fire and grazed areas as described by Mueller-Dumbois and Ellenberg (1974). The levels of disturbance recorded were assessed on a subjective scale of 0-3, detailed as follows: (0)-nil; (1)-moderate; (2)-heavy; (3) (Kumlachew and Yeshtla and Tamrat Bekele, 2002). 60 representative relevés measuring 20m x 20m were established in each stratum using random selection methods as proposed by Braun-Blanquet, 1965). 5m x 5m quadrats were established within the layer plots for sampling herbaceous species (Kent & Coker, 1992). All vascular plants encountered were listed and their cover abundance estimated by using percentage scales, which were then converted to a 1-9 Braun-Blanquet (1932) scale using the modified Van der Maarel (1979) method, cited in Zerihun (1985).

The relative plant cover / abundance matrix was analyzed using multivariate numerical classification methods and vegetation types were identified. The occurrence and percentage (relative) abundance of vegetable plant species was established and compared between the different vegetation types. In addition, during the wet season a 5mx1000m transect was laid from the house site to the margins of the gardens or fallow lands towards the forest in each village. Within transects, the type of vegetables found, number of individuals of each type and habitats of plants were recorded. Data were collected from 60 plots, by taking 12 plots from each transect.

4.5 Data analysis

- Ethnobotanical and vegetation data were analyzed using a Statistical Package for Social Sciences (SPSS) and Microsoft Excel and summarized in the form of tables and graphs.
- Descriptive statistical methods such as percentages were employed to analyse and summarize the ethnobotanical data from the interviews on reported vegetable plants and associated knowledge.
- Preference ranking was used for comparison of the most preferred, least preferred and scarce vegetable plant species in the study area.

For vegetation data analysis, matrices for cover abundance values for both dry and wet seasons were produced. These were subjected to multivariate numerical analyses as described by Digby & Kempton (1987). According to Podani (2000), the dendrograms produced by SYNTAX software are based on the type of division that is agglomerative and hierarchical. This analysis shows the different sample sites forming the distinct community types against the similarity scale ranging between 0-1. According to Podani (2000), to minimize variation, the values were standardized using $\log_{10}$. The similarity ratio was calculated using the following matrix notation:

$$SR_{i,j} = \sum X_{k,i} * X_{kj,} / (\sum x^2_{k,i} + \sum X^2_{k,j} - \sum X_{k,i} * X_{k,j})$$

Where: $SRi_{i,j}$, is the similarity ratio between vegetation samples i and j, m_{ij} for the presence absence data; where X_k is the value of the k^{th} variable in the i^{th} and j^{th} samples and m_{ij} is the value of the m^{th} variable in the i^{th} and j^{th} samples.

After the fusion of the i^{th} and j^{th} samples on the basis of their high similarity, a new sample, by species (n*m) matrix is established with the average of the k^{th} (quantitative data) or m^{th} (presence-absence data) variables or the previously combined i^{th} and j^{th} samples. In this analysis, the species association was recognized and then categorized into groups.

4.5.1 Species diversity

Species diversity was determined using Shannon-Wiener diversity index (Fowler and Cohen, 1992) as follows:

$H' = -\Sigma P_i \ln P_i$, Where: H' = Shannon-Wiener diversity index

P_i = Proportion of a particular species in a sample

ln = Natural logarithm

Species richness index of the study site corresponds to the total number of species present in it and thus indicated the relative wealth of species in the study site.

5 RESULTS

5.1 Diversity of plant species used as vegetables by the indigenous people

Information about 56 species used as vegetables by the Nyaturu people in the study area was recorded from a total of 180 sample plots and through interviews. These species represent 21 families and 39 genera (Table 4). All these fall in a broad spectrum that ranges from being completely wild, semi-wild, domesticated /cultivated, exotic or naturalised. Most of the vegetable plant species in Mgori Division are wild in nature and still collected from the wild, disturbed areas, fallow lands and / or arable lands.

Table 4: The list of different vegetable plant species used by the indigenous people
(**L**= Tender leaves, **F**= Fruits, **B**= Bulbs, **Ts**= Tender shoots, **Fw**= Flowers, **Tp**= Tender pods and **S**= Seeds)

S/N	Species name*	Nyaturu name	Family name	Status	Habit	Parts used
1	*Abelmonchus esculentus*	Mbamia	Malvaceae	Cultivated	H	L, F
2	*Adansonia digitata*	Muandu	Bombacaceae	Wild, nurtured	T	L, F
3	*Adenia gumnifera*	Itindimburi	Passifloraceae	Wild, nurtured	S	L
4	*Ageratum conyzoides*	Jembo	Asteraceaea	Narture	H	L
5	*Alium cepa*	Kitunguu	Alliaceae	Exotic, nurtured	H	B, L
6	*Amaranthus dubius*	Mogha	Amaranthaceae	Wild, nurtured	H	L, Ts
7	*A. hybridus*	Muchicah-ni-ukuu/nyambu	Amaranthaceae	Exotic, cultivated	H	L, Ts
8	*A. lividus*	Muchicha -ni-ukhoku	Amaranthaceae	Wild, nurtured	H	L, Ts
9	*A. spinosus*	Mogha-wa maghuya	Amaranthaceae	Wild, nurtured	H	L, Ts
10	*Asystasia gangetica*	Mukhombi	Acanthaceae	Wild, gathered	H	L, Ts

Table 4 continued

11	*A. mysorensis*	Mufuu/Ndui-ya-mbui	Acanthaceae	Wild, gathered	H	L
12	*Azanza garckeana*	Mutogho	Malvaceae	Wild, nurtured	T	F
13	*Barleria acanthoides*	Kilombelombe	Acanthaceae	Wild, gathered	H	L
14	*Cajanus cajan*	Mbaasi	Fabaceae	Exotic, cultivated, naturalised	S	S
15	*Capsicum annuum*	Firifiri-a-ariko	Solanaceae	Exotic, cultivated, naturalised	H	F
16	*Ceratotheca sesamoides*	Mbata	Pedaliaceae	Wild, nurtured	H	L, Ts
17	*Cleome hirta*	Ghasira	Capparidaceae	Wild, gathered	H	L, Ts
18	*Coccinia adoensis*	Maimbe-a-ng'ughuya	Cucurbitaceae	Wild, gathered	C	L, F,
19	*C. grandis*	Maimbe	Cucurbitaceae	Wild, domesticated	C	L. F
20	*Corchorus capsularis.*	Ikhonda-ra-anyabi	Tiliaceae	Wild, gathered	H	L
21	*C. olitorius*	Muundi	Tiliaceae	Wild, gathered	H	L
22	*C. tricularis*	Ahungu	Tiliaceae	Wild, collected	H	L,
23	*Crotalaria cylindrostachyus*	Mukukuru	Fabaceae	Wild, collected	H	L, Ts
24	*C. polysperma*	Songa	Fabaceae	Wild, collected	H	L
25	*Cuccumis dipsaceus*	Mahanjo-a-nghughuya	Cucurbitaceae	Wild, gathered	C	L, F, Fw,
26	*C. aculeatus*	Mung'ang'aa	Cucurbitaceae	Wild, gathered	C	L, F, Fw
27	*C. figarei*	Mahukuma-o-mufumbu	Cucurbitaceae	Wild, collected	C	L, F, Fw
28	*C. melo*	Ghunga	Cucurbitaceae	Exotic, cultivated, naturalised	C	L, F, Fw
29	*Cucurbita maxima*	Muhukuma	Cucurbitaceae	Exotic, cultivated, naturalised	C	L, F, Fw

Table 4 continued

30	*C. pepo*	Munyungu	Cucurbitaceae	Exotic, cultivated, naturalised	C	L, F, Fw
31	*Erythrococca bongensis*	Gutinti	Euphorbiaccae	Wild, collected	S	L
32	*Fimbristlyis ferruginea*	Sasa-o-makuja	Cyperaceae	Wild, collected	Sg	L
33	*Gongroneuma angolense*	Nduta	Asclepidaceae	Wild, gathered	C	L
34	*Cleome gynandra*	Mung'ang'i	Capparidaceae	Wild, nurtured	H	L, Ts
35	*Hygrophila schulli*	Nkokomea	Acanthaceae	Wild, gathered	H	L
36	*Ipomoea batatas*	Mudoro	Convolvulaceae	Exotic, cultivated, naturalised	C	L
37	*I. cairica*	Maghanja-a-wambu	Convolvulaceae	Wild, collected	C	L
38	*I. sinensis*	Mungudungudu	Convolvulaceae	Wild, gathered	C	L
39	*Launaea cornuta*	Gahunga	Asteraceae	Wild, gathered	H	L
40	*Lycopersicon esculentus*	Munyanya	Solanaceae	Exotic, cultivated, naturalised	H	L, F
41	*Manihot esculenta*	Muhogo	Euphorbiaceae	Exotic, cultivated, naturalised	S	L
42	*M. glaziovii*	Muhogomufira	Euphorbiaceae	Exotic, cultivated, naturalised	S	L
43	*Momordica foetida*	Mahanjo-o-mufumbu	Cucurbitaceae	Wild, gathered	C	L
44	*Mukia maderaspatana*	Mung'ang'aa	Cucurbitaceae	Wild gathered	C	L
45	*Oxygonum sinuatum*	Mbighii	Polygonaceae	Wild, gathered	H	L
46	*Pentarrhinum insipidium*	Makutwi-a-njou	Asclepidaceae	Wild, gathered	C	L
47	*Phaseolus vulgaris*	Muharage	Fabaceae	Exotic, cultivated	H	L, S, Tp

Table 4 continued

48	*Pipper nigrum*	Mufirifiri	Piperaceae	Exotic, cultivated	H	F
49	*Pyrenacantha kuarabassana*	Nduta-ni-nkuu	Icacinaceae	Wild, cultivated	C	L
50	*Sesamum angustifolium*	Ikhonga	Pedaliaceae	Wild, gathered, nurtured	H	L
51	*S. indicum*	Ikhugha	Pedaliaceae	Wild, gathered, nurtured	H	L
52	*Solanum nigrum*	Muntomolankuku	Solanaceae	Wild, gathered, nurtured	H	L
53	*Spermacoce senensis*	Ndisia	Rubiaceae	Wild, gathered	H	L
54	*Tragia brevipes*	Urambi	Euphorbiaceae	Wild, gathered	C	L
55	*Triumpheta rhomboidea*	Kifou	Tiliaceae	Wild, gathered	H	L
56	*Vigna unguiculata*	Mukusa	Fabaceae	Exotic, cultivated, naturalised	C	L, S, Tp

** For names of authorities, see Appendix 1.*

Of all the identified vegetable plant species, 2 (3.6%) were trees, 5 (8.9%), shrubs, 18 (32%) climbers and 30 (53.6%) herbs (Fig. 3). This suggests that herbs have a significant contribution to vegetables than trees and shrubs. Further analysis revealed that, plant species belonging to the Family Cucurbitaceae contributes more species for use as vegetables by the indigenous people in the area, accounting for 17.9%. The distribution of vegetable plant species among the Families is shown in Table 5.

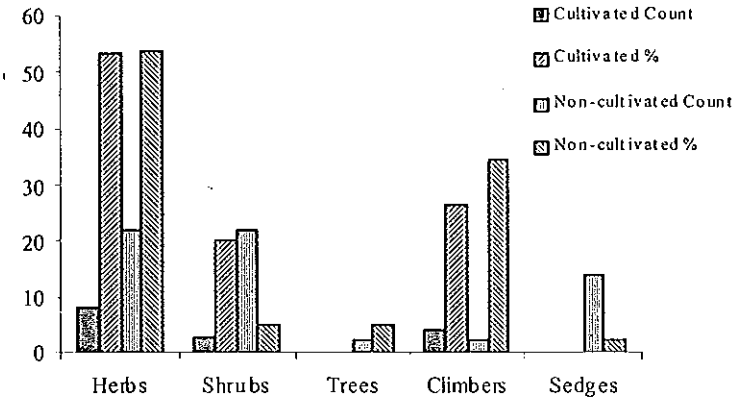


Fig. 3: Habits and status of vegetable plant species

Table 5: Plant Families and the number of species

S/N	Family name	No. of species	% of the total
1	Acanthaceae	4	7.14
2	Alliaceae	1	1.78
3	Amaranthaceae	4	7.14
4	Asclepidaceae	2	3.57
5	Asteraceae	2	3.57
6	Bombacaceae	1	1.78
7	Capparidaceae	2	3.57
8	Convolvulaceae	3	5.35
9	Cucurbitaceae	10	17.85
10	Cyperaceae	1	1.78
11	Euphorbiaceae	4	7.14
12	Fabaceae	5	8.93
13	Icacinaceae	1	1.78
14	Malvaceae	2	1.78
15	Passifloraceae	1	1.78
16	Pedaliaceae	3	5.35
17	Piperaceae	1	1.78
18	Polygonaceae	1	1.78
19	Rubiaceae	1	1.78
20	Solanaceae	3	5.35
21	Tiliaceae	4	7.14
	Total	**56**	**100%**

5.1.1 Species preferences

Summary results for ranking scores of vegetable plant species reported as being most preferred, least preferred and most valuable as perceived by the respondents from all the five villages are presented in Tables 6 to 9. Rankings slightly varied from village to village. However, since the interest was to show the overall ranks by villages, then the preference scores from each village were combined together. For example, the analysis of data given in Table 6 shows the rank order of plant species based on their popularity as vegetables. Only the 10 most preferred wild vegetables were considered and *Coccinia grandis* was the overall most preferred vegetable in the five villages.

Table 6: Aggregate preference ranking scores for 10 most liked wild vegetables

Species name		Aggregate scores by villages (Coded V_1-V_5)					Total	Ave-rage	Rank
Nyaturu name	Botanical name	V_1	V_2	V_3	V_4	V_5			
Mogha	*Amaranthus spinosus*	79	81	78	75	72	385	77	4th
Mbata	*Ceratotheca sesamoides*	84	76	79	78	75	392	78.4	3rd
Mungudungudu	*Ipomea sinensis*	22	19	23	30	39	184	37	7th
Mukukuru	*Crotolaria cylindrostachyus*	53	42	42	48	41	226	45.2	6th
Ikhonda	*Sesamum angustifolium*	54	51	62	60	51	278	56	5th
Maimbe	*Coccinia grandis*	91	91	93	79	88	442	88.4	1st
Mahukuma	*Cucurbita pepo*	76	79	83	83	77	401	80.2	2nd
Mung'ang'i	*Cleome gynandra*	27	38	29	21	27	142	28.4	10th
Jimboankuku	*Solanum nigrum*	24	23	28	28	47	150	30	9th
Kilombelombe	*Barleria acanthoides*	36	44	32	33	36	181	36.2	8th

Note: For villages: V_1= Unyampanda, V_2=Mughanga, V_3= Nduamughanga, V_4= Ngimu and V5= Pohama

Preferred vegetables are due to their widely appreciated taste, sweetness (palatability), storage ability (could be store in dry places for over a year), ease of availability, ease of collection as they normally grow near homestead and above all, they may be sold in cash or bartered with food commodities such as cereals and legumes or other household items. Nearly in all the five villages, *Coccinia grandis* ranked the first, whereas *Sesamum angustifolium* ranked the 5th. However, *Sesamum angustifolium* is highly consumed during the dry seasons when other preferred wild vegetables were off-season. *Sesamum angustifolium* is usually collected fresh all the year round. Of all the wild vegetables in the area, *Coccinia grandis* is the most preferred due to its sweet (palatable) taste, ability to cook fast and easy availability (naturalized and cultivated around the homes). It may also be stored when dried or in the form of dry cakes or powder and above all, it is one of their cultural vegetable sauces. Likewise, *Sesamum angustifolium* is one of the most preferred and commonly used vegetables in the area, among other reasons, is its use value as both food and medicine. Its leaves and roots are being used to cure stomachaches and eye diseases, which are prevalent in both cattle and human beings (Table 11). Further analyses as indicated in Tables 7 and 8 revealed more interest on the indigenous vegetable species than on the exotic species. For example, in Table 8 the first three most preferred vegetables are wild. Exotic species are ranked high, which shows low preference by the communities toward these species.

Table 7: Preference ranking scores for both exotic and wild vegetable species carried out at Unyampanda village in Mgori Division

Species name		Scores by key respondents (Coded R_1-R_{10})										Total	Rank
Nyaturu /common name	Botanical name	R_1	R_2	R_3	R_4	R_5	R_6	R_7	R_8	R_9	R_{10}		
Cabbage	*Brassica oleracea***	4	2	1	2	1	3	2	3	4	1	23	9th
Ikhonda[Ny]	*Sesamum angustifolium**	9	10	8	8	7	7	6	10	8	7	80	3rd
Muchicha[Ny] / Amaranthus	*Amaranthus hybridus****	6	7	5	7	5	6	8	5	10	8	67	5th
Spinach	*Spinacia oleracea***	5	4	6	4	3	4	5	1	3	3	38	7th
Mogha[Ny]/ Pig wed	*Amaranthus dubius**	8	9	7	10	6	10	9	7	9	9	84	2nd
Swisschard	*Beta vulgaris L.***	1	1	2	3	2	5	1	2	1	2	20	10th
Mung'ang'i[Ny] / Cat's whiskers	*Gynandra gynandropsis**	3	6	4	5	9	1	4	6	7	5	50	6th
Chinese cabbage	*Brassica campestris L.***	2	3	3	1	4	2	3	4	2	6	30	8th
Mahukuma[Ny]/ Pumpkin leaves	*Cucurbita pepo****	7	5	9	6	10	8	7	8	6	4	70	4th
Maimbe	*Coccinia grandis**	10	8	10	9	8	9	10	9	5	10	88	1st

Note: * = *Wild*, ** = *Exotic* and *** = *Naturalized*, Ny=Nyaturu name.

Classification based on works by (Okigbo, 1980) and (Ruffo *et al.*, 2000).

The dendrogram in Fig. 4 further reveals a high degree of consistency in the responses among the respondents at a much higher similarity level but shows some discrepancies down the tree, at a much lower similarity level. It forms three major clusters: R2, R4, R10, R9; R1, R7, R3, R6 and R5, R8. Respondents R6 in the middle cluster and R9 in the upper most cluster seem to have different perceptions and preferences.

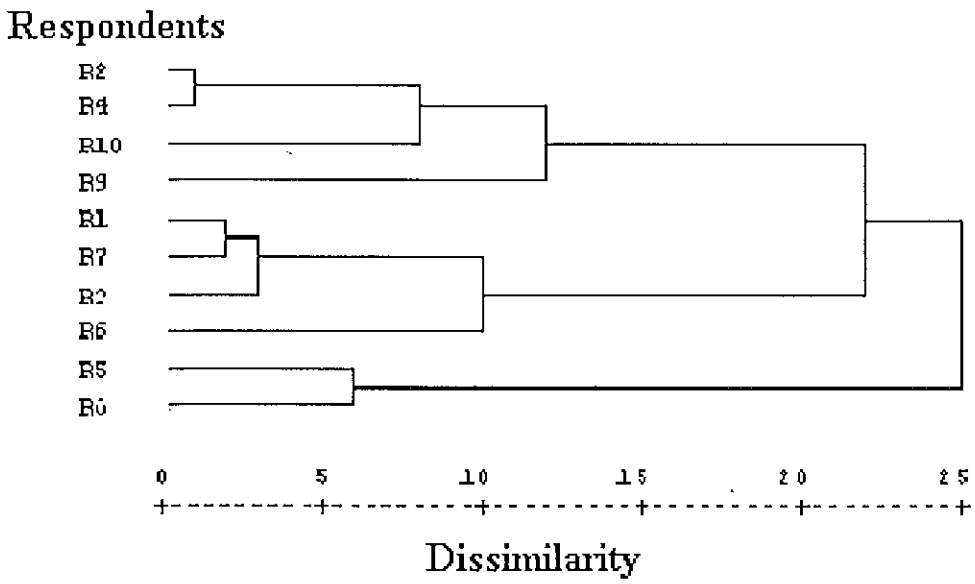


Fig. 4: Dendrogram of preference ranking for both exotic and indigenous vegetables, using Ward Method

Table 8: Paired comparison scores of the most valuable (marketable) wild vegetable plant species that have been randomized for the sequence of pairs and the order within each pair *(Preference for the most valuable species within each pair is shown in bold)*

Pair	Order	Paired wild vegetable species
5	2,5	Mahukuma (*Cucurbita pepo*), **Mbata** *(Ceratotheca sesamoides)*
10	4,5	**Maimbe** (*Coccinia grandis*), Mbata *(Ceratotheca sesamoides)*
3	1,5	Mbata *(Ceratotheca sesamoides)*, **Ikhonda** *(Sesamum angustifolium)*
8	2,3	Mahukuma (*Cucurbita pepo*), **Mogha** (*Amaranthus dubius*)
2	1,4	**Ikhonda** (*Sesamum angustifolium*), Maimbe (*Coccinia grandis*)
9	3,5	**Mogha** (*Amaranthus dubius*), Mbata (*Ceratotheca sesamoides*)
4	1,2	**Ikhonda** (*Sesamum angustifolium*), Mahukuma (*Cucurbita pepo*)
6	3,1	Mogha (*Amaranthus dubius*), **Ikhonda** (*Sesamum angustifolium*)
1	2,4	Mahukuma (*Cucurbita pepo*), **Maimbe** (*Coccinia grandis*)
7	3,4	Mogha (*Amaranthus dubius*), **Maimbe** (*Coccinia grandis*)

Summarized results of paired comparisons in tabular form

Ikhonda	Mahukuma	Mogha	Maimbe	Mbata		Score	Rank
	Ikhonda	**Ikhonda**	**Ikhonda**	**Ikhonda**	Ikhonda	4	1st
		Mogha	**Maimbe**	**Mbata**	Mahukuma	0	5th
			Maimbe	**Mogha**	Mogha	2	3rd
				Maimbe	Maimbe	3	2nd
					Mbata	1	4th

(The total number of pairs is given by n (n-1) / 2, where n is equal to the number of items)

In Table 9, the least preferred wild vegetables are given to be *Launnea cornuta, Azanza garckeana, Hygrophila schulli, Cleome hirta* and *Oxygonum sinuatum.*

Table 9: Aggregate preference-ranking scores for the 5 least preferred wild vegetables

Species names		Aggregate scores by villages (Coded V_1-V_5)					Total	Average	Rank
Nyaturu name	Botanieal name	V1	V2	V3	V4	V5			
Gahunga	*Launnea cornuta*	14	15	26	17	18	90	18	4th
Motoghoo	*Azanza garckeana*	43	42	30	40	39	154	30.8	3rd
Nkokomea	*Hygrophila schulli*	37	36	34	34	36	177	35.4	2nd
Gharisa	*Cleome hirta*	16	16	25	14	15	86	17.2	5th
Mbighii	*Oxygonum sinuatum*	44	42	33	45	43	207	41.4	1st

For village codes, see Table 6

The least preference for some wild vegetables is attributed to their bitterness, difficulty to store and the case of some their processing for preparation takes much longer time. For example, *Launnea cornuta* is least preferred because it is more seasonal in its occurrence and many respondents less appreciate its bitter taste. Its bitter taste commands longer boiling and often requires pouring out bitter solution formed after a short boiling. Occasionally, it is being prepared with milk or mixed with other vegetable species to make its taste milder.

5.1.2 Plant parts and mode of preparation

Assessment of the different plant parts utilised as vegetables reveals that leafy vegetables are most commonly used and account for over 50 % of all the recorded vegetable plant species followed by those utilised for both their leaves and tender shoots (16.07%). Other useful parts include leaves, fruits and flowers (10.71%), only fruits (5.34%), leaves and fruits (8.93%) (Table 10)

Table 10: Useful parts of vegetable plant species

	B&L	F	Only L	L & F	L, F & Fw	L, S &Tp	L & Ts	S	Total
Cultivated	1	2	3	2	3	2	1	1	15
Non-cultivated	0	1	25	3	3	1	8	0	41
Total	1	3	28	5	6	3	9	1	56
% of total	1.79	5.34	50	8.93	10.71	3.34	16.07	1.79	100

(L= Tender leaves, F= Fruits, B= Bulbs, Ts= Tender shoots, Fw= Flowers, Tp= Tender pods and S= Seeds)

5.1.3 Preparation of vegetables for consumption

Wild vegetables are used like spinach and eaten as a form of sauce "**nyanyi**", or mboga in Swahili, which is served as a side dish of staple food, most commonly stiff maize porridge locally known as "**ughae**" or **ugali** in Swahili. The process of preparing wild vegetables for a meal is somewhat the same as for the exotic ones, although some details may differ from one species to another. The stages for preparing **"nyanyi"/"matembee"** from wild vegetables are:

(i) Leaves and young shoots are sorted out; old leaves as well as petioles are removed.

(ii) Leaves are cut once or twice. After that they are rinsed,

(iii) Leaves are boiled shortly and then squeezed dry. The water used for boiling is not

used for other purposes.

(iv) Leaves are cooked in oil (if any) for 15 to 30 minutes, usually together with tomatoes and onions (whenever available), salt and some spices are then added.

For preparation of "**matembee**", boiling in water is not always needed before cooking into oil. However, some species are so bitter that they need to be boiled longer or twice. The vegetables are often mixed with other vegetables. Examples of commonly used but bitter species are *Launnea cornuta* and *Cleome gynandra*.

Preparation of "**mlenda**" for a meal is a little bit different to that of "**matembee**" in that, this preparation is usually a mixture of various parts of vegetables from different vegetable plant species, water, bicarbonate of soda and one of the species that can produce a mucilaginous material / ingredient must be added as part of the mixture. The edible members of Pedaliaceae family such as *Sesamum angustifolium, S. indicum* and *Ceratotheca sesamoides* are commonly used for this purpose. Members of Tiliaceae, such as *Triumfeta rhomboidea* and *Corchorus species*; the members of Solanaceae such as fruits of *Abelmonchus esculentus*; members of Malvaceae family such as tender or mature but dry fruits of *Azanza garckeana*, are used as the alternative sources of mucilaginous material. Having been boiled and softened, the mixture is crushed through a rigorous stirring process until a uniform greenish viscous/gel-like mucilaginous mass i.e. "**mlenda**" is formed. This **mlenda** is served with **ugali** as a sauce or side dish almost every time even when there is an alternative sauce such as meat or legume seeds.

5.1.4 Vegetable plant species of medicinal importance (Nutraceuticals)

According to the informants and some traditional healers consulted in the area, 20 indigenous vegetable plant species are also used as herbal remedies for both human and livestock ailments (Table 11). Foods that have both nutritional and pharmaceutical values are known as nutraceuticals. These constituted 9 climbers, 8 herbs, 2 shrubs and one tree species.

Table 11: List of important vegetable plant species with medicinal values

Note: For parts used: **F**= Fruits, **L**= Leaves, **B**= Barks, **S**= Shrubs, **Wp**= Whole plant and **R**= Roots.
For habit: **H**= Herbs, **C**= Climber, **S**= Shrubs and **T**= Trees.

S/N	Species name	Nyaturu name	Family	Habit	Part used	Application	Method of preparation	Route
1	*Adansonia digitata*	Muandu	Bombacaceae	T	B, L & R	To expel retained placenta in both humans and livestock	Barks and leaves are boiled, cooled and decoction given to either humans or cattle for expulsion of retained placenta. In humans, roots and barks are used	Oral
2	*Amaranthus dubius*	Mogha	Amaranthaceae	H	L	Intestinal worms	Leaves are half cooked. Leaves and its solution are taken without adding salt	Oral
3	*Asystasia gangetica*	Mukhombi	Acanthaceae	H	R	Antidote to poisoning, Hyperacidity, Pruritus	Roots boiled and decoction given to the patient	Oral
4	*Cajanus cajan*	Mbamea	Fabaceae	S	L	Nose bleeding	Leaves are crushed and inserted / put into the nose	External
5	*Coccinia grandis*	Maimbe	Cucurbitaceae	C	R & F	Leprosy; Gastric disorders; Weaning babies or calves in cows	For leprosy and gastric disorders, roots boiled and decoction given to the patient	Skin surface

Table 11 continued

6	*Cucumis melo*	Ghunda	Cucurbitaceae	C	R	Ulcers	Roots boiled and decoction given to the patient	Oral
7	*C. acuelatus*	Mung'ang'aa	Cucurbitaceae	C	R&F	Abdominal pains in women, Weaning of babies	Roots boiled and concoction given to the patient. Cut fruit is rubbed onto breasts	Oral, Skin surface
8	*C. figarei*	Mahaukuma-o-mufumbu	Cucurbitaceae	C	R	Indigestion; Constipation; The maceration of the roots are used against gonorrhoea	Roots boiled and decoction given to the patient	Oral
9	*Erythrococca bongensis*	Gutinti	Euphorbiaceae	S	L	Intestinal worms, Reduce fever, Malaria	Leaves are boiled and decoction given the patient, Leaves are half cooked and eaten by the patient	Oral
10	*Gongroneuma angolense*	Nduta	Asclepidaceae	C	R	Waist pains in women	Roots boiled, cooled and concoction given to the patient	Oral

Table 11 continued

11	*Cleome gynandra*	Mung'ang'i	Capparidaceae	H	L&R	Earache (wounds in the ears), Constipation & backbone ache Intestinal worms, Severe headache, Body inflammations	For earache leaves are crushed and squeezed .The juice applied into the ear(s), For constipation and backbone ache , the crushed leaves are inserted into the rectum. For the relief of severe headache, the crushed leaves are inhaled or smelled. For stomachaches & body inflammation the half cooked leaves eaten without salt and take a warm shower with the leaves infusion added in water.	Oral/ Skin Surface Depending on the nature of the ailment
12	*Ipomea batatas*	Mudoro	Convolvulaceae	C	L	Intestinal worms, Induces vomiting after ingestion of poison and snake bite	The juice from boiled leaves and or the half cooked leaves are given to the patient	Oral

Table 11 continued

13	*I. sinensis*	Mungudungudu	Convolvulaceae	C	R	Headache,	Roots boiled and decoction given to the patient	Oral
14	*Launnea cornuta*	Gahunga	Asteraceae	H	L	Stomach pains, Anti-worms, Measles	Leaves are half cooked and eaten without adding salt	Oral
15	*Momordica foetida*	Mahanjo-o-mufumbu	Cucurbitaceae	C	R	Treatment of bloody diarrhoea	Roots boiled and decoction given to the patient	Oral
16	*Mukia maderaspatan*	Ing'ang'aa	Cucurbiraceae	C	F	Treatment of foot and mouth disease of cattle and goats	The cut pieces of the fruit are rubbed on the affected parts	External
17	*Sesamum angustifolium*	Ikhugha	Pedaliaceae	H	R	Eye disorders in both humans & livestock	Roots are chewed and extract/ solution is spit into the affected eye(s)	External
18	*S. indicum*	Ikhonda	Pedaliaceae	H	R	Treatment of lumbago	Roots boiled and decoction given to the patient	Oral

Table 11 continued

19	*Solanum nigrum*	Muntomol-ankuku	Solanaceae	H	B, F & L	Fungal skin infections. Treatment of jaundice and rectal prolapse in humans	Infusion from barks and fruits is mixed with animal/milk butterfat and rubbed on the skin. Drinking the infusion from the boiled leaves	Skin surface
20	*Tragia brevipes*	Urambi	Euphorbiaceae	H	R , Wp	Coughing, Waist pains in women, Tonsils, Haemorrhoids	Roots or the whole plant is boiled and concoction given by the patient	Oral

5.2 Extent of household dependency on indigenous vegetables

Based on the opinions by the respondents, several reasons for use / reliance on wild vegetables over their exotic counterparts were solicited. These factors are also associated with the scarcity of the vegetable plant species. They are summarized in Appendix 6 and depicted in Fig. 5.

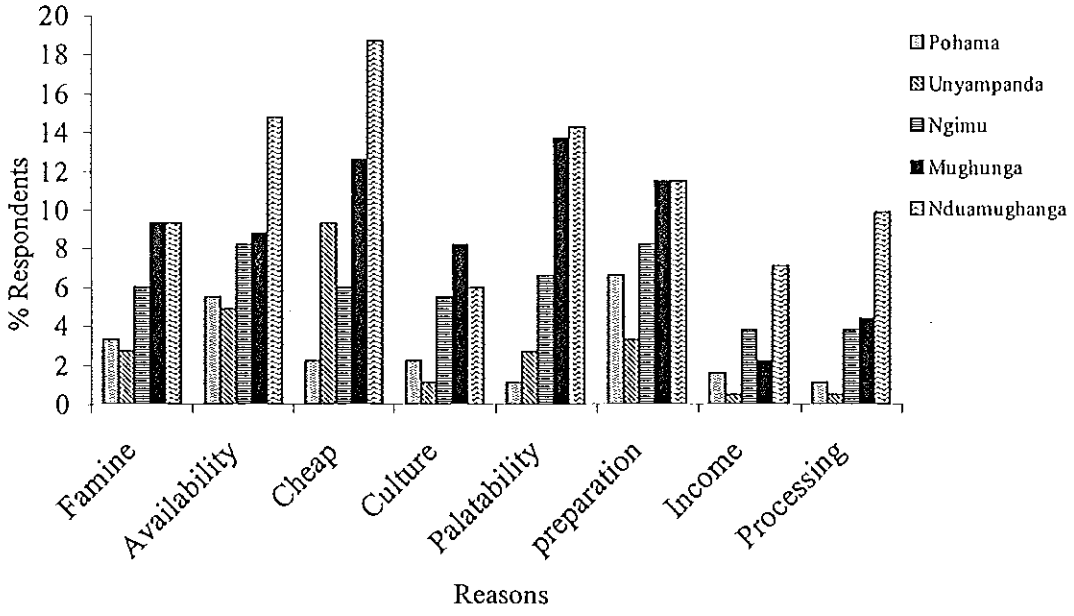


Fig. 5: Reasons associated with popularity of indigenous vegetables over the exotic ones

The analysis of data given in Fig. 5 shows that, indigenous vegetables are preferred because they are cheap, scoring highest (18.7%) in Nduamughanga village, easily available with highest score in Mughunga and Nduamughanga villages of about 11.5% and due to their palatability, appreciated by most respondents (14.3% in Nduamughanga village). Other factors associated with dependency are culture, famine, ease of preparation, income generation and ease of processing.

In line with dependency, further analysis in Fig. 6 showed that household's consumption of vegetables varied considerably. The minimum consumption being 250g and the maximum was 1750 g. Minimum consumption was recorded in hoseholds with about two family members wheareas the highest consumption was recorded in households with 8 or more family members.

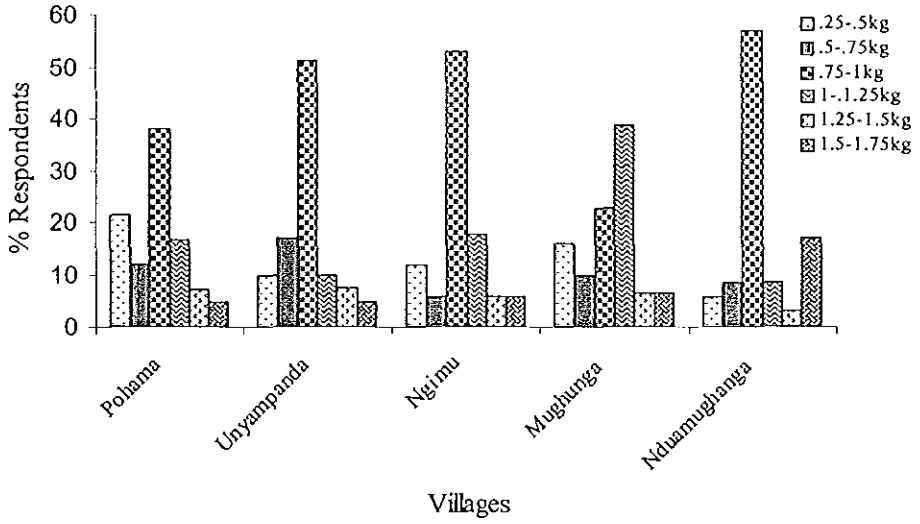


Fig. 6: Household's collection/consumption of vegetables per meal by villages

The weekly income gained from sales of vegetables in the area varies from less than 1500 Tsh (<1US$) up to 5000 Tsh (>5 US$) depending on the efforts (Fig. 7). However, the average income as indicated in Fig. 7 ranged from 4500-5000Tsh (4.5-5 US$). A pile of fresh vegetables that was equivalent to half a kilogram was sold at 100 Tsh (0.1US$) and could go up to 200 Tsh (0.2US$) during famine. An individual vendor was capable of selling 250 piles of fresh vegetables in a season generating a minimum of 36,000 Tsh (36 US$). It can be

observed in Fig. 7 that, more incomes were generated in Ngimu and Unyampandà villages, which means that vegetable sales was more active in these villages that in others.

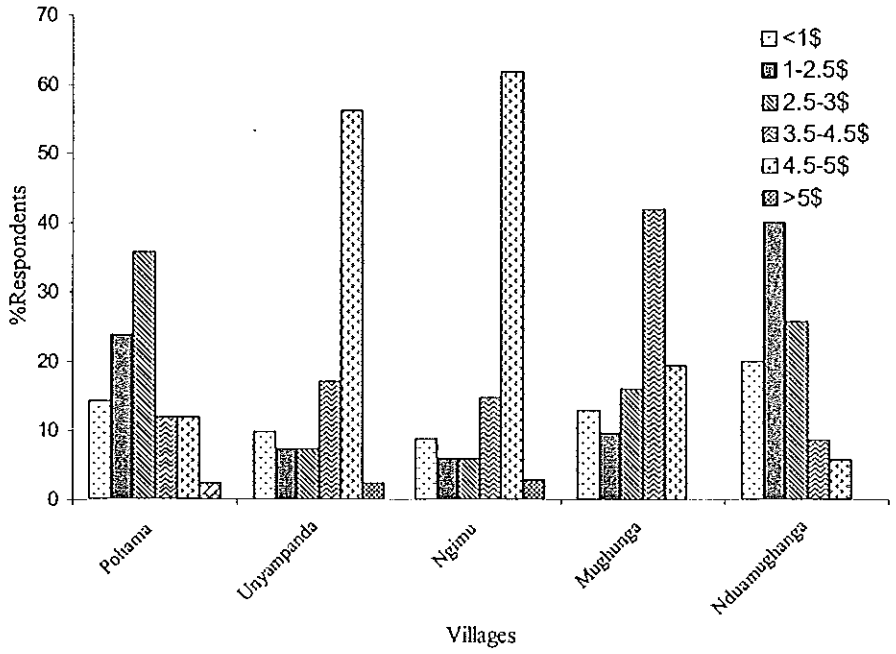


Fig. 7: Household's income accrued from sales of vegetables

5.2.1 Trends of availability of wild vegetables

As observed in Fig. 8, most wild vegetables have peak availability between December and April i.e. during the rainy season. Vegetation surveys also indicated that, vegetables were abundant during the wet seasons of the year and very scarce during the dry seasons. This is because most of the plant species used as vegetables in the area are annuals, except a few species such as *Sesamum angustifolium*, *Adansonia digitata*, *Erythrococca bongensis*, which are being collected all the year round (see Plate 4). A few respondents (1-4%) indicated that the annuals, vegetable plant species were available all the year round. *Sesamum angustifolium*

was reported by over 50% of the respondents to be available throughout the year. This trend coincides with the rainy season in the area, which normally begins late in November and ends in April or May. The trend is also in line with the statistics that, (76.7%) of all the wild vegetables were being collected during the wet season, (7.5%) during the dry season and (15.9%) all the year round. When vegetables are scarce or absent, over (50%) of the local people buy from the neighbours who had collected enough during the wet season or from the local markets. The dried forms of all the annual wild and cultivated vegetable plants are mainly used during the dry season instead.

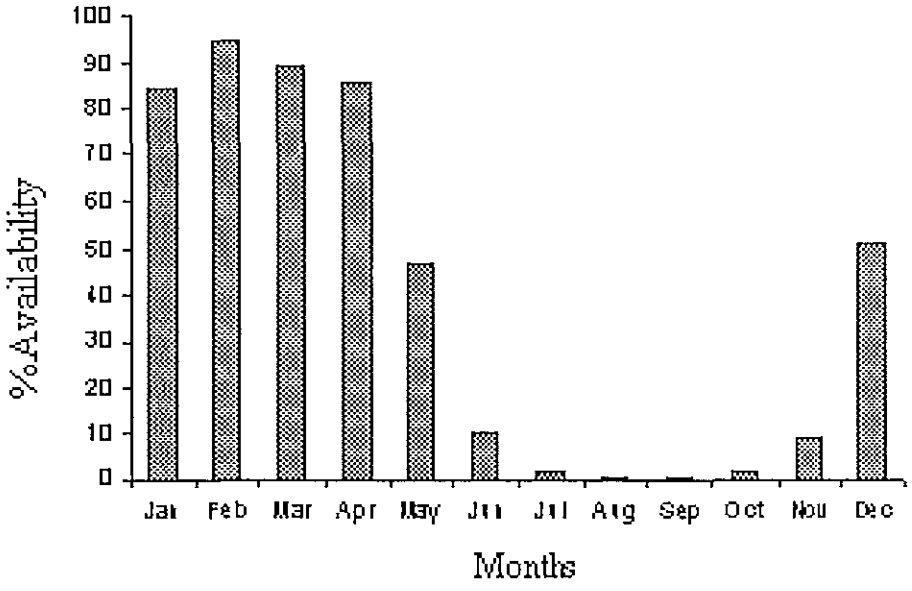


Fig. 8: Seasonal / monthly availability of vegetable plant species

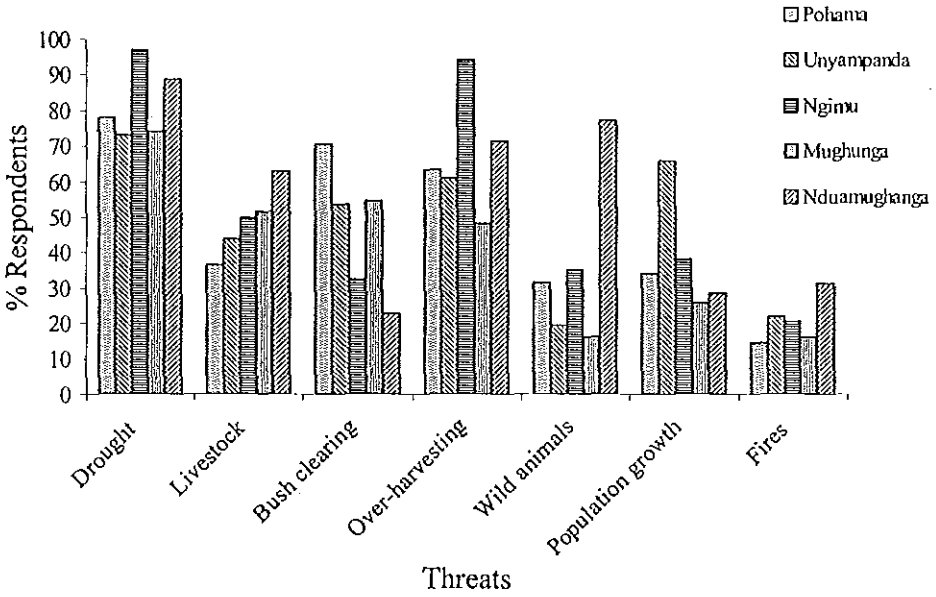
Plate 4: Collection of *Sesamum augustifolium* during the dry season in Nduamughanga village

5.3 Threats to the diversity and availability of vegetable plant species

Several factors are associated with less availability of vegetable plant species in the study area. In this study, several approaches were applied to identify the potential threats to the diversity and availability of vegetable plant species and thus point out those species that are threatened or under pressure. They include questionnaires, preference ranking and vegetation survey both in the natural forest and from the laid down belt transects.

The questionnaire method that was carried out to solicit information on the factors associated with less availability of vegetable plant species in the area resulted into multiple responses that required cross tabulation analysis (Appendix 6) and summarised further in Fig. 9. Based

on these results, of all the indicators of scarcity, drought has the highest score of up to 97.1% in Ngimu Village and next is over-harvesting, which scored 94.1% in the same village. Collection and sales of vegetable plant species such as *Sesamum angustifolium*, *Ceratotheca sesamoides* and many others was more pronounced in Ngimu village than in other villages. The third most important factors are wild animals and insects, which were reported by 77.1% of all the respondents in Nduamughanga village. Fires had the least contribution of about



31% in Nduamughanga village to the scarcity of wild vegetables.

Fig. 9: Factors associated with scarcity (threats) of vegetable plant species in the area

Preference ranking that was performed to identify the potential practices/ uses that can be considered as major threats to vegetable plant species in the study area as perceived by the key informants revealed the same trend. The analysis of preference ranking matrix indicates similar results to those ones by the households (Table 12). Analysis of data in Table 12 shows that drought still scored the highest (20.1%) and ranked the first, followed by over harvesting

16.6%, and the third most important indicator is population growth (15.9). Population growth seems to be a driving force to over-harvesting. Population growth is also considered a reason for extensive bush clearing that is taking place in the area for agricultural activities (see Plate 5. In this analysis, fires still ranked the last (8.9%) and opposite results are on wild animals, which ranked the second (15.9%).

Plate 5: Extensive land clearing for agricultural activities in Pohama village

Table 12: Preference ranking scores of factors for scarcity "threats" of vegetables as perceived by the key informants

(Scores: 5 highest; 3 medium and 1 least score)

Indicators of threats	Scores by respondents (Coded R_1-R_{10})										Total	%	Rank
	R_1	R_2	R_3	R_4	R_5	R_6	R_7	R_8	R_9	R_{10}			
Drought	5	3	3	2	2	1	4	4	5	5	34	20.1	1
Livestock	3	1	2	2	3	4	3	3	2	1	24	14.2	5
Bush clearing	4	3	3	2	5	1	2	1	2	3	26	15.4	4
Over-harvesting	3	4	3	3	4	5	1	2	2	1	28	16.6	2
Wild animals	2	1	1	2	1	2	1	1	2	3	16	9.5	6
Population Growth	2	4	1	5	2	3	3	4	1	2	27	15.9	3
Fires	1	1	2	1	1	2	3	2	1	1	15	8.9	7

Cluster analysis that was performed to crosscheck the similarity of responses among the informants is shown in Fig. 10. The clustering results depicted in the dendrogram (Fig. 10), exhibited a clear separation of respondents at the lower cluster levels.

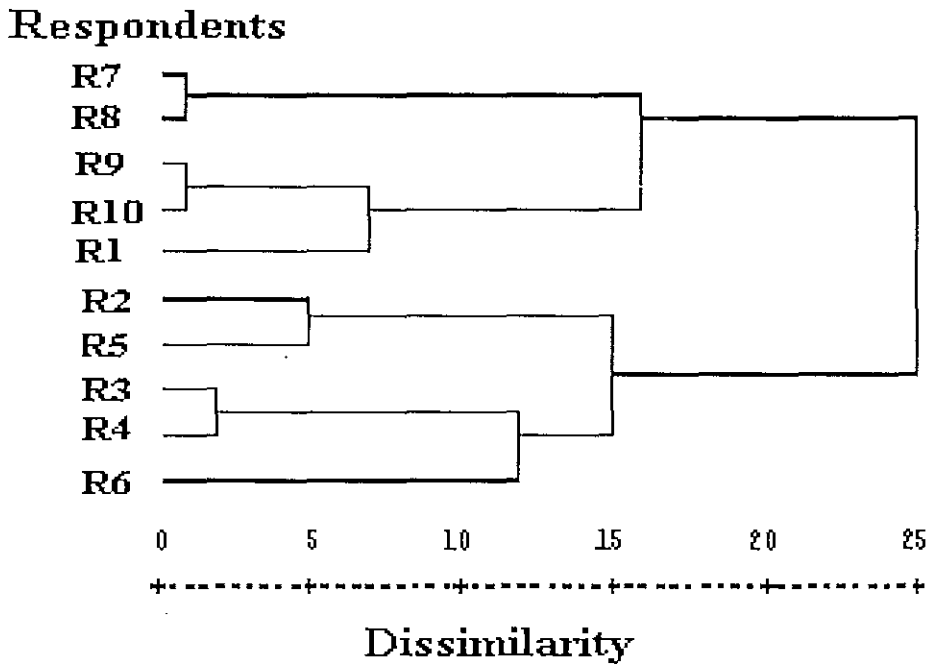


Fig. 10: Dendrogram showing the similarity of responses on factors associated with scarcity of vegetables

Further analysis in Table 13 indicates that the scarce vegetables ranked 1 & 2, i.e. *Mormodica foetida* and *Cucumis figarei* respectively, are mostly obtained in the natural forest, which is now a reserved area in which human activities are strictly restricted including collection of wild vegetables.

Table 13: Aggregate preference-ranking scores for the scarce vegetables in Mgori Division by villages. *(For village codes, see Table 6.)*

Species names		Aggregate scores by villages (Coded V_1-V_5)					Total	Average	Rank
Nyaturu name	Botanical name	V_1	V_2	V_3	V_4	V_5			
Ikhonda	*Sesamum angustifolium*	23	28	29	28	29	137	27.4	3rd
Mbata	*Ceratotheca sesamoides*	29	23	25	30	27	134	26.8	4th
Mahanjo-o-mufumbu	*Mormodica foetida*	42	40	37	40	36	195	39	1st
Jimbo-a-nkuku	*Solanum nigrum*	22	18	16	18	23	97	19.4	5th
Mahukuma-o-mufumbu	*Cucumis figarei*	36	41	37	39	36	189	37.8	2nd

The variations in responses given in Table 13, as observed in the cluster analysis showed in Fig. 11, suggests different perceptions among the respondents on the actual meaning of "scarcity" due to threats. For example, when asked to mention and / or to rank the scarce vegetables, respondents from village Ngimu village (V4) gave more scores on the two species that are found abundantly in the reserved area.

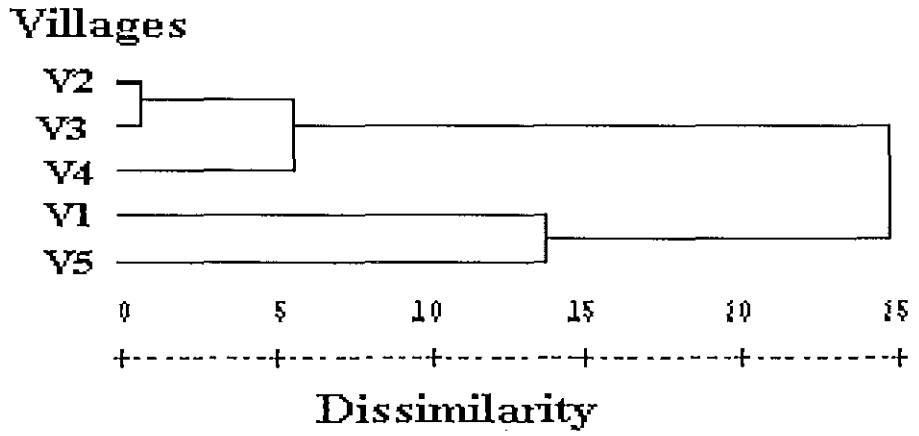


Fig. 11: Dendrogram showing the similarity of responses in Table 13 most scarce vegetables using Complete Linkage method

5.4 Indigenous practices by the local people to conserve vegetable plant species

Based on the information obtained from the respondents and observations, five major practices for conserving vegetable plant species in the area are commonly in use. These include domestication/cultivation, seed storage, application of kraal manures, home gardening and nurturing (Fig. 12). Of all these, application of manures and nurturing are the most common practices in the area accounting to over 75% in all the villages. Domestication and storage of seeds are relatively at a much lower levels (less than 45%) across all the villages. Gardening is least practiced (<25%) across all the five villages (Fig. 12). This is because of drought in the area coupled with lack of permanent water sources to enable irrigation during the dry season.

Fig. 12: Common indigenous practices for conserving vegetable plant species

5.5 Vegetation classification and distribution of vegetables into community types

304 plant species that belongs to 53 families were collected and identified from the study area. The dendrograms for both dry and wet season vegetation analyses are given in Fig. 13 and 14 respectively.

The dendrograms produced by SYNTAX software shows the different sample sites forming the distinct community types against the similarity scale ranging between 0-1. From this analysis, species association was recognized and then categorized into 4 groups at a dissimilarity level of 0-1, during the dry season and 5 groups at a dissimilarity level of 0-0.95 during the wet season. Apparently, 9 groups were formed during both seasons. However, it should be noted that since vegetation data were collected from the same plots monitored in both seasons, then some factors are responsible for the instability of the communities. Such factors are discussed in section 6.5 of chapter 6. Despite such factors, the wet season community types still correspond to the dry season community types. For example, Community I & II of the wet season correspond to community I of the dry season. Likewise, community III of the wet season correspond to community II of the dry season, and community V of the wet season correspond to community IV of the dry season.

Based on the dendrogams, the distinct groups were named community types and were designated as I, II, III and IV, (Fig. 13) for the dry season and I, II, III, IV and V (Fig. 14) for the wet season. Plant community types have been named by use of dominant plant species within each group (Appendices 3 & 4). One or more plant species with the highest mean cover abundance value have been used in naming the plant communities (Whittaker, 1970).

To get the mean cover abundance value, the average cover/abundance scale of each species in every community where they occur was calculated. According to Whittaker (1975), more than one species normally dominate one particular plant community.

Dry season Plant Community type include:

Community type I: ***Jubernadia globiflora-Lonchocarpus eriocalyx*** **community**

Jubernadia globiflora is the dominant tree layer in this community. This community occurs in the village forest reserves (VFRs) or zones II and III, which belong to Nduamughanga, Pohama and Mughunga villages. This area occurs at altitudes of about 1436 m a.s.l, 1468 m a.s.l and 1445 m a.s.l, for Nduamughanga, Pohama and Mughunga village forest reserves respectively. Vegetable plants that are common in this area include *Sesamum angustifolium* and *Erythrococca bongensis*. Other woody species associated with this community include *Pterocarpus angolensis, Commiphora mossambicensis, Brachystegia spiciformis* and *Combretum molle*. The herbacious layer constitute mainly of *Panicum maximum, indigofera volkensii* and *Eragrostis aspera*.

Community type II: ***Albizia harveyi-Acacia drepanolobium-Loudetia simplex*** **community**

Albizia harveyi-Acacia and *drepanolobium-Loudetia simplex* are the typical characteristics features of this community. The plots describing this community type occur mainly in Masiriva area in Pohama part of forest reserve. The average altitude of this area is 1523 m a.s.l. Woody species such as *Commiphora tronthae* and *Brachystegia spiciformis* are also common in this community. Other non-woody species common in this community are *Hyparrhenia rufa, Panicum maximum* and *Tridax procumbens*. The vegetable species that

occur in this area include *Erythrococca bongensis* and *Sesamum angustifolium.*

Community type III: ***Boscia angustifolia-Justicia salvadois*** **community**

Boscia agustifolium, Justicia salvadois are characteristic species of this community. This community type occurs in zone III of Mughunga village forest reserve. It exist as an outlier of community type II and constitute the least area or plots. Other woody species that are part of this community include *Boscia mossambicensis, Vitex keniensis, Commiphora molle, Grewia bicolor* and *Combretum molle.* Other common non-woody species in this community are *Tridax procumbens* and *Rynchelytrum repens.* The average altitude in which this plant community type was found to occur is 1445 m a.s. l. None of vegetable plant species were recorded in this community type.

Community type IV: ***Ficus stuhlmanii-Tricalysia ruandensis*** **community**

This community corresponds to the community V of the wet season. *Ficus stuhlmanii* and *Tricalysia ruandensis* are the characteristic features of this community. This plant community type is mainly located in zone III of Ngimu village forest reserve and partly in zone II of the same area at an average altitude of 1458 m a.s.l. In respect to the vegetable plant species available in this community type, *Adansonia digitata* was the most common followed by *Erythrocacca bongensis.* Other common vegetable plant species include *Gongroneuma angolense* and *Sesamum angustifolium.*

The five wet season plant community types are:

Community type I: *Jubernadia globiflora-Brachystegia speciformis* community

This community corresponds to community I of the dry season. *Jubernadia globiflora* dominates this community type. *Brachystegia speciformis* is the next dominant species. *Loudetia simplex* and *Panicum maximum* constitute the ground cover. Another plant species that is closely associated with this community type is *Pterocarpus angolensis*. The average altitude for which this community type occurs is 1437 m a.s.l, located in Nduamughanga village forest reserve and 1468 m a.s. l. in Pohama village. The presence of grasses as dominant under storey species suppressed the growth of herbs and shrubs that were observed to be rare. Climbers, most of which are useful as vegetables by the local people are common in this community type. These include *Ipomoea sinensis, Cucumis figarei* and *Momordica foetida.* The lower canopy layer is composed of species such as *Catunaregum spinosa, Canthium burtuii, Commiphara mossabicensis* and *Lannea humilis.*

Community type II: *Jubernadia globiflora-Digitaria perrottetii* community

This community type also corresponds to community I of the dry season. It is characterised by *Jubernadia globiflora* as a dominant tree layer, while *Digitaria perrottetii* forms the ground layer. *Cleome hirta* is a common edible herb in this community. Grass species such as *Loudetia simplex* and *Panicum maximum* were also available. Other woody species associated with this plant community type are *Pterocarpus angolensis, Schrebera trichoclada, Xeroderis stuhlmanii, Strophanthus eminii,* and *Combretum zeyheri. Cucumis figarei* is the common vegetable species in this community.

Community type III: ***Brachystegia speciformis-Digitaria perrottetii*** **community**

This community corresponds to community II of the dry season. This community is mostly dominated by *Brachystegia spiciformis* in the tree layer and ***Digitaria perrottetii*** in the under storey layer. Other non-woody plant species in the ground layer include *Tridax procumbens, Bidens pilosa, Justicia salvadois* and *Aspilia mosambicensis.* Other associated woody plant species are *Pseudovigna argentae, Boscia mosambicensis, Commiphora africana, Daldergia stuhlmanii, Pseudolachnostylis maprounifolia* and *Rhynchelytrum repens. Cucumis figarei* is the abundant edible climbing herb in this community type. This community seems to be an outlier of community type II and constitute the least number of sample plots. This community type is located in zone III of Mughunga village forest reserve. This area has an average altitude of 1445 m a.s.l and generally dominated by sandy- loamy soils.

Community type IV: ***Lonchocarpus bussei-Eragrostis cylindriflora*** **community**

This community corresponds to community III of the dry season. This type of community is dominated by *Lonchocarpus bussei* in the tree layer and *Eragrostis cylindriflora* in the ground layer. Many of acacia plant speeies exist in this community type. They include: *Acacia seyal val seyal, A. drepanolobium, A. tanganyikensis* and *A. tortilis.* Other woody species in this community type include *Albizia harveyi, Caturanegum spinosa, Commiphora tronthae* and *Capparis tomentosa.* The associated grass species include *Hyparrhenia rufa, Panicum maximum* and *Tridax procumbens.* This plant community type is located in Pohama village forest reserve, sub-village Masiriva, at an average altitude of 1523 m a.s.l, and partly dominated with sandy-loamy soils and clay (black) soils.

Community type V: *Adansonia digitata-Ficus stuhlmanii* community

This community corresponds to community IV of the dry season. This plant community type is more or less equally dominated by *Adonsonia digitata* and *Ficus stuhlmanii* in the tree layer. The next dominant tree species is *Tricalysia ruandensis.* Other woody species in this community include *Terminalia sericea, T. brownii, Premna sinensis, Euphorbia grantii, E. matabelensis* and *Capparis tomentosa.* The ground cover constitutes grass species such as *Eragrostis racemosa, Digitaria abyssinica, D. perrottetii* and *Brachystegia brizantha. Adansonia digitata, Sesamum angustifolia* and *Erythrococca bongensis* are the most common wild vegetable plant species in this plant community type. This community type is found in Ngimu village forest reserve, at an average altitude of 1458 m a. s. l.

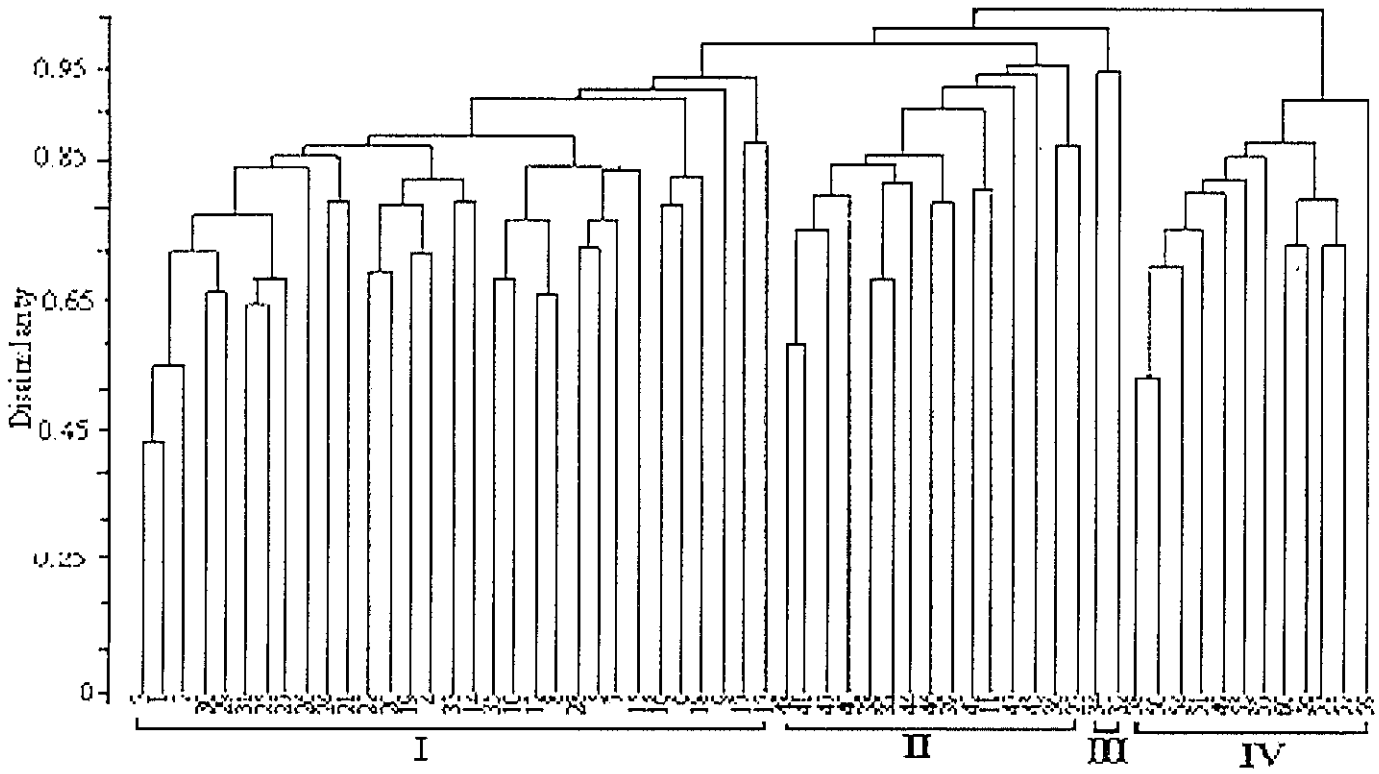


Fig. 13: Dendrogram of vegetation community types for the dry season

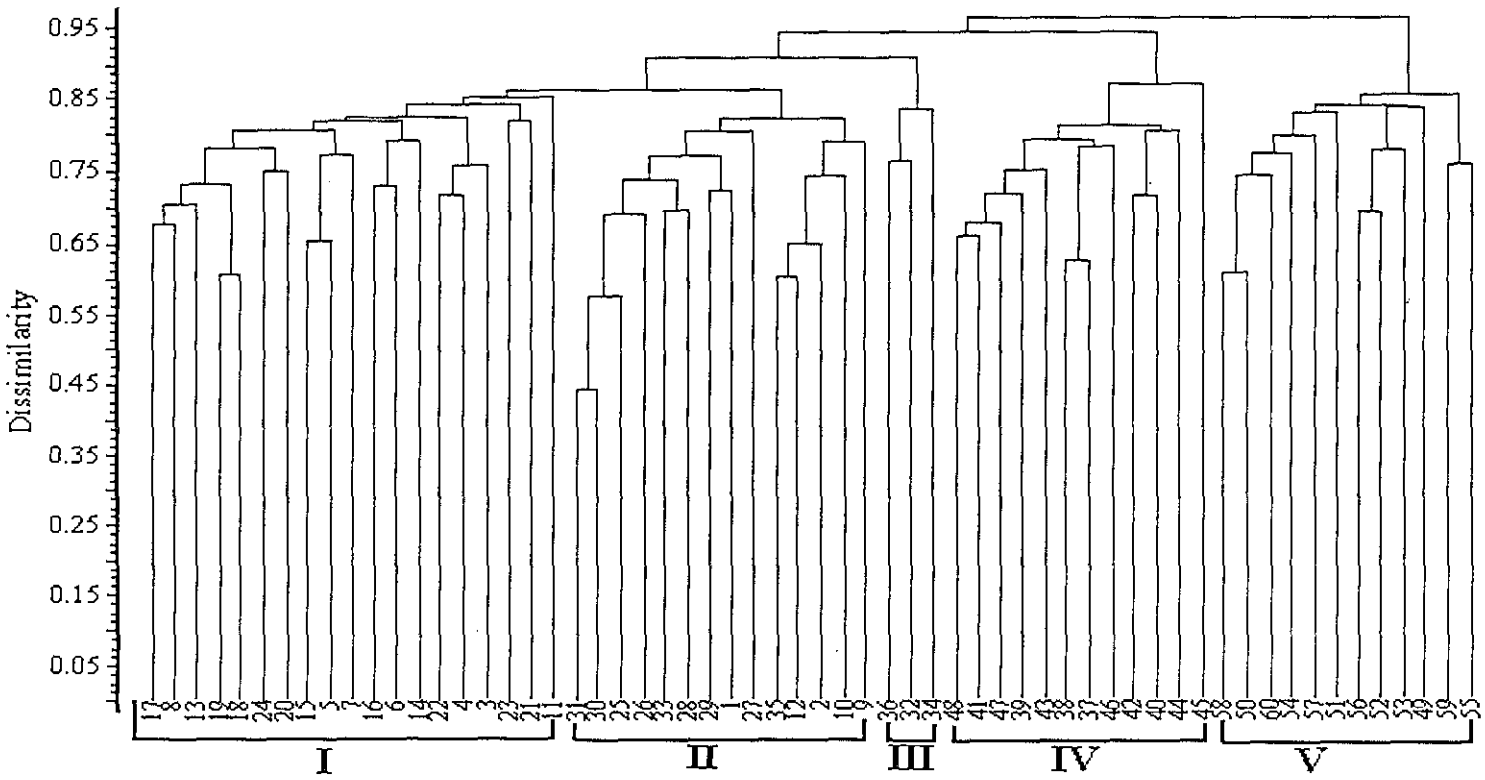


Fig. 14: Dendrogram of vegetation community types for the wet season

5.5.1 Species diversity and their distribution among families

The study area was found to have diverse species composition that was represented by 53 families (Table 14). The plant species were identified from 120 plots sampled over both seasons in the forest reserve (Appendices 1, 3 & 4). More than 50% of the plant species encountered belonged to 8 families only.

Table 14: Distribution of species among Families

S/N	Family	No. of species	% of the total	S/N	Family	No. of species	% of the total
1	Acanthaceae	11	3.6	28	Icacinaceae	1	0.3
2	Aizoaceae	1	0.3	29	Lamiaceae	7	2.3
3	Alliaceae	1	0.3	30	Liliaceae	4	1.3
4	Aloaceae	2	0.7	31	Loganiaceae	2	0.7
5	Amaranthaceae	6	2.0	32	Malvaceae	7	2.3
6	Anacardiaceae	7	2.3	33	Meliaceae	1	0.3
7	Antharicaceae	1	0.3	34	Moraceae	1	0.3
8	Apocynaceae	3	1.0	35	Ochnaceae	1	0.3
9	Asclepidaceae	3	1.0	36	Olacaceae	2	0.7
10	Asteraceae	9	3.0	37	Passifloraceae	1	0.3
11	Balanitaceae	1	0.3	38	Pedaliaceae	3	1.0
12	Bignoniaceae	3	1.0	39	Piperaceae	1	0.3
13	Bombacaceae	1	0.3	40	Poaceae	42	13.8*
14	Boraginaceae	4	1.3	41	Polygonaceae	1	0.3
15	Burseraceae	5	1.6	42	Rhizophoraceae	1	0.3
16	Fabaceae	56	18.42*	43	Rubiaceae	13	4.3*
17	Capparidaceae	8	2.6	44	Santalaceae	1	0.3
18	Combretaceae	10	3.3	45	Scropholariaceae	2	0.7
19	Commelinaceae	4	1.3	46	Solanaceae	5	1.6
20	Compositae	1	0.3	47	Sterculiaceae	1	0.3
21	Convolvulaceae	7	2.3	48	Tiliaceae	8	2.6
22	Cucurbitaceae	11	3.6	49	Umbelliferae	1	0.3
23	Cyperaceae	10	3.3	50	Verbenaceae	3	1.0
24	Ebenaceae	1	0.3	51	Vitaceae	5	1.6
25	Euphorbiaceae	20	6.6*	52	Zingiberaceae	1	0.3
26	Flacourtiaceae	1	0.3	53	Zygophoraceae	1	0.3
27	Gensinaniaceae	1	0.3				

The family Poaceae had the highest contribution of species with 42 (13.8%) of the total number of species. Next to it are the families Fabaceae 56 (18.42%), Euphorbiaceae 20 (6.6%), Rubiaceae 13 (4.3%) and Cucurbitaceae 11 (3.6). Others include Combretaceae 10 (3.3%), Cyperaceae 10 (3.3%), Capparidaceaea 8 (2.6%) and Tiliaceae 8 (2.6%).

Data on plant species diversity (H'), evenness (E) and richness (N) of all the plant communities for both seasons are indicated in Tables 15 and 16. Dry season plant community types I, has the highest species diversity and richness, followed by plant community type II and IV. Plant community type III had the least species diversity and richness.

Table 15: Comparison of plant species diversity, evenness and richness between the 4 community types for the dry season

	Dry season plant community types			
	I	II	III	IV
Species diversity (H')	4.1	3.85	2.41	3.64
Species evenness (E)	0.84	0.85	0.87	0.86
Species richness (N)	130	95	16	69

Table 16: Comparison of plant species diversity, evenness and richness between the 5 community types for the wet season

	Wet season plant community types				
	I	II	III	IV	V
Species diversity (H')	4.63	4.08	3.22	3.9	3.96
Species evenness (E)	0.91	0.85	0.89	0.84	0.88
Species richness (N)	164	121	37	106	90

In order to determine which group is different from the other and if the environmental factors contributed to the existing differences, both the groups and the environmental factors were subjected to multiple comparison tests. In this case, one-way ANOVA was used. In the dry season, vegetation clusters did not show any significant difference from each other, but the effect of fire was highly significant (Table 17). In the wet season clusters, fire and slope were significantly different (Table 18).

Table 17: Analysis of variance (ANOVA) for dry season clusters

Attribute	Variables	SS	df	F	Sig.
Community	Altitude	9990.82	3	0.21	0.89 *
	Slope	14.06	3	1.91	0.14 *
	Fire	28.73	3	5.08	0.004 ***

Table 18: Analysis of variance (ANOVA) for wet season clusters

Attribute	Variables	SS	df	F	Sig.
Community	Altitude	16175.44	4	0.25	0.91 *
	Slope	27.86	4	3.12	0.02 **
	Fire	6.47	4	9.68	0.00 ***

* Non-significant
** Significant
*** Highly significant

Further more when the environmental factors (altitude, slope and fire) were considered for all the vegetation communities and subjected to Duncan's Multiple Range test in which only fire was significantly different in all the vegetation groups for both seasons (Tables 19 & 20).

Table 19: Duncan's Multiple Range Tests for dry season community types

Factors	Community Types (No. of plots)			
	I (31)	II (2)	III (12)	IV (15)
Altitude	1445.096b	1448.00b	1458.92b	1476.13b
Slope	5.03b	5.83b	6.20b	5.76b
Fire	3.39b	3.00ab	1.58a	2.67ab

Harmonic mean sample 5.863, Alpha = 0.05
Different letter notations in each column indicate significance difference at $p<0.05$

Table 20: Duncan's Multiple Range tests for wet season community types

Factors	Community Types (No. of plots)				
	I (14)	II (19)	III (3)	IV (12)	V (12)
Altitude	1439.00b	1447.21b	1455.00b	1458.92b	1485.67b
Slope	4.37a	5.41ab	6.11b	6.20b	5.97b
Fire	1.50b	1.74b	1.00a	1.00a	1.00a

Harmonic mean sample 8.012, Alpha = 0.05
Different letter notations in each column indicate significance difference at $p<0.05$

6 DISCUSSION

6.1 Household dependency on indigenous vegetables

This study indicated extensive use of indigenous vegetables by the local communities in the area. Of the 56 plant species that were identified for use as vegetables only 15 (25.9%) were cultivated mostly exotic and naturalised. The rest, 43 (74.1%) were non-cultivated, traditional wild, semi-wild species (see Table 4). Some 21 species identified during this study were also reported by Hamza and Kitula (2003) in their previous inventory of non-timber forest products for Mgori Forest Reserve, although the present study provides a more comprehensive list. Based on the opinions of the respondents several reasons for use / reliance on wild vegetables over the exotic species were solicited. They are summarized in Appedix 6 and shown in Fig. 5.

Preference ranking for both exotic and wild vegetables in one of the villages explains that indigenous vegetables are more popular in the area and most liked than the exotic ones (Table, 7). The most commonly vegetables are leafy vegetables. In her dietary study in the Usambara Mountains of Tanzania, Fleuret (1979a) concluded that, indigenous vegetables leafy accounted for 80 percent of all leafy vegetables consumed.

Based on tbe analysis of responses in the preference ranking shown in Fig. 4, respondents R6 and R9 seem to have given to the exotic species relatively higher scores, which means their preference is more on exotic species. They are both leaders in the local government of the village and somehow educated and with relatively higher income to afford the exotic ones. Perhaps, their education levels might have also influenced their attitudes towards wild vegetables.

Based on these analyses, the study establishes that, majority of the people of the area prefers indigenous vegetables to the exotic ones. These results are in line with those reported by Fleuret (1979a) and Mwasumbi *et al.*, (1997), in the Sambaa people of East Usambara Mountains in Tanzania. According to the respondents, wild vegetables were also used more often than the exotic ones in the households' meals. Ole *et al.*, (2001) observed similar trend in Burkina Faso.They are regarded as being cheap, easily obtainable, easily cooked, more palatable than the exotic species, their cultural heritage foods, easily processed and stored, income generating and useful during the time of food scarcity (famine) in all the five villages in the study area (Appendix 6 and Fig. 5).

Another important reason for dependency on the indigenous vegetable species is the fact that their traditional preparation of vegetable sauce "**mlenda**" (as described earlier) requires much fewer additives i.e. water and salt. Cooking oil, tomatoes, onions and spices, which are costly and seem to be important in other sauces, are not part of this preparation. Majority of the local people are low-income earners and thus can poorly afford the additives necessary for the cooking of most exotic vegetables. In line with this is the fact that, even their production requires more agro-inputs and skills.

According to their opinions and despite their preferences on traditional species over their counterparts, collection of wild vegetables is troublesome due to their seasonal occurrence (mostly during wet season) and many other constraints (Appendix 8). However, one of the most important reasons that was not mentioned by the respondents but might have contributed to their

shifted interest on the traditional species of vegetables is the fact that there are no permanent water sources for them to be able to engage themselves in gardening through irrigation during the dry seasons. This would have made the exotic species of vegetables much more available and affordable by the majority. However, their preference on the indigenous vegetables deserves to be appreciated for it contributes to domestication of such species and hence their conservation. From these findings, it can be concluded that, indigenous species of vegetables will remain to be important source of minerals and vitamins to the local people for a much longer time than their exotic counterparts.

6.1.1 Economic significance for dependency on wild vegetables

Certain households expend considerable efforts to derive some income from the sales of vegetable plant species. Many do not simply collect for sales, but first nurture the important wild vegetables within or near their homesteads and croplands, then dry and store them for sale later on. The business is at its peak during the dry season when most of the herbs for use as vegetables are off-season. It is important that such activities are encouraged further, especially within and outside the study area because they can increase some form of informal employment and income generation among the local people. The widespread popularity of traditional vegetables in the area, suggests that people in the area might respond to interventions promoting the usage and thus conservation of such species through cultivation or domestication. Hence, indigenous vegetable plant species may potentially be used as economic solutions to increase the incomes of the small scale farming in rural poor communities such as the ones in Mgori Division. The potential indigenous vegetable plant species for promotion based on their market potential (income

generation) are listed and ranked in Table 9. In this table, *Sesamum angustifolium* ranks the first in its potentiality as a tool for income generation in Mgori rural communities.

These findings are slightly different from those by Hamza and Kitula (2003) in the same area in which 190 piles of fresh vegetables were being sold and income of 31,000 Tsh (31 US$) was generated. It was further argued that the amount was about 3.8% of the total income earned per year per individual vendor. The money accrued from the sales of vegetables was used to buy some additional food and other household requirements. It is therefore evident that, there are some economic justifications in favour of wild vegetable plant species and intervention would promote use, domestication/cultivation and consequently conservation of such species, which are now under pressure. Likewise, the amount collected and or consumed per household ranges from 250gm to 1750gm, depending on the size of the family. Based on respondents and personal observations, the average amount consumed per meal in most households varies from 0.75-1kg (Fig. 6). Data on monthly, yearly consumption and income levels were difficult to obtain because of lack of records.

6.2 Threats to the diversity and availability of vegetables

The local people of the area are quite knowledgeable on their surroundings and the importance of natural environment for their survival and wellbeing. The National campaigns through the media and a number of visits by National, Regional or District leaders in the area have heightened their understanding on the factors that can make them loose the natural vegetation and other resources available on their land.

In respect to the information in Table 12, the factors that are associated with scarcity of vegetables in the study area include drought, livestock which can feed on them, bush clearing for agricultural purposes, over-harvesting mostly for stocking /preserving for use during the times of scarcity (especially during the dry season), wild animals and occasionally insect pests, population growth which translates to increased demand on this resource and fires. Drought is the main contributing factor to the scarcity in all the five villages followed by over-harvesting, which is highest in Ngimu village. Ngimu village was observed to be the place where most local people are engaged in collection and sales of vegetable plants species, within the village and some even transport the dried forms of vegetables such as *Sesamum angustifolium, S. indicum and Ceratotheca sesamoides* to distant villages and exchange with cereals. Some people/ households were reported to spend much of their time during the wet season in collecting wild vegetables than in cropping. Such households do obtain their food by exchanging the dried/processed forms of vegetables with cereals. Further results indicated more consumption level in Ngimu village (Fig. 6) and more income accrued from sale of vegetables in the same village (Fig. 7). Hamza and Kitula (2003) also reported on active butter trade that exists in the area. The cash obtained from the sales of vegetables is used to buy food and other households' items. This translates to the existence of a considerable pressure on vegetable plant species in the area due to overharvesting.

Nduamughanga village whose respondents associated wild animals and insects to the scarcity of vegetables is located in the remote part of the Division and in which a larger population of wild games do exist. There has been an outbreak of armyworms in the previous year (*Spodoptera*

exempta), which have devastating effects on vegetation and field crops. The least contribution of fires to the scarcity of wild vegetables in all the five villages in the Division is probably because such a factor usually occurs in the dry season when most edible herbs such as vegetables are off-season. The relatively high score of fires in Nduamughanga village is probably because fire incidences were more in this village than in other villages.

The clustering results depicted in the dendrogram (Fig. 10), indicated more consistency in responses at the higher level of the tree and some dissimilarity at the lower levels. It separated the two respondents (R1 & R6) from the rest. Further, the tree shows the presence of similarities between informants-locality (village), age, and gender and knowledge on local wild vegetables. Highest similarity exists between informants R7, R8, R9 and R10. These are women aged 34, 38, 55, and 58 respectively, from different villages. Informants R2, R3 and R5 are women under 30 years old, whereas R1 is a man under 30 and R5 and R6 are men over 50. Women who are the main collectors of vegetables were generally more consistent in their responses than is the case with men whose responses were generally different. Some respondents like R3 & R5, R7 and R10, were from the same villages and thus, their responses were influenced by the most pronounced indicators of threat that existed in their localities. Hence, the analysis reveals that age, gender, and localities influence knowledge about factors for scarcity of some vegetables and that some factors are location specific e.g. wild animals, insects like army worms and fires were of major concern in Nduamughanga village than in other villages. This finding agrees with that by Pieroni (1999), in which the collection of vegetables is still a ritual for many women of Gallicano village in Central Italy.

6.2.1 Scarce vegetables

The identified, most scarce vegetables are *Sesamum angustifolium*, *Ceratotheca sesamoides*, *Momordica foetida, Solanum nigrum*, and *Cucumis figarei* (Table 13 and Fig. 11). Arranged in the order of decreasing level of scarcity *Momordica foetida* ranked the first whereas *Solanum nigrum* ranked the fifth: *Momordica foetida* > *Cucumis figarei* > *Sesamum angustifolium* >*Ceratotheca sesamoides* > *Solanum nigrum.* According to the respondents, the scarcity was associated with many factors, such as drought (in relation to *Sesamum anguistifolium* and *Ceratotheca sesamoides*); livestock, especially chickens which feed heavily on both the leaves and fruits of jimbo-a-nkunku (*Solanum nigrum*), as the name reflects: "*Jimbo-a-nkuku*" i.e. " favourite food for chicken", and hence its scarcity even during the wet seasons. The scarcity of *Momordica foedita* and *Cucumis aculeatus* is attributed to the fact that, the two species are only gathered in the forest "**Mufumbu**" i.e. "Miombo woodland." as the name reflects, which is a restricted zone from which people are not allowed to harvest anything. Table 12, summarizes the percentage contribution of factors that are considered as threats to the wild vegetables in the study area. However, it can be argued that, their scarcity cannot be considered as a threat to their availability because the species could still be harvested in plenty if these factors never existed, although prolonged drought would threaten the disappearance of most species of wild vegetables. It can therefore be concluded that, the local people's perception about "threats" is different from that of scientific context. To them, threat means unavailability or inaccessibility of plant species in question in their vicinity. In this case, short supply or distant collection, is considered as scarcity. The scientific context of the term threat means any causal factor that has a negative impact on the survival of species and that the existence of a species is unlikely if the causal factor

continue operating. According to the IUCN red data list (1997), threats may be any factors that can reduce the taxa or their habitats drastically to a critical level and place them in a danger of extinction. Although vegetable plant species such as *Momordica foetida* and *Cucumis figarei* are mentioned to be scarce in Table 13, they were found to be abundant in the natural forest. Since the protected and the species that are in the forest are no longer accessible to the local people.

During this study, no potential factors that can be considered as threats to the existing vegetable plant species were pointed out, although such plants are under pressure due to multiple use, over-harvesting and environmental factors such as drought.

The respondents proposed some solutions or measures, which can be used to ensure the availability of vegetables in their localities. They include *in-situ* conservation (25.8%), Cultivation (29.2%), domestication (37.3%), seed collection and storage (7.7%). However, the actual practices in the localities as observed during vegetation survey revealed that, (25.3%) of the local people had the initiatives to nurse/tend the wild vegetable plant species that grew in their fields or around their homesteads that were not deliberately planted, (52.25%) of the local people cultivated or domesticated the wild vegetables and (22.2%) had the initiatives to store wild vegetable seeds and later on broadcast them in their fields at the beginning of rain the seasons (Fig. 12).

6.3 Indigenous practices used by the Nyaturu people to conserve vegetable plant species

This study established that, generally, most people of the area have a considerable knowledge on vegetable plant species, about their biological characteristics and their habitats. On average, every respondent could mention a minimum of 10 plant species for use as vegetables available in their localities. The people know where and in what season to find certain vegetable plant species and they know how to harvest and cook the plants and they are aware of the medicinal value of some vegetable plant species. However, women are generally more knowledgeable on various aspects of vegetables than men and children. The reason for this is the cultural division of labour in which the indigenous women are responsible for cooking the household meals. Hence, collection and cooking of vegetables is one of women's core responsibilities. These findings are in line with arguments by Howard (2002) that; "In many contexts and cultures around the world women are the primarily managers and users of plant resources and are thus the principal bearers and repositories of ethnobotanical knowledge". This author further claims; "Over much of the world, it is women who are wild gatherers and managers, home gardeners and plant domesticators, herbalists and healers, as well as seed custodians. On the other hand, the medicinal value of some vegetable plant species is clearer and well explained by elders especially the traditional healers in the area (Table 4). The medicinal value of some vegetable plant species contributes to their increased use value and hence their potentials for being domesticated.

It was also noted that, people understand their dependency on ecosystem for survival, and the ecosystem, in turn, is affected by their activities. They even utilize different lands such as "**mbuga**" that is black soils, permanent dry lands, and home gardens and they know types of

vegetable plant species and other crops that best suit such areas. They know which part(s) of plant(s) are edible (for use as vegetables), which vegetables can be used as medicines. In addition, they have learned that some vegetable plant species are annuals, biannual/perennials and those that are also food to their livestock and wild games. Annual vegetable plant species are therefore being collected in large quantities during the wet season, processed, dried and preserved for use in the times of scarcity mostly during the dry seasons of the year. Shackleton *et al,* (1998) reported similar knowledge by the indigenous people of Central Lowveld Savanna Region in South Africa and Rubaihayo (1994) reported the same in Uganda.

Based on the information obtained from the respondents and observations, five main practices for conserving vegetable plant species in the area are commonly in use. These include domestication/cultivation, seed storage, application of kraal manures, and gardening nurturing (Fig. 12).

Although most vegetable plant species are also feed to the livestock, it was noted that there was no concern about this, not even taking necessary precautions like avoiding grazing in landscapes, which are rich in vegetable plant species. Their explanation behind this phenomena is that, livestock, though can feed on some species of vegetables such as *Ceratotheca sesamoides* (sheep and cattle), *Sesamum angustifolium* (sheep and cattle), most members of Cucurbitaceae and Convolvulaceae (goats, sheep and cattle) *Adansonia digitata* and *Erythrococca bongensis* (goats), *Solanum nigrum* (chicken and goats) etc, and cause a considerable scarcity, they contribute a lot in bringing them closer to their homes (i.e. domestication) through their droppings, which could

still contain viable seeds of some vegetable plant species. The vegetable scarcity due to livestock is therefore not taken as a threat but considered beneficial. Based on this knowledge and perhaps many other reasons, the Nyaturu homestead is usually built in such a way that the cattle "**boma**"- the stall is just next to the residence, which is also located in the middle of the farm. The main house where people sleep is partitioned to accommodate chicken, young animals, sheep and goats at night. The whole compound is fenced using carefully selected plant species some of which are used as vegetables. In the morning all the droppings from the animals in the house are usually swept out and collected at one point to undergo further decomposition and later on, usually before the sowing season, such heaps of kraal manure are dispersed on the home gardens and croplands near homesteads. The most preferred vegetable plant species that germinate during the wet season are being tended or nurtured in croplands during weeding. In this case, the livestock bring at home vegetable species from far landscapes and natural forest. Households with no livestock do request for manure from their neighbours for them to apply on their croplands to fertilise their fields and to have the vegetables growing near homes. This indigenous knowledge has been passed from generation to generation and has enabled these people to obtain plant species for use as vegetables closer to their surroundings for so long. Thus, livestock contributes to the domestication of such species.

In addition, the people of the area do cultivate/domesticate some preferred indigenous vegetables. Nearly all households cultivate small areas around the homesteads during the rainy season and harvest several different kinds of resources from them, including vegetables. The most commonly cultivated or nurtured wild vegetables are *Amaranthus spinosa, A. dubius, A. lividus, Ipomoea*

batatas, Solanum nigrum, Cleome gynandra, Coccinia grandis, Adenia gumnifora (nurtured in fences), *Sesamum angustifolia, Ceratotheca sesamoides*, local varieties of tomatoes, piper and trees species such as *Adansonia digitata* and *Azanza garckeana*. Kajuju *at al.* (2000) reported similar practices by the Nduuri community of Embu in Kenya. Exotic vegetable plant species that are being cultivated include, *Abelmonchus esculentus, Lycopersicon esculentus, Solanum nigrum* and *Phaseoulus vulgaris*. The naturalized alien species include, *Curcurbita melo, C. pepo, C. maxima, Manihot esculentus, M. glaviozii, Ipomoea batatas* and *Amaranthus hybridus*. Related to this, the pure stands of indigenous vegetables that germinated spontaneously during the wet season are being fenced to restrict livestock that may feed on them. Some perennial vegetable plant species, especially the climbers and a few climbing herbs, are included in live fences around the homesteads or animal stalls. Examples include species such as *Adenia gumnifera, Curcubita spp.* and some local varieties of tomatoes that can remain green for an extended time in the dry season.

Apart from conserving the vegetable plant species by cultivating, tending/nurturing them in the fields, the methods of harvesting reflect their awareness in conserving this resource. 100 (94.8%) of respondents in all the five villages reported harvesting of only useful parts whereas harvesting by uprooting was being practiced by only 6 (5.3%) of the respondents. In this study, no myths, rituals and taboos that are specifically related to the conservation of both wild and cultivated vegetable plant species were brought forth.

6.4 Vegetation types

The vegetation classification results revealed instability of the plant communities. The existence of two sets of communities from one study site that was monitored during both seasons, is an indication that some factors are responsible for the instability. The reason behind the existence of two sets of communities in one study area could be because of the incidence of fire or the effect of the climate that was responsible for the manifestation of two sets of communities. The difference between the two classification results is caused by the presence of annuals in the wet season or by their relative higher abundance. Good examples are *Digitaria perrottetii* and *Eragrostis cylindriflora* whose mean cover abundance values were as high as 23.33 and 26.75 in community Types II and IV of the wet season respectively (Appendices 3&4). Duncan's Multiple Range tests showed that fire had a highly significant effect at ($p<0.05$) in the manifestation of vegetation in plant community Types II & IV of the dry season. Likewise, % Slope had a significant contribution at ($p<0.05$) in the variation of vegetation in the community type II of the wet season. Vegetation analysis results in Appendices 3 & 4 indicate higher mean cover abundance values of annuals than those of most trees and shrubs during the wet season. The life forms of each species are indicated in Appendices 3&4 because they account for the community types differences between the wet and the dry seasons. Since the instability in plant community types was due to the effects of fire and annuals that grew during the wet season, it can be concluded that, the dry season community types are the vegetation types of Mgori Forest Reserve.

6.4.1 Distribution of vegetables into vegetation types

Vegetables were distributed in various landscapes depending on the degree of management and the influence of animals. Cultivated vegetables were more abundant and available closer to the homesteads and the opposite was true for the non-cultivated ones. The wild and yet preferred species that grew spontaneously were being tolerated or nursed in home gardens and croplands. During the weeding operations, they are never cut but rather nursed. The diversity of vegetable plant species in the grazed landscapes was observed to be low as compared to home gardens and natural forest. This is because most of the vegetable plant species are also fodder for the livestock. The non-cultivated vegetable species were more abundant in fallowed areas than in the home gardens.

Based on the respondents, 28.1% of the vegetables were found in the disturbed soils of gardens, 28.8% in fallowed landscapes, 14% in the arable lands and 29.1% in the natural forest. However, the actual situation on the ground following vegetation survey revealed that, about 22 (39.3%) of all the identified vegetable plant species in the area are found in the natural forest, which is now a forest reserve (Table 22) and about 34 (60.9%) were found in other landscapes. These observations are in agreement with Cunningham (1988), that many wild vegetable species are ruderals, which commonly increase in areas with disturbed soils and agricultural activity. Number of species and cover abundance values of vegetables that were encountered in each community type are indicated in Table 21.

Table 21: Number of species and cover abundance values of vegetable species in each community Type

Season/ Species counts	Community Types				
	I	II	III	IV	V
Dry sason Species counts/ Cumulative mean cover abundance	2 (0.87)	6 (1.38)	-	3 (6.45)	-
Wet season species counts /Cumulative mean cover abundance	10 (18.16)	9 (17.24)	3 (12.65)	8 (10.24)	14 (28.59)

The analysis in Table 22 indicates that the wet season community Type V recorded more counts of vegetable species with cumulative mean cover abundance values of 28.59. The wet season community Type I recorded the next highest counts and mean cover abundance values of vegetables. Zero or Least counts and cover abundance values were observed in all the dry season community Types. This suggests that more of these species are annuals.

Vegetable plant species such as *Cucumis figarei, C. dipsaceus, C. aculeatus, Momordica foetida, Ipomoea sinensis, Erythrococca bongensis* and *Sesamum angustifolium* were more abundant and collected from the wild/ natural forest. For example, *Ipomoea sinensis, Cucumis figarei* and *Momordica foetida* were common in the *Jurbenadia globifora-Brachystegia speciformis* community type of the wet season. Likewise, *Erythrococca bongensis* and *Sesamum angustifolium* were common in the *Jubernadia globiflora- Lonchocarpus eriocalyx* and in the *Albizia harvey-acacia drepanolobium-Loudetia simplex* community types during the dry season.

Gongroneuma angolense and *Sesamum angustifolium* were common in the *Ficus stuhlmanii-Tricalysia ruandensis* community type in the dry season (Sce Tables 22 &23 and Appendices 3 & 4).

Further analysis in Table 24 indicates that only 9 (16%) of all the identified vegetables in the area were found to exist during the dry season. Of these, only 3 species were evergreen and could be harvested, the rest were dry (annuals).

Table 22: Distribution and mean cover abundance values of vegetables into the natural forest (wet season community types)

S/N	Species name	Wet season community Types					Total
		I	II	III	IV	V	
1	*Adansonia digitata*	-	0.36	-	-	14.58	14.94
2	*Azanza garckeana*	-	-	1.25	-	-	1.25
3	*Bidens pilosa*	2.37	1.14	6.69	2.08	1.50	13.78
4	*Cleome hirta*	2.89	3.57	-	0.58	0.92	7.96
5	*Corchorus capsularis*	0.11	-	-	-	0.25	0.36
6	*C. olitorius*	0.26	-	-	1.83	0.42	2.51
7	*Crotalaria cylindrostachyus*	0.21	0.71	-	-	0.92	1.84
8	*Cucumis aculeatus*	1.11	0.71	-	-	-	1.82
9	*C. dipsaceus*	0.63	-	-	-	-	0.63
10	*C. figarei*	0.84	3.86	6.00	1.17	1.08	12.95
11	*Erythrococca bongensis*	-	-	-	-	0.42	0.42
12	*Gongroneuma angolensis*	-	0.71	-	-	2.25	2.96
13	*Hygrophila schulli*	-	-	-	-	0.08	0.08
14	*Ipomoea cairica*	-	-	-	0.42	0.33	0.75
15	*I. sinensis*	-	0.13	-	-	-	0.13
16	*Launnea cornuta*	3.68	1.76	-	0.67	0.17	6.28
17	*Momordica foetida*	1.21	1.71	-	-	-	2.92
18	*Oxygonum sinuatum*	2.16	-	-	-	1.17	4.87
19	*Pyrenacantha kuarabassana*	0.53	-	-	0.83	-	1.36
20	*Sesamum angustifolium*	2.16	2.71	-	0.83	3.08	8.78
21	*S. indicum*	-	-	-	-	0.42	0.42
22	*Triumfetta rhomboidea*	-	-	-	0.42	-	0.42
	Total	**18.16**	**17.37**	**12.67**	**10.24**	**28.59**	**87.43**

Table 23: Distribution and mean cover abundance values of vegetables into the natural forest (dry season community types)

Species that remained green during the dry season are indicated with asterix

S/N	Species name	Dry season community Types				Total
		I	II	III	IV	
1	*Adansonia digitata**	0.77	-	-	6.08	6.85
2	*Azanza garckeana**	-	0.07	-	-	0.07
3	*Erythrococca bongensis**	-	-	-	0.20	0.20
4	*Ipomoea cairica*	-	0.47	-	-	0.47
5	*I. sinensis*	-	0.13	-	-	0.13
6	*Launnea cornuta*	-	0.73	-	-	0.73
7	*Hygrophila schulli*	0.10	-	-	0.17	0.27
8	*Pyrenacantha kuarabassana*	-	0.40	-	-	0.40
9	*Triumfetta rhomboidea*	-	0.33	-	-	0.33
	Total	**0.87**	**2.13**	**0**	**6.45**	**9.45**

In Table 23, two species (1&7) were encounted in two community types (I & IV), all others were encounted in one community type and community type two harbours 6 species while there were none in community type III. The wet season analysis in Table 23 yielded more vegetables that are more evenly distributed in the five community types. Exceptionally no vegetables were found in community type III.

The management and conservation strategies focused on these vegetable plant species would be possible if the vegetation types in which these species are found to be common are also conserved.

7 CONCLUSION AND RECOMMENDATIONS

7.1 CONCLUSION

In the present study, it became clear that a great diversity of traditional vegetables are being used and collected from the wild. They are utilized on daily basis and most probably, they make up an important source of minerals and vitamins in otherwise poor staple food. It can also be concluded that elders (both men and women) are generally more knowledgeable on various aspects of wild vegetable plant species than others. Although men seem to know the vegetable plant species and some of them are able to describe the food-making process, women are generally more knowledgeable than men because they usually collect and prepare vegetables for meals. Children are even better than men. They know how to identify and use wild vegetables, which they have usually learnt from their mothers. Vegetables are taken in almost every meal, with a few exceptions when they are scarce. This gives good reasons to presume that eating wild vegetables is not considered as falling behind development, or generally looked down as compared to the exotic ones in the area.

Based on the consumption and dependency patterns, this study establishes that wild and cultivated vegetables are very important for the livelihood of local communities in the study area, whether they are part of the subsistence economy or traded in the market. However, it appears that there is much more dependency on indigenous vegetable species than on the exotic ones and that more of these indigenous vegetables are still gathered from various land use categories. Domestication has therefore not taken its course and is still restricted to only a few species. Although many traditions have been lost, the remoteness of the area and perhaps the generally

low income of the local people in the area, has permitted the survival of the rich traditional cooking "**ugali** and **mlenda**" being maintained in many families in the area. The traditional preparation of vegetable sauce "**mlenda**" makes use of lots of vegetable plant species mixed together in one cooking. For this feature, the role that this traditional preparation of sauce has in domestication and in turn, the conservation of the vegetable plant species has to be appreciated. While much of the indigenous knowledge is getting lost in many other Tanzanian ethnic groups because of rapid development and the young generation migrating into towns, the special role-played by the traditional foods "**ugali**" and "**mlenda**", has resisted this loss. They still preserve the cultural heritage of food tradition especially the gathering of wild species for use as side dishes. Significant difference was found in the paired comparison between wild and exotic vegetables species, in which wild species are most preferred over the exotic species.

Although farmers gave a diversity of vegetables in their home gardens or croplands, they were considered as minor crops and their production was at the subsistence levels. Production is restricted during the wet season because there are no water bodies or permanent sources to enable production during the dry season. There is a general shortage of fresh vegetables during most of the dry period of the year and a great reliance on dried/processed forms of vegetables. Strategies should be laid to have adequate vegetables throughout the year, considering that these crops are nutritionally essential. Based on this scenario, exotic vegetables will not replace the indigenous (traditional) ones in the area for many years to come. Many traditional wild, semi wild and cultivated species have economic value as both vegetables and medicinal plants in the area. Growing of these potential vegetables species should be encouraged as a way of conserving agro-

biodiversity, improving the nutritional and health status of the local societies, and reducing poverty through income generation.

7.2 RECOMMENDATIONS

1. Food habits in both rural and urban areas are rapidly changing all over Tanzania and Africa at large with imported (exotic) food varieties replacing the traditional African diets. Exotic vegetables plant species are becoming particularly popular and more nutritious traditional vegetable plant species are becoming out of date and old-fashioned. Their cultivation and preparation have diminished in many parts of the country and instead there has been an increasing dependency on the exotic species, which the majority of Tanzanians can ill afford daily. This has proved not to hold true in Mgori Division in which the trend is the opposite. In this area there is still more dependency on the indigenous vegetable plant species than on the exotic ones. The District councils program to promoting self-sufficiency in food, poverty alleviation and improved nutritional status of its people, should never overlook the potential contribution of vegetable plant species in this overall goal.

2. A policy to improve and promote traditional vegetables growing in the area will thus be well suited to their traditional farming system and will have both long and short term benefits in terms of biodiversity conservation, soil conservation, improved land fertility and increased income-generation for the local communities. In this context, LAMP-Singida should have an important role to play. A strategy to improve and promote certain

vegetables would benefit producers, growers and consumers. The producers will increase consumption from their own production and generate income by selling them in the local market. Promoting of such species is important as income generating tool, particularly for women who usually use the income for the welfare of children and thus contributing to the alleviation of malnutrition.

3. The landscapes that are rich in the diversity of vegetable plant species ought to be given due considerations for conservation. Techniques such as *in-situ* conservation and *on-farm conservation through cultivation* may prove more successful in such areas. Conservation and management of these species should therefore be actively encouraged in extension programs, notably because there is some evidence regarding a declining availability of these species due to use trends and drought. More data on their potentials for cultivation and regeneration in the field are needed, however.

4. The extensively used wild herbaceous vegetable plant species in the area are *Sesamum angustifolium*, *Ceratotheca sesamoides*, *Cleome gynandra* and *Coccinia grandis*. These could be actively promoted as garden crops or even field crops as they seem to grow easily in field and home gardens without maintenance. Their market potentials could also be developed further in the future.

5. The cultivated species, *Coccinia grandis*, *Cucurbita pepo*, *C. maxima* and others are already traditionally integrated in the farming systems of the local people in the area.

However, research on these species is limited for their improved integration as the focus has been on cereals alone or in combination with legumes such as *Cajanus cajan*, *Vigna unguiculata* and *Phaseolus vulgaris*. Moreover, extension services in the whole Singida Region do not incorporate vegetables in their programmes to any significant extent. Extension work could, however, draw on the findings of this study and other related studies in the country, which demonstrate the unexploited potentials of vegetables in the improved nutritional, income generation and hence a significant contribution in poverty alleviation in the area.

6. More studies of this nature could be replicated in other parts of the Region and country at large and over longer time span in order to provide adequate data on human vegetable preferences and document their hidden potential use values as perceived by the local communities.

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9 APPENDICES

Appendix 1: List of 304 plant species collected and identified from Mgori Division

S/N	Species name	Family name	Habit	Voucher No.
1	*Abelomonchus esculentus* L.	Malvaceae	H	RJS-294
2	*Abrus precatorius* L.	Fabaceae	L	RJS-061
3	*Acacia hockii* De Wild.	Fabaceae	T	RJS-131
4	*A. senegal* (L.) Willd	Fabaceae	T	RJS-002
5	*A. seyal var seyal* Del.	Fabaceae	S	RJS-144
6	*A. brevispica* Harms	Fabaceae	C	RJS-156
7	*A. drepanolobium* Sjost.	Fabaceae	S	RJS-122
8	*A. nilotica* (L.) Del.	Fabaceae	T	RJS-148
9	*A. stulhumanii* Taubert	Fabaceae	S	RJS-130
10	*A. tanganyikensis* Engl.	Fabaceae	T	RJS-129
11	*A.tortlis* (Forsskål) Hayne	Fabaceae	T	RJS-137
12	*Acalypha indica* L.	Euphorbiaceae	H	RJS-255
13	*Achyranthes aspera* L.	Amaranthaceae	H	RJS-254
14	*Achyrospermum perviflorum* S. Moore	Lamiaceae	S	RJS-202
15	*Adansonia digitata* L.	Bombacaceae	T	RJS-164
16	*Adenia gumnifera* L.	Passifloraceae	S	RJS-068
17	*Aerva lanata* (L.) Schultes	Amaranthaceae	S	RJS-196
18	*Aeschynomene abyssinica* (A. Rich.) Vatke	Fabaceae	S	RJS-206
19	*Aframomum angustifolium* R.E.Fr.	Zingiberaceae	H	RJS-222
20	*Agasithanthemum bojeri* Bridson	Rubiaceae	H	RJS-201
21	*Ageratum conyzoides* L.	Asteraceae	H	RJS-050
22	*Albizia antunesiana* Harms	Fabaceae	T	RJS-135
23	*A. harveyi* Foum	Fabaceae	T	RJS-065
24	*A. petersiana* (Boile) Oliv.	Fabaceae	T	RJS-070
25	*A. versicolor* Oliver	Fabaceae	T	RJS-141
26	*Alfezia quanzensis* Welw.	Fabaceae	T	RJS-096
27	*Allium cepa* L.	Alliaceae	H	RJS 304
28	*Aloe secundiflora* L.	Aloaceae	H	RJS-238
29	*Amaranthus spinosus* L.	Amaranthaceae	H	RJS-233
30	*A. dubius* L.	Amaranthaceae	H	RJS-276
31	*A. hybridus* Engl.	Amaranthaceae	H	RJS-246
32	*A. lividus* (L.) Thell.	Amaranthaceae	H	RJS-281
33	*Anthericum monophyllum* Baker.	Antharicaceae	H	RJS-210
34	*Aristida adoensis* Hochst.	Poaceae	G	RJS-198
35	*Asparagus africanus* (Lam.) Brown & Massey	Asparagaceae	S	RJS-081
36	*A. falcatus* L.	Asparagaceae	S	RJS-080
37	*A. suave* L.	Asparagaceae	S	RJS-228
38	*Aspilia africana* L.	Asteraceae	H	RJS-010

Appendix 1 continued

39	*A. mosambicensis* (Oliv.) Willd	Asteraceae	H	RJS-090
40	*AstrIpomoea malvacea* (Klotzsch) Meas	Convolvulaceae	S	RJS-149
41	*Asystasia gangetica* (L.) T. Anders	Acanthaceae	H	RJS-219
42	*A. mysorensis* (Roth.) T. Anders	Acanthaceae	H	RJS-264
43	*Azanza garckeana* DC.	Malvaceae	T	RJS-132
44	*Balanites aegyptiaca* (L.) Del.	Balanitaceae	T	RJS-182
45	*Barleria acanthoides* Vahl	Acanthaceae	H	RJS-257
46	*Becium angustifolium* (Benth) N.Br.	Lamiaceae	H	RJS-051
47	*Bidens lineariloba* Oliv.	Asteraceae	H	RJS-153
48	*B. pilosa* L.	Asteraceae	H	RJS-057
49	*Blepharis affinis* Juss.	Acanthaceae	H	RJS-074
50	*B. madespspatensis* (L.) Roth	Acanthaceae	H	RJS-063
51	*Boscia angustifolia A.*Rich.	Capparidaceae	T	RJS-022
52	*B. mossambicensis* Klotzsch	Capparidaceae	T	RJS-087
53	*B. salicifolia* Oliv	Capparidaceae	T	RJS-071
54	*Brachiaria brizantha* (A. Rich.) Stapf	Poaceae	G	RJS-106
55	*B. purrurance*(A. Rich.) Steud.	Poaceae	G	RJS-301
56	*Brachystegia microphylla* Harm	Fabaceae	T	RJS-115
57	*B. speciformis* Benth	Fabaceae	T	RJS-046
58	*Bridelia amoena* Pax & Vatke	Euphorbiaceae	S	RJS-241
59	*B. cathartica* Bertol.f.	Euphorbiaceae	S	RJS-176
60	*Bulbostylis buchananii* C.B.Cl.	Cyperaceae	Sg	RJS-027
61	*Cajanus cajan* L.	Fabaceae	S	RJS-293
62	*Canthium burtii ssp. Burtii* S.Moore	Rubiaceae	T	RJS-043
63	*Capparis tomentosa* Lawi	Capparidaceae	S	RJS-121
64	*Capsicum annuum* L.	Solanaceae	H	RJS-304
65	*Cassia abbreviata* Oliv.	Fabaceae	S	RJS-118
66	*Cassipourea mollis* (R.E.Fries) Alston	Rhizophoraceae	T	RJS-039
67	*Catunaregum spinosa* (Thumb) Tirvengadum	Rubiaceae	S	RJS-008
68	*Ceratotheca sesamoides* Engl.	Pedaliaceae	H	RJS-295
69	*Chloris gayana* Kunth.	Poaceae	G	RJS-134
70	*C. pycnothrix* Trin	Poaceae	G	RJS-186
71	*C. roxbourghiana* Schult.	Poaceae	G	RJS-151
72	*C. virgata* Sw.	Poaceae	G	RJS-147
73	*Cissus cornifolia L.*	Vitaceae	H	RJS-136
74	*C. rubiginosa* (Bak.) Planch	Vitaceae	S	RJS-217
75	*C. tronthae* Engl.	Vitaceae	S	RJS-032
76	*Cleome hirta* (Klotzsch) Oliv.	Capparidaceae	H	RJS-208
77	*Coccinia adoensis* (A.Rich.) Cogn	Cucurbitaceae	C	RJS-283
78	*C. grandis* (L.) Voight.	Cucurbitaceae	C	RJS-296
79	*Combetum pentagonum* Sonder	Combretaceae	T	RJS-111
80	*C. apiculatum* Sonder	Combretaceae	C	RJS-150

Appendix 1 continued

81	*C. collinum* Fresen	Combretaceae	T	RJS-110
82	*C. molle* R.Br. ex.G.Don.	Combretaceae	T	RJS-014
83	*C. obovatum* F.Hoffm	Combretaceae	T	RJS-159
84	*C. zeyheri* Sonder	Combretaceae	T	RJS-010
85	*Commelina africana* L.	Commelinaceae	H	RJS-171
86	*C. benghalensis* L.	Commelinaceae	H	RJS-028
87	*Commiphora africana* (A. Rich.) Engl	Burseraceae	S	RJS-013
88	*C. merkeri* Engl.	Burseraceae	S	RJS-184
89	*C. mollis* (Oliv.) Engl.	Burseraceae	T	RJS-037
90	*C. mossambicensis* (Oliv.) Engl.	Burseraceae	T	RJS-007
91	*C. ugongensis* Engl.	Burseraceae	T	RJS-069
92	*Corchorus capsularis* L.	Tiliaceae	H	RJS-227
93	*C. olitorius* L.	Tiliaceae	H	RJS-218
94	*C. tricularis* Engl.	Tiliaceae	H	RJS-216
95	*Cordia ovalis* DC.	Boraginaceae	H	RJS-175
96	*Crabbea velutina* S. Moore	Acanthaceae	H	RJS-207
97	*Craterostigma hirsutum* Hochst.	Scropholariaceae	C	RJS-261
98	*Crotalaria cylindrostachyus* Baker	Fabaceae	H	RJS-215
99	*C. goreensis* Guil & Perrot	Fabaceae	H	RJS-243
100	*C. greenwayi* Engl.	Fabaceae	H	RJS-258
101	*C. laburnifolia* L.	Fabaceae	H	RJS-259
102	*C. polysperma* Kotz.	Fabaceae	H	RJS-253
103	*Croton niloticus* Hochst.	Euphorbiaceae	S	RJS-267
104	*Cucumis dipsaceus* Ehreb. Ex. Spach	Cucurbitaceae	C	RJS-278
105	*C. aculeatus* Cogn.	Cucurbitaceae	C	RJS-279
106	*C. figarei* Naud.	Cucurbitaceae	C	RJS-273
107	*C. melo* L.	Cucurbitaceae	C	RJS-209
108	*Cucurbita maxima L.*	Cucurbitaceae	C	RJS-275
109	*C. pepo* L.	Cucurbitaceae	C	RJS-260
110	*Cycnium tuburosum* (L. F.) Engl.	Scropholariaceae	H	RJS-263
111	*Cynodon dactylon* (L) Pers	Poaceae	G	RJS-178
112	*Cynotis foecunda* Hassk	Commelinaceae	H	RJS-265
113	*Cyperus articulatus* L.	Cyperaceae	Sg	RJS-268
114	*C. diffusus* Vahl	Cyperaceae	Sg	RJS-235
115	*C. latifolius* L. Poik	Cyperaceae	Sg	RJS-277
116	*C. obtusiflorus* Vahl	Cyperaceae	Sg	RJS-229
117	*C. otundus* L. subsp.rotundus	Cyperaceae	Sg	RJS-240
118	*Cyphostema gigantophyllum* Planch	Vitaceae	C	RJS-221
119	*C. adenocaule* (A.Rich) Willd & Drum	Vitaceae	C	RJS-093
120	*Dactylectenium aegyptium* (L) Willd.	Poaceae	G	RJS-152
121	*D. geminatum* Hark	Poaceae	G	RJS-287
122	*Dalbergia melanoxylon* Guill. & Perr.	Fabaceae	S	RJS-100

Appendix 1 continued

123	*D. nitidula Baker*	Fabaceae	S	RJS-120
124	*D. stuhlmanii* (Taub.) Tussac.	Fabaceae	T	RJS-020
125	*Dicanthium annulatum* (Forsk) Stapf	Poaceae	G	RJS-220
126	*D. rivae* (Chiov) Stapf	Poaceae	G	RJS-145
127	*Dichrostachys cinerea* (L) Wight.Arns	Fabaceae	S	RJS-003
128	*Digitaria abyssinica* (A.Rich) Stapf	Poaceae	G	RJS-138
129	*D. macroblephara* (Hack) Stapf	Poaceae	G	RJS-168
130	*D. perrottetii* (Kanty) Stapf	Poaceae	G	RJS-146
131	*D. scalarum* L.	Poaceae	G	RJS-124
132	*Diospyros usambarensis* F.White	Ebenaceae	T	RJS-108
133	*Diplorhynchos condylocarpon* (Muell-Arg) Pichon	Apocynaceae	T	RJS-172
134	*Dolichos kilimandscharica*Taub.	Fabaceae	S	RJS-079
135	*D. oliveri* Schweinf	Fabaceae	L	RJS-119
136	*Ehretia amoena* DC.	Boraginaceae	S	RJS-174
137	*Emilia javanica* (Burm.F) Merr	Asteraceae	H	RJS-185
138	*Enteropogon macrostachys* (A.Rich.) Benth	Poaceae	G	RJS-177
139	*Eragrostis superba* Peyrs	Poaceae	G	RJS-048
140	E. cylindriflora *Hochst.*	Poaceae	G	RJS-112
141	*E. racemosa* (Thunb) Steud	Poaceae	G	RJS-170
142	*Eragrotis aethiopica* Chiov	Poaceae	G	RJS-181
143	*E. aspera* (Jack) Nees	Poaceae	G	RJS-193
144	*E. patens* Oliv.	Poaceae	G	RJS-077
145	*Erthyrina abyssinica* DC.	Fabaceae	T	RJS-064
146	*Erythrococca bongensis* Pax	Euphorbiaceae	S	RJS-280
147	*Euphorbia candelabrum* L.	Euphorbiaceae	T	RJS-123
148	*E. grantii* Pax	Euphorbiaceae	S	RJS-041
149	*E. hirta* L.	Euphorbiaceae	H	RJS-165
150	*E. matabelensis* Pax	Euphorbiaceae	T	RJS-189
151	*E. tirucali* L.	Euphorbiaceae	T	RJS-157
152	*Fadogia obovata* Benth	Rubiaceae	H	RJS-211
153	*Ficus stuhlmannii* Warb	Moraceae	T	RJS-160
154	*Fimbristlyis ferruginea* (L.) Chiov.	Cyperaceae	Sg	RJS-288
155	*Flacourtia indica (Burm.f) Merrill*	Flacourtiaceae	S	RJS-270
156	*Fuerina umbellata* Rottb.	Cyperaceae	Sg	RJS-230
157	*Gloriosa superba* L.	Liliaceae	H	RJS-075
158	*Gomphocarpus stemophylus* Oliv.	Asclepidaceae	S	RJS-290
159	*Gongroneuma angolensis* (N.E.Br) Bullock	Asclepidaceae	C	RJS-162
160	*Grewia bicolor* Juss	Tiliaceae	S	RJS-083
161	*G. fallax* DC.	Tiliaceae	S	RJS-092
162	*G. mollis* Willd	Tiliaceae	S	RJS-030
163	*Cleome gynandra* (L) Brig	Capparidaceae	H	RJS-245

Appendix 1 continued

164	*Harpachne schimperi* (Hochst.) ex. A. Rich.	Poaceae	G	RJS-076
165	*Heliotropium ovalifolium* Forsk	Boraginaceae	H	RJS-244
166	*Heteropogon contortus* (L.) Roem	Poaceae	G	RJS-291
167	*Hibiscus cannabinus* L.	Malvaceae	H	RJS-223
168	*H. micranthus* L.f.	Malvaceae	H	RJS-284
169	*H. vitifolius* (L.f.) Lat	Malvaceae	H	RJS-292
170	*Hirpicium diffusum* (O.Hoffm) Roess	Asteraceae	H	RJS-191
171	*Hoslundia opposita* Vahl	Lamiaceae	S	RJS-143
172	*Hygrophila schulli* (Hamilt.) Almeida &Almeida	Acanthaceae	H	RJS-161
173	*Hymenodictyon parvifolium* (Hochst.) Stapf	Rubiaceae	T	RJS-024
174	*Hyparrhenia filipendula* (Hochst.) Stapf	Poaceae	G	RJS-078
175	*H. rufa* (Nees) Stapf	Poaceae	G	RJS-016
176	*Hypoestes forskaolii (Vahl) R. Br.*	Acanthaceae	G	RJS-082
177	*Indigofera arrecta* A.Rich.	Fabaceae	H	RJS-105
178	*I. cuneata* Oliv.	Fabaceae	H	RJS-194
179	*I. hirsuta* A.Rich.	Fabaceae	H	RJS-214
180	*I. rhynchocarpa* Baker	Fabaceae	S	RJS-094
181	*I. volkensii Taub*	Fabaceae	H	RJS-026
182	*Ipomoea babatas* (L) Lam	Convolvulaceae	C	RJS-250
183	*I. cairica* (L.) Sweet	Convolvulaceae	C	RJS-139
184	*I. obscurea* (L.) Kel-Gawel	Convolvulaceae	C	RJS-133
185	*I. rubens* Choeist.	Convolvulaceae	C	RJS-242
186	*I. sinensis* (Derv.) Choissy	Convolvulaceae	C	RJS-140
187	*Jubernadia globiflora* (Benth) Troupin	Fabaceae	T	RJS-006
188	*Justicia anselliana* (Nees) T. Anders.	Acanthaceae	H	RJS-114
189	*J. salvadois*(Nees) T. Anders.	Acanthaceae	H	RJS-192
190	*Kigelia africana* (Lam) Benth.	Bignoniaceae	T	RJS-101
191	*Kylinga alata* Nees	Cyperaceae	Sg	RJS-056
192	*K. cristatus* (Kunth) Mart.	Cyperaceae	Sg	RJS-269
193	*Landolphia kirkii* Beauv	Apocynaceae	C	RJS-155
194	*Lannea fulva* (Engl.) Engl.	Anacardiaceae	S	RJS-104
195	*L. humillis* (Oliv) Engl.	Anacardiaceae	T	RJS-086
196	*L. schimperi* (Hochst.ex.A.Rich.) Engl.	Anacardiaceae	T	RJS-015
197	*Launnaea cornuta* (Oliv.Hiern) C.Jeffrey	Asteraceae	H	RJS-098
198	*Leucas diflexa* L.	Lamiaceae	H	RJS-226
199	*Lonchocarpus capassa* Rolle	Fabaceae	T	RJS-045
200	*L. bussei* Harms	Fabaceae	T	RJS-009
201	*L. eriocarlyx* Harms	Fabaceae	T	RJS-005
202	*Loudetia simplex* (Nees) C.E.Hulbbard	Poaceae	G	RJS-001
203	*Lycopersicon esculentus* L.	Solanaceae	H	RJS-285
204	*Macrotyloma axillare* Benth	Fabaceae	C	RJS-247
205	*Maerua angolensis* DC	Capparidaceae	S	RJS-095

Appendix I continued

206	*M. edulis* (Gilg & Baned.) De Wolf	Capparidaceae	S	RJS-097
207	*Manihot esculentus* Crantz	Euphorbiaceae	S	RJS-299
208	*M. glaziovii Muell.* Arg	Euphorbiaceae	S	RJS-183
209	*Maprounea africana* Muell.Arg	Euphorbiaceae	T	RJS-107
210	*Margaritaria discoidea* (Baill.) Webster	Euphorbiaceae	T	RJS-173
211	*Markhamia lutea* (Benth.) K. Schum	Bignoniaceae	S	RJS-103
212	*M. obtusifolia* (Benth.) K.Schum	Bignoniaceae	S	RJS-019
213	*Microchloa kunthii* Derv.	Fabaceae	G	RJS-049
214	*Momordica foetida* Schumach.	Cucurbitaceae	C	RJS-237
215	*M. spinosa* (Gilg) Chiov.	Cucurbitaceae	C	RJS-203
216	*Monsania angustifolia* A.Rich	Gensinaniaceae	H	RJS-234
217	*Mukia maderaspatana* (L.) M. J. Roem	Cucurbitaceae	C	RJS-298
218	*Mundulea sericea* (Willd) A.Chev.	Fabaceae	S	RJS-142
219	*Murdania simplex* (Vahl) Brenan	Commelinaceae	H	RJS-232
220	*Ochna autropurpurea* DC.	Ochnaceae	S	RJS-089
221	*Ocimum bassilicum*	Lamiaceae	H	RJS-205
222	*O. cirlicifolium*	Lamiaceae	H	RJS-004
223	*Ormocarpum trichocarpum* (Taub) Engl.	Fabaceae	T	RJS-059
224	*Osyris quadripartila* Decn.	Santalaceae	S	RJS-262
225	*Oxygonum sinuatum* (Meisn.) Dammer.	Polygonaceae	H	RJS-190
226	*Ozoroa insignis* Del.	Anacardiaceae	T	RJS-067
227	*Panicum astrosanguena* A. Rich.	Poaceae	G	RJS-180
228	*P. coloratum* L.	Poaceae	G	RJS-047
229	*P. maximum* Jacq.	Poaceae	G	RJS-042
230	*Pavetta gardeniifolia* A.Rich.	Rubiaceae	S	RJS-163
231	*P. stuhlmanii* K.Schum.	Rubiaceae	S	RJS-040
232	*Pavonia zeylanica* Cav.	Malvaceae	S	RJS-251
233	*Pennisetum typhoides* (Burm.) Stapf &C.Hubb	Poaceae	G	RJS-029
234	*Pentarrhinum insipidium* E. Mey	Asclepidaceae	C	RJS-297
235	*Perotis patens* Gond	Poaceae	G	RJS-200
236	*Phaseolus vulgaris* L.	Fabaceae	H	RJS-289
237	*Phyllanthus englerii* Pax	Euphorbiaceae	S	RJS-187
238	*Pipper nigrum* L.	Piperaceae	H	RJS-286
239	*Plectranthus barbatus* Anders.	Lamiaceae	S	RJS-179
240	*Premna sinensis* L.	Euphorbiaceae	S	RJS-084
241	*Pseudolachnostylis maprounifolia* Pax.	Euphorbiaceae	T	RJS-034
242	*Pseudovigna argentae* (Willd) Verde	Euphorbiaceae	C	RJS-300
243	*Psychotria kirkii* Hiern	Rubiaceae	H	RJS-167
244	*Pterocarpus angolensis* DC.	Fabaceae	T	RJS-011
245	*Pyllanthus amarus Schum.* Thon	Euphorbiaceae	H	RJS-272
246	*Pyrenacantha kuarabassana* Baill	Incanacenaceae	C	RJS-099
247	*Rhus natalensis* Benth	Anacardiaceae	S	RJS-128

Appendix 1 continued

248	*R. vulgaris* Meikle	Anacardiaceae	S	RJS-236
249	*Rhynchosia minima* (L.) DC.	Fabaceae	H	RJS-116
250	*R. resinosa* Hochst.	Fabaceae	S	RJS-058
251	*Ruellia paluta* Jacq.	Acanthaceae	H	RJS-195
252	*Rynchelytrum repens* (Willd) C.B.Hubb	Poaceae	G	RJS-109
253	*Schrebera trichoclada* Welw.	Oleaceae	T	RJS-035
254	*Sclerocariya birrea* (A.Rich) Hochst.	Anacardiaceae	T	RJS-038
255	*Senna singueana* Del.	Fabaceae	S	RJS-125
256	*Sesamum angustifolium* (Oliv.) Engl.	Pedaliaceae	H	RJS-066
257	*S. indicum* L.	Pedaliaceae	H	RJS-252
258	*Setaria sphacelata* Beauv.	Poaceae	G	RJS-091
259	*S. vexilata* Beauv.	Poaceae	G	RJS-302
260	*Sida alba* L.	Malvaceae	H	RJS-249
261	*Solanum incanum* L.	Solanaceae	H	RJS-126
262	*S. nigrum* Vatke	Solanaceae	H	RJS-166
263	*Spermacoce senensis* (Klotszch) Hien	Rubiaceae	H	RJS-225
264	*Spirostachys africana* Sond.	Poaceae	G	RJS-169
265	*Sporobolus fimbriatus* (Trin) Nees	Poaceae	G	RJS-073
266	*S. panicoides* A.Rich	Poaceae	G	RJS-088
267	*S. stapfianus* Gand.	Poaceae	G	RJS-017
268	*Stegnataenia araliacea* Hochst.	Umbelliferae	S	RJS-239
269	*Strophanthus eminii* Aschers	Apocynaceae	S	RJS-062
270	*Strychonos madagascariensis* Gilg.	Loganiaceae	T	RJS-023
271	*S. potatorum* L.f.	Loganiaceae	T	RJS-044
272	*Tarrenna groveolenis* (S.Moore) Brem	Rubiaceae	S	RJS-266
273	*Tephrosia pumila* (Lam) Pers.	Fabaceae	H	RJS-018
274	*T.virgata* H.M. Forb	Fabaceae	H	RJS-117
275	*Terminalia brownii* Duels.	Combretaceae	T	RJS-158
276	*T. mollis* C. Law.	Combretaceae	T	RJS-053
277	*T. sericea* Burch.ex DC.	Combretaceae	T	RJS-060
279	*T. kilimandjarica* Engl.	Combretaceae	T	RJS-127
280	*Thunbergia alata* Bojer ex Sims.	Acanthaceae	H	RJS-224
281	*Tragia brevipes* Pax.	Euphorbiaceae	C	RJS-154
282	*Tragus berteroniacus* Schult.	Poaceae	G	RJS-197
283	*Tribulus terrestris* L.	Zygophoraceae	H	RJS-199
284	*Tricalysia ruandensis* Bremek.	Rubiaceae	T	RJS-036
285	*Trichodesma zeylanicum* (L) Rr.Br.	Boraginaceae	H	RJS-231
286	*Tridax procumbens* L.	Asteraceae	H	RJS-213
287	*Triumfetta deck-deckiana*	Tiliaceae	H	RJS-204
288	*Triumfetta rhomboidea* Jacq.	Tiliaceae	H	RJS-054
289	*Turaea robusta* L.	Meliaceae	S	RJS-274
290	*Vangueria infausta* Burch.	Rubiaceae	S	RJS-072

Appendix 1 continued

291	*V. madagascariensis* Gmel.	Rubiaceae	S	RJS-021
292	*Vernonia perrottii* Walp	Asteraceae	H	RJS-256
293	*Vigna reticulata* Hook.f.	Fabaceae	C	RJS-282
294	*V. unguiculata* L.	Fabaceae	H	RJS-248
295	*Vitex doniana* Sweet	Verbenaceae	T	RJS-025
296	*V. keniensis* Turrill	Verbenaceae	T	RJS-085
297	*V. mombassae* Vatke.	Verbenaceae	T	RJS-113
298	*Waltheria indica* L.	Sterculiaceae	H	RJS-102
299	*Withania somnifera* (L) Dunal	Solanaceae	H	RJS-055
300	*Xeroderris stuhlmanii* (Taub) Engl.	Fabaceae	T	RJS-033
301	*Ximenia cafra* L.	Olacaceae	S	RJS-031
302	*X. americana* L.	Olacaceae	T	RJS-052
303	*Zaleya pentandra* (L.) Jeffrey	Aizoaceae	S	RJS-271
304	*Zornia setosa* L	Fabaceae	S	RJS-212

Appendix 2: List of vegetable plant species collected and identified from Mgori Division

S/N	Species name and Authority	Nyaturu name	Family name	Habit	Voucher No.
1	*Abelmonchus esculentus*	Mbamia	Malvaceae	H	RJS-294
2	*Adansonia digitata*	Muandu	Bombacaceae	T	RJS-164
3	*Adenia gumnifera*	Itindimburi	Passifloraceae	S	RJS-068
4	*Ageratum conyzoides*	Jembo	Compositae	H	RJS-050
5	*Alium cepa*	Kitunguu	Alliaceae	H	RJS 304
6	*Amaranthus dubius*	Mogha	Amaranthaceae	H	RJS-276
7	*A. hybridus*	Muchicah-ni-ukuu/nyambu	Amaranthaceae	H	RJS-246
8	*A. lividus.*	Muchicha -ni-ukhoku	Amaranthaceae	H	RJS-281
9	*A. spinosus*	Mogha-wa maghuya	Amaranthaceae	H	RJS-233
10	*Asystasia gangetica*	Mukhombi	Acanthaceae	H	RJS-219
11	*A. mysorensis*	Mufuu/Ndui-ya-mbui	Acanthaceae	H	RJS-264
12	*Azanza garckeana*	Mutogho	Malvaceae	T	RJS-132
13	*Barleria acanthoides*	Kilombelombe	Acanthaceae	H	RJS-257
14	*Cajanus cajan*	Mbaasi	Fabaceae	S	RJS-293
15	*Capsicum annum*	Firifiri-a-ariko	Solanaceae	H	RJS-303
16	*Ceratotheca sessamoides*	Mbata	Pedaliaceae	H	RJS-295
17	*Cleome hirta*	Ghasira	Capparidaceae	H	RJS-208
18	*Coccinia adoensis*	Maimbe-a-ng'ughuy	Cucurbitaceae	C	RJS-283
19	*C. grandis.*	Maimbe	Cucurbitaceae	C	RJS-296
20	*Corchorus capsularis*	Ikhonda-ra-anyabi	Tiliaceae	H	RJS-227
21	*C. olitorius*	Muundi	Tiliaceae	H	RJS-218
22	*C. tricularis*	Ahungu	Tiliaceae	H	RJS-216
23	*C. cylindrostachyus*	Mukukuru	Fabaceae	H	RJS-215
24	*C. polysperma*	Songa	Fabaceae	H	RJS-253

Appendix 2 continued

25	*Cuccumis dipsaceus*		Cucurbitaceae	C	RJS-278
26	*C. aculeatus*	Mung'ang'aa	Cucurbitaceae	C	RJS-279
27	*C. figarei*	Mahukuma-o-mufumbu	Cucurbitaceae	C	RJS-273
28	*C. melo*	Ghunga	Cucurbitaceae	C	RJS-209
29	*Cucurbita maxima*	Muhukuma	Cucurbitaceae	C	RJS-275
30	*C. pepo*	Munyungu	Cucurbitaceae	C	RJS-260
31	*Erythrococca bongensis*	Gutinti	Euphorbiaceae	S	RJS-280
32	*Fimbristlyis ferruginea*	Sasa-o-makuja	Cyperaceae	Sg	RJS-288
33	*Gongroneuma angolense*	Nduta	Asclepidaceae	C	RJS-162
34	*Cleome gynandra*	Mung'ang'i	Capparidaceae	H	RJS-245
35	*Hygrophila schulli*	Nkokomea	Acanthaceae	H	RJS-161
36	*Ipomoea babatas*	Mudoro	Convolvulaceae	C	RJS-250
37	*I. cairica*	Maghanja-a-wambu	Convolvulaceae	C	RJS-139
38	*I. sinensis*	Mungudungudu	Convolvulaceae	C	RJS-140
39	*Launaea cornuta*	Gahunga	Asteraceae	H	RJS-098
40	Lycopersicon esculentus	Munyanya	Solanaceae	H	RJS-285
41	*Manihot esculenta*	Muhogo	Euphorbiaceae	S	RJS-299
42	*M. glaziovii*	Muhogomufira	Euphorbiaceae	S	RJS-183
43	*Momordica foetida*	Mahanjo-o-mufumbu	Cucurbitaceae	C	RJS-237
44	*Mukia maderaspatana*	Mung'ang'aa	Cucurbitaceae	C	RJS-298
45	*Oxygonum sinuatum*	Mbighii	Polygonaceae	H	RJS-190
46	*Pentarrhinum insipidium*	Makutwi-a-njou	Asclepidaceae	C	RJS-297
47	*Phaseolus vulgaris*	Muharage	Fabaceae	H	RJS-289
48	*Pipper nigrum*	Mufirifiri	Piperaceae	H	RJS-286
49	*Pyrenacantha kuarabassana*	Nduta-ni-nkuu	Icacinaceae	C	RJS-099

Appendix 2 continued

25	*Cuccumis dipsaceus*		Cucurbitaceae	C	RJS-278
26	*C. aculeatus*	Mung'ang'aa	Cucurbitaceae	C	RJS-279
27	*C. figarei*	Mahukuma-o-mufumbu	Cucurbitaceae	C	RJS-273
28	*C. melo*	Ghunga	Cucurbitaceae	C	RJS-209
29	*Cucurbita maxima*	Muhukuma	Cucurbitaceae	C	RJS-275
30	*C. pepo*	Munyungu	Cucurbitaceae	C	RJS-260
31	*Erythrococca bongensis*	Gutinti	Euphorbiaceae	S	RJS-280
32	*Fimbristlyis ferruginea*	Sasa-o-makuja	Cyperaceae	Sg	RJS-288
33	*Gongroneuma angolense*	Nduta	Asclepidaceae	C	RJS-162
34	*Cleome gynandra*	Mung'ang'i	Capparidaceae	H	RJS-245
35	*Hygrophila schulli*	Nkokomea	Acanthaceae	H	RJS-161
36	*Ipomoea babatas*	Mudoro	Convolvulaceae	C	RJS-250
37	*I. cairica*	Maghanja-a-wambu	Convolvulaceae	C	RJS-139
38	*I. sinensis*	Mungudungudu	Convolvulaceae	C	RJS-140
39	*Launaea cornuta*	Gahunga	Asteraceae	H	RJS-098
40	Lycopersicon esculentus	Munyanya	Solanaceae	H	RJS-285
41	*Manihot esculenta*	Muhogo	Euphorbiaceae	S	RJS-299
42	*M. glaziovii*	Muhogomufira	Euphorbiaceae	S	RJS-183
43	*Momordica foetida*	Mahanjo-o-mufumbu	Cucurbitaceae	C	RJS-237
44	*Mukia maderaspatana*	Mung'ang'aa	Cucurbitaceae	C	RJS-298
45	*Oxygonum sinuatum*	Mbighii	Polygonaceae	H	RJS-190
46	*Pentarrhinum insipidium*	Makutwi-a-njou	Asclepidaceae	C	RJS-297
47	*Phaseolus vulgaris*	Muharage	Fabaceae	H	RJS-289
48	*Pipper nigrum*	Mufirifiri	Piperaceae	H	RJS-286
49	*Pyrenacantha kuarabassana*	Nduta-ni-nkuu	Icacinaceae	C	RJS-099

Appendix 2 continued

50	*Sesamum angustifolium*	Ikhonga	Pedaliaceae	H	RJS-066
51	*S. indicum*	Ikhugha	Pedaliaceae	H	RJS-252
52	*Solanum nigrum*	Muntomolankuku	Solanaceae	H	RJS-166
53	*Spermacoce senensis*	Ndisia	Rubiaceae	H	RJS-225
54	*Tragia brevipes*	Urambi	Euphorbiaceae	C	RJS-154
55	*Triumpheta rhomboidea*	Kifou	Tiliaceae	H	RJS-054
56	*Vigna unguiculata*	Mukusa	Fabaceae	C	RJS-248

Appendix 3: Wet season mean cover abundance values of each species in every plant community

S/N	*Species Name*		Community				
		Habit	**I**	**II**	**III**	**IV**	**V**
1	*Abrus precatorius*	L	0.00	0.36	0.00	0.25	0.00
2	*A. brevispica*	C	0.00	0.00	0.00	0.00	0.42
3	*A. drepanolobium*	S	0.00	0.00	0.00	8.33	0.00
4	*A. hockii*	T	0.00	0.00	0.00	2.50	0.00
5	*A. nilotica*	T	0.00	0.00	0.00	2.92	0.00
6	*A. senegal*	T	0.00	0.00	0.00	3.33	0.00
7	*A. seyal val seyal*	S	0.00	0.71	0.00	7.08	0.00
8	*A. stulhumanii*	S	0.00	0.00	0.00	1.67	0.00
9	*A. tanganyikensis*	T	0.00	0.00	0.00	5.00	0.00
10	*A. tortlis*	T	0.00	0.00	0.00	4.58	0.00
11	*Achyrospermum perviflorum*	S	0.26	0.00	0.00	0.00	0.00
12	*Adansonia digitata*	T	0.00	0.36	0.00	0.00	**14.58**
13	*Aerva lanata*	S	0.26	0.00	0.00	0.00	0.17
14	*Aeschynomene abyssinica*	S	0.26	0.00	0.00	0.00	0.00
15	*Aframomum angustifolium*	H	0.11	0.36	0.00	0.00	0.00
16	*Agathisanthemum bojeri*	H	0.26	0.00	0.00	2.50	0.00
17	*Ageratum conyzoides*	H	0.00	0.00	0.00	0.00	0.00
18	*Albizia antunesiana*	T	0.00	0.00	0.00	0.83	0.00
19	*A. harveyi*	T	0.26	0.71	0.00	9.58	0.00
20	*A. petersiana*	T	0.47	0.29	0.00	1.25	0.00
21	*A. versicolor*	T	0.00	0.00	0.00	2.08	0.00
22	*Alfezia quanzensis*	T	1.05	0.14	0.00	1.67	0.00
23	*Aloe secundiflora*	H	0.26	0.00	0.00	0.00	0.00
24	*Anthericum monophyllum*	H	0.53	0.71	0.00	0.25	0.00
25	*Aristida adoensis*	G	0.95	0.00	0.00	0.00	0.00
26	*Asparagus africanus*	S	0.79	0.71	0.00	0.00	1.25
27	*A. falcatus*	S	0.00	0.00	0.00	0.83	0.00
28	*A. suave*	S	0.00	0.00	0.00	0.00	0.00
29	*Aspilia africana*	G	0.00	1.79	0.00	0.00	0.00
30	*A. mosambicensis*	G	1.84	1.00	3.33	0.83	0.08
31	*AstrIpomoea malvacea*	S	0.00	0.00	0.00	0.83	0.00
32	*Azanza garckeana*	T	0.00	0.00	0.00	1.25	0.00
33	*Balanites aegyptiaca*	T	1.42	0.71	0.00	0.00	2.08
34	*Becium angustifolium*	H	0.53	0.71	0.00	0.00	0.00

Appendix 3 continued

35	*Bidens lineiloba*	H	0.79	0.36	0.00	0.00	0.75
36	*B. pilosa*	H	2.37	1.14	6.67	2.08	1.50
37	*Blepharis affinis*	H	3.63	0.86	0.00	0.00	0.00
38	*Boscia angustifolia*	T	0.79	4.64	3.33	2.08	0.00
39	*B. mossambicensis*	T	0.00	1.43	5.00	1.67	0.00
40	*B. salicifolia*	T	1.58	1.79	0.00	0.83	0.00
41	*Brachiaria brizantha*	G	0.00	0.43	0.00	0.08	0.00
42	*B. purrurance*	G	0.53	0.00	0.00	0.00	2.92
43	*Brachstegia microphylla*	T	2.11	0.00	0.00	0.83	0.00
44	*B. speciformis*	T	**8.95**	3.93	**23.33**	0.00	0.00
45	*Bridelia amoena*	S	0.53	0.00	0.00	0.00	0.00
46	*B. carthetica*	S	1.05	0.00	0.00	0.00	0.83
47	*Bulbostylis buchananii*	Sg	0.79	0.36	0.00	0.00	0.00
48	*Canthium burtii ssp. Burtii*	T	4.05	1.21	0.00	0.00	0.00
49	*Capparis tomentosa*	S	1.21	2.50	0.00	3.08	6.25
50	*Cassia abbreviata*	S	0.53	0.14	0.00	1.67	0.00
51	*Cassipourea mollis*	T	2.11	2.00	0.00	0.00	0.00
52	*Catunaregum spinosa*	S	4.21	1.79	0.00	3.42	0.00
53	*Chloris gayana*	G	0.00	0.00	0.00	0.00	1.00
54	*C. pycnothrin*	G	0.00	0.00	0.00	0.00	3.58
55	*C. roxbourghiana*	G	2.37	1.36	0.00	0.00	1.50
56	*C. virgata*	G	0.68	0.00	0.00	0.00	0.58
57	*Cissus cornifolia*	H	2.11	2.14	0.00	0.17	0.00
58	*C.rubiginosa*	S	3.95	0.71	1.33	0.50	0.00
59	*C. Tronthae*	S	0.53	1.79	1.67	0.83	0.00
60	*Cleome hirta*	H	2.89	3.57	0.00	0.58	0.92
61	*Combetum pentagonum*	T	0.00	0.00	1.67	0.00	0.00
62	*C. apiculatum*	C	0.53	0.14	0.00	0.42	0.00
63	*C. collinum*	T	0.47	2.79	1.67	0.42	0.00
64	*C. molle*	T	3.05	2.29	3.33	0.83	0.00
65	*C. obovatum*	T	0.79	1.07	0.00	0.17	0.00
66	*C. zeyheri*	T	3.00	3.57	0.00	0.00	0.00
67	*C. africana*	H	0.26	0.64	0.00	0.00	0.00
68	*Commelina benghalensis*	H	1.05	2.57	0.00	1.83	0.00
69	*C. trophae*	S	0.53	0.00	0.00	5.83	0.00
70	*Commiphora africana*	S	2.79	2.36	3.33	0.83	0.00
71	*C. mollis*	T	0.00	0.00	0.00	0.00	0.00
72	*C. mossambicensis*	T	3.32	2.00	0.00	1.25	0.00
73	*C. ugongensis*	T	2.37	1.29	3.33	1.67	0.00
74	*Corchorus capsularis*	H	0.11	0.00	0.00	0.00	0.25
75	*C. olitorius*	H	0.26	0.00	0.00	1.83	0.42
76	*Crabbea velutina*	H	2.21	0.50	0.00	0.00	0.00

Appendix 3 continued

77	*Creterostigma hirsutum*	C	0.26	0.00	0.00	0.00	0.00
78	*Crotalaria cylindrostachyus*	H	0.21	0.71	0.00	0.00	0.92
79	*C. greenwayi*	H	0.53	0.64	0.00	0.00	0.00
80	*Croton niloticus*	H	0.11	0.29	0.00	0.00	0.00
81	*Cucumis aculeatus*	C	1.11	0.71	0.00	0.00	0.00
82	*C. dipsaceus*	C	0.63	0.00	0.00	0.00	0.00
83	*C. figarei*	C	0.84	3.86	6.00	1.17	1.08
84	*Cycnium tubulosum*	H	0.26	0.00	0.00	0.00	0.00
85	*Cynadon dactylon*	G	0.68	0.36	0.00	0.00	1.00
86	*Cyperus articulatus*	Sg	0.26	0.14	0.00	0.00	0.00
87	*C. diffusus*	Sg	0.26	0.00	0.00	0.00	0.00
88	*C. obtusiflorus*	Sg	0.00	0.00	0.00	0.00	0.00
89	*C. rotundus ssp.rotundus*	Sg	0.00	0.29	1.67	0.00	0.00
90	*Cyphostema giganteus*	C	0.53	0.00	0.00	0.42	0.00
91	*C. adenocaule*	C	2.11	0.71	0.00	0.00	0.00
92	*Dactylectenium aegyptium*	G	0.79	0.00	0.00	0.00	2.92
93	*D. geminatum*	H	0.26	0.00	0.00	0.00	0.67
94	*Dalbergia melanoxylon*	H	1.84	1.07	0.00	1.42	0.00
95	*D. nitidula*	S	0.26	0.71	1.67	1.67	0.00
96	*D. stuhlmanii*	T	1.58	1.07	3.33	1.25	3.92
97	*Dichanthium rivae*	G	2.11	0.00	0.00	0.33	0.83
98	*Dichrostachys cinerea*	D	1.68	0.00	0.00	3.33	0.83
99	*Digitaria abyssinica*	G	0.00	0.00	0.00	0.42	1.83
100	*D. macroblephara*	G	0.53	0.00	0.00	0.00	0.50
101	*D. perrottetii*	G	0.00	23.21	23.33	0.17	2.67
102	*D. scalarum*	G	0.79	0.00	0.00	0.75	3.75
103	*Diospyros usambarensis*	T	0.00	0.93	0.00	0.00	1.67
104	*Diplorhynchos condylocarpon*	T	0.00	0.00	0.00	0.00	2.92
105	*Dolichos kilimandscharica*	S	1.05	1.43	0.00	0.00	0.00
106	*D. oliveri*	L	0.00	0.71	1.67	0.42	0.00
107	*Ehretia amoena*	S	0.00	0.00	0.00	0.00	2.50
108	*Emilia javanica*	H	3.16	0.71	0.00	0.00	0.00
109	*Enteropogon macrostachys*	G	0.00	0.00	0.00	0.00	0.83
110	*Eragrostis cylindriflora*	G	1.05	1.57	0.00	26.75	0.33
111	*E. racemosa*	G	0.26	0.00	0.00	0.17	4.42
112	*E. superba*	G	0.53	1.29	2.67	0.00	0.42
113	*Eragrotis aethiopica*	G	0.00	0.00	0.00	0.83	0.58
114	*E. aspera*	G	0.00	0.00	0.00	0.00	1.25
115	*E. patens*	G	0.53	0.00	0.00	0.00	0.00
116	*Erthyrina abyssinica*	T	0.00	1.43	0.00	0.00	0.83

Appendix 3 continued

117	*Erythriccoca bongensis*	S	**0.00**	0.00	0.00	0.00	0.42
118	*Euphorbia candelabrum*	T	**0.00**	0.00	0.00	2.08	0.00
119	*E. grantii*	S	**2.63**	0.00	0.00	2.92	5.42
120	*E. hirta*	H	**0.00**	0.00	0.00	0.00	0.83
121	*E. matabalensis*	T	**0.37**	0.50	0.00	0.00	6.67
122	*E. tirucali*	T	**0.00**	0.00	0.00	0.00	8.75
123	*Fadogia obovata*	H	**0.95**	0.50	0.00	0.00	0.00
124	*Ficus stuhlmannii*	T	**0.00**	0.00	0.00	0.00	**13.75**
125	*Fuerina umbellata*	Sg	**0.00**	0.00	0.00	0.00	0.00
126	*Gloriosa superba*	H	**1.26**	0.00	0.00	0.00	0.00
127	*Gongroneuma angolensis*	C	**0.00**	0.71	0.00	0.00	2.25
128	*Grewia bicolor*	S	**0.00**	0.43	1.67	2.08	0.00
129	*G. fallax*	S	**0.00**	0.71	0.00	0.83	3.75
130	*G. mollis*	S	**1.05**	0.36	0.00	0.83	3.75
131	*Harpachne schimperi*	G	**1.16**	0.00	0.00	0.58	0.00
132	*Heliotropium ovalifolium*	H	**1.05**	1.00	0.00	0.00	0.00
133	*Heteropogon contortus*	G	**3.42**	1.79	0.00	0.00	0.83
134	*Hibiscus cannabinus*	H	**0.00**	0.00	0.00	0.00	0.00
135	*H. micranthus*	H	**0.00**	0.00	0.00	0.00	0.00
136	*Hirpicium diffusum*	H	**1.32**	0.00	0.00	0.00	0.00
137	*Hoslundia opposita*	S	**0.00**	0.00	0.00	0.83	1.67
138	*Hygrophila schulli*	H	**0.00**	0.00	0.00	0.00	0.08
139	*Hymenodictyon parvifolium*	T	**0.42**	0.00	0.00	1.67	0.00
140	*Hypoestes forskaolii*	G	**1.95**	0.00	0.00	0.00	0.00
141	*Hyparrhenia filipendula*	G	**0.00**	1.43	0.00	0.42	0.00
142	*H. rufa*	G	**2.37**	0.00	2.67	10.75	1.17
143	*Indigofera arrecta*	H	**0.26**	0.00	0.00	0.42	0.42
144	*I.cuneata*	H	**0.00**	0.57	0.00	0.00	0.50
145	*I. hirsuta*	H	**1.26**	0.71	0.00	0.00	0.83
146	*I. rhynchocarpa*	S	**1.21**	0.57	0.00	0.42	2.08
147	*I. volkensii*	H	**0.53**	0.00	0.00	0.00	1.33
148	*Ipomoea cairica*	C	**0.00**	0.00	0.00	0.42	0.33
149	*I.obscurea*	C	**0.00**	4.14	2.67	2.17	1.50
150	*I. rubens*	C	**0.21**	0.14	0.00	0.17	0.58
151	*I. sinensis*	C	**0.00**	0.00	0.00	0.58	0.58
152	*Jubernadia globiflora*	T	**16.58**	**24.29**	0.00	0.00	0.00
153	*Justicia anseliana*	H	**1.05**	0.00	0.00	0.00	0.00
154	*J. salvadois*	H	**0.00**	0.00	10.0 0	0.00	0.00
155	*Kigelia africana*	T	**0.53**	0.00	0.00	0.83	3.33
156	*Kylinga alata*	Sg	**0.26**	0.00	0.00	0.17	0.00
157	*K. cristatus*	Sg	**0.00**	0.00	0.00	0.00	0.00

Appendix 3 continued

158	*Landolphia kirkii*	C	0.00	0.00	0.00	0.00	0.42
159	*Lannea fulva*	S	0.26	0.00	0.00	0.67	1.25
160	*L. humillis*	T	4.47	0.00	0.00	2.92	2.08
161	*L. schimperi*	T	3.42	0.71	0.00	1.25	3.33
162	*Launnea cornuta*	H	3.68	1.79	0.00	0.67	0.17
163	*Leucas diflexa*	H	0.26	0.50	0.67	0.00	0.00
164	*Lonchocarpus bussei*	T	0.79	0.36	0.00	**23.33**	0.00
165	*L. capassa*	T	0.00	0.00	0.00	2.92	0.00
166	*L.eriocarlyx*	T	0.95	0.00	0.00	0.00	0.00
167	*Loudetia simplex*	G	5.26	7.14	0.00	0.00	0.00
168	*Macrotyloma axillare*	C	0.58	0.00	0.00	0.00	0.00
169	*Maerua angolensis*	S	0.79	0.00	0.00	0.00	0.00
170	*M. edulis*	S	0.89	0.00	0.00	0.00	0.00
171	*Maprounea africana*	T	0.00	0.71	0.00	0.00	0.00
172	*Margaritaria discoidea*	T	0.00	0.00	0.00	0.00	3.75
173	*Markhamia lutea*	S	0.00	0.36	0.00	0.00	0.00
174	*M. obtusifolia*	S	3.32	1.43	0.00	0.42	0.00
175	*Microchloa kunthii*	G	1.68	1.57	0.00	0.00	0.00
176	*Momordica foetida*	C	1.21	1.71	0.00	0.00	0.00
177	*M. spinosa*	C	0.68	1.79	0.00	0.00	0.00
178	*Monsania angustifolia*	H	1.84	0.43	0.00	0.00	0.00
179	*Mundulea sericea*	H	0.00	0.00	0.00	0.42	0.00
180	*Murdania simplex*	H	0.00	0.14	0.00	0.17	0.00
181	*Ochna mossambicensis*	S	0.53	0.36	1.67	0.00	0.00
182	*Ocimum bassilicum*	H	0.42	0.00	0.00	0.00	0.00
183	*O. cirlicifolium*	H	0.26	0.71	0.00	0.00	0.00
184	*Ormocarpum trichocarpum*	T	4.05	0.57	0.00	0.42	0.00
185	*Oxygonum sinuatum*	H	2.16	0.00	0.00	0.00	1.17
186	*Ozoroa insignis*	T	0.42	0.00	0.00	0.17	0.00
187	*Panicum astrosanguena*	G	0.00	0.00	0.00	0.00	0.67
188	*P. coloratum*	G	1.95	0.64	2.67	0.42	0.00
189	*P. maximum*	G	4.74	5.07	0.00	6.67	0.00
190	*Pavetta gardeniifolia*	S	0.26	0.00	0.00	0.00	2.08
191	*P. stuhlmanii*	S	1.32	0.00	0.00	0.00	0.83
192	*Pavonia zeylanica*	S	0.53	0.00	0.00	0.00	0.00
193	*Pennisetum typhoides*	G	0.74	0.86	1.67	1.17	0.00
194	*Perotis patens*	G	0.26	0.00	0.00	0.00	0.00
195	*Phyllanthus englerii*	S	1.11	0.00	0.00	0.00	0.83
196	*Plectranthus barbatus*	S	0.00	0.00	0.00	0.00	2.50
197	*Premna sinensis*	S	0.26	0.00	0.00	0.42	7.08
198	*Pseudolachnostylis maprounifolia*	T	0.53	0.00	5.00	0.00	0.00

Appendix 3 continued

199	*Pseudovigna argentae*	C	0.53	1.21	10.00	0.17	0.00
200	*Psychotria kirkii*	C	0.00	0.00	0.00	0.00	0.17
201	*Pterocarpus angolensis*	T	5.79	5.36	0.00	0.00	0.00
202	*Pyrenacantha kuarabassana*	C	0.53	0.00	0.00	0.83	0.00
203	*Rhus vulgaris*	S	0.26	0.36	0.00	0.00	0.00
204	*Rhynchosia minima*	H	0.00	1.07	0.00	0.00	0.00
205	*R. resinosa*	S	1.32	5.00	0.00	1.25	0.00
206	*Ruellia paluta*	H	0.79	0.00	0.00	0.00	0.00
207	*Rynchelytrum repens*	G	0.00	0.36	6.67	0.00	0.00
208	*Schrebera trichoclada*	T	1.58	6.07	0.00	0.00	0.00
209	*Sclerocariya birrea*	T	2.89	0.00	0.00	0.00	0.00
210	*Senna singueana*	S	1.21	0.00	0.00	2.42	2.08
211	*Sesamum angustifolium*	H	2.16	2.71	0.00	0.83	3.08
212	*S. indicum*	H	0.00	0.00	0.00	0.00	0.42
213	*Setaria sphacelata*	G	1.32	0.00	0.00	1.00	0.00
214	*S. vexilata*	G	0.00	1.50	0.00	0.25	0.00
215	*Solanum incanum*	H	0.00	0.36	5.33	0.67	0.42
216	*Spirostachys africana*	G	0.00	0.00	0.00	0.00	0.83
217	*Sporobolus panicoides*	G	1.32	0.00	0.00	0.00	0.00
218	*S. stapfianus*	G	1.84	0.00	2.00	0.00	0.00
219	*Stegnataenia araliacea*	S	0.00	0.71	0.00	0.00	0.00
220	*Strophanthus eminii*	S	0.26	4.50	0.00	0.83	0.00
221	*Strychonos madagascariensis*	T	1.05	1.07	0.00	0.00	0.00
222	*S. potatorum*	T	1.47	1.79	0.00	0.00	0.00
223	*Tephrosia pumila*	H	1.84	0.00	0.00	0.00	0.00
224	*T. virgata*	H	0.00	0.36	0.00	0.00	0.42
225	*Terminalia brownii*	T	0.00	0.00	0.00	1.25	5.42
226	*T.kilimadscharica*	T	0.26	0.00	0.00	0.00	0:00
227	*T. mollis*	T	0.00	0.00	0.00	0.83	2.08
228	*T. sericea*	T	4.21	0.36	0.00	1.25	7.92
229	*Thunbergia alata*	H	0.42	1.43	0.00	0.00	0.00
230	*Tragia brevipens*	C	0.00	0.00	0.00	0.00	0.42
231	*Tragus berteroniacus*	G	2.42	0.00	1.67	0.00	0.00
232	*Tribulus terrestris*	H	0.26	0.00	0.00	0.00	0.00
233	*Tricalysia ruandensis*	T	0.53	0.00	0.00	0.00	11.67
234	*Tridax procumbens*	T	0.53	0.71	6.67	4.92	0.00
235	*Triumfetta deck-deckiana*	H	0.11	0.00	0.00	0.00	0.00
236	*T. rhomboidea*	H	0.00	0.00	0.00	0.42	0.00
237	*Vangueria infausta*	S	2.74	1.07	0.00	0.00	0.00
238	*V. madagascariensis*	S	3.16	0.36	3.33	0.00	0.00

Appendix 3 continued

239	*Vigna reticulata*	C	0.00	0.36	0.00	0.00	0.00
240	*Vitex doniana*	T	0.53	0.00	0.00	1.25	0.00
241	*V. keniensis*	T	0.26	0.00	3.33	2.08	0.00
242	*V. mombassae*	T	0.00	0.36	0.00	0.00	2.92
243	*Xeroderris stuhlmanii*	T	2.63	6.07	3.33	0.00	2.92
244	*Ximenia cafra*	S	2.11	0.71	0.00	0.00	0.00
245	*Zornia setosa*	S	0.11	0.00	0.00	0.00	0.00

Appendix 4: Dry season mean cover abundance values of each species in all communities

No.	*Species Names*		Community			
		Habit	**I**	**II**	**III**	**IV**
1	*Abrus precatorius*	L	0.06	0.00	0.00	0.00
2	*A. hockii*	T	0.39	1.53	0.00	0.00
3	*A. stulhumanii*	S	0.97	1.33	0.00	0.00
4	*A. tanganyikensis*	T	0.00	2.33	0.00	0.00
5	*A. tortlis*	T	0.16	2.00	0.00	0.00
6	*A. brevispica*	C	0.00	0.00	0.00	0.17
7	*A. seyal val seyal*	S	0.00	2.33	0.00	0.00
8	*A. drepanolobium*	S	0.13	**5.00**	0.00	0.00
9	*A. nilotica*	T	0.26	0.40	0.00	0.00
10	*A. senegal*	T	0.23	1.20	0.00	0.00
11	*Adansonia digitata*	T	0.77	0.00	0.00	6.08
12	*Adenia gumnifera*	S	0.00	0.67	0.00	0.00
13	*Ageratum conyzoides*	H	0.00	0.00	0.00	0.00
14	*Albizia antunesiana*	T	1.29	1.13	0.00	0.00
15	*A. harveyi*	T	0.16	**6.00**	0.00	0.00
16	*A. petersiana*	T	0.00	0.67	0.00	0.00
17	*A. vescolor*	T	0.23	1.00	0.00	0.00
18	*A. quanzensis*	T	0.84	0.33	0.00	0.00
19	*Asparagus africana*	H	0.32	0.00	0.00	0.17
20	*A. falcatus*	S	0.06	0.33	0.00	0.58
21	*Aspilia africana*	H	0.13	0.00	0.00	0.00
22	*A. mosambicensis*	H	0.48	0.47	0.00	0.00
23	*AstrIpomoea malvacea*	S	0.10	0.33	0.00	0.00
24	*Azanza garckeana*	T	0.00	0.07	0.00	0.00
25	*Balanites aegyptiaca*	T	0.00	0.00	0.00	0.83
26	*Becium angustifolia*	H	1.13	0.00	0.00	0.00
27	*Bidens lineiloba*	H	0.16	0.00	0.00	0.33
28	*B. pilosa*	H	1.48	0.40	1.00	0.17
29	*Blefaris affinis*	H	1.23	0.00	0.00	0.00

Appendix 4continued

30	*Boscia angustifolia*	T	2.81	1.33	**5.00**	0.00
31	*B. mossambicensis*	T	0.00	0.00	3.50	0.00
32	*B. salicifolia*	T	0.71	0.67	0.00	0.00
33	*Brachiaria brizantha*	G	0.39	0.00	0.00	0.00
34	*Brachstegia microphylla*	T	0.97	0.00	0.00	0.00
35	*B. speciformis*	T	3.39	3.67	0.00	0.00
36	*Bridelia carthetica*	S	0.26	0.00	0.00	0.92
37	*Bulbostylis buchananii*	Sg	0.00	0.00	0.00	0.00
38	*Canthium burtii ssp. Burtii*	S	0.94	1.53	0.00	0.00
39	*Capparis tomentosa*	S	0.00	1.67	0.00	4.25
40	*Cassia abbreviata*	S	0.00	1.47	0.00	0.00
41	*Cassipourea mollis*	T	1.45	0.00	0.00	0.00
42	*Catunaregum spinosa*	S	1.32	1.60	0.00	0.00
43	*Chloris gayana*	G	0.10	0.00	0.00	0.75
44	*C. pycnothrin*	G	0.19	0.00	0.00	1.67
45	*Chloris roxbourghiana*	G	0.58	0.00	0.00	0.50
46	*C. virgata*	G	0.16	0.00	0.00	0.33
47	*Cissus cornifolia*	S	0.00	0.33	0.00	0.00
48	*C. rubiginosa*	S	0.06	0.47	0.00	0.00
49	*C.Tronthae*	S	0.39	0.27	0.00	0.00
50	*Combetum pentagonum*	T	0.00	0.00	1.00	0.00
51	*C. apiculatum*	C	0.16	0.13	0.00	0.00
52	*C. collinum*	T	0.97	0.47	1.00	0.00
53	*C. molle*	T	2.42	0.47	2.00	0.00
54	*C. obovatum*	T	0.06	0.00	0.00	0.00
55	*C. zeyheri*	T	2.10	1.73	0.00	0.00
56	*Commelina africana*	H	1.03	1.00	0.00	0.00
57	*C. benghalensis*	H	1.00	0.33	0.00	0.00
58	*Commiphora africana*	S	1.32	0.33	2.50	0.00
59	*C. merkeri*	S	0.00	4.20	0.00	0.00
60	*C. mollis*	S	0.52	0.00	0.00	0.00
61	*C..mossambicensis*	T	3.77	1.33	0.00	0.00
62	*C. ugongensis*	T	0.23	2.80	0.00	0.00

Appendix 4continued

94	*E. tirucali*	T	0.00	0.00	0.00	4.58
95	*Ficus stuhlmanii*	H	0.00	0.00	0.00	**9.33**
96	*Gloriosa superba*	H	0.03	0.00	0.00	0.00
97	*Grewia bicolor*	S	0.13	1.00	2.50	0.42
98	*G. fallax*	S	0.10	0.33	0.00	1.33
99	*G. mollis*	S	0.19	1.00	0.00	2.08
100	*Herpachne schimperi*	G	0.06	0.00	0.00	0.00
101	*Heteropogon contortus*	G	0.00	0.00	0.00	0.67
102	*Hoslundia opposita*	S	0.00	0.33	0.00	1.08
103	*Hygrophila schulli*	H	0.00	0.00	0.00	0.17
104	*Hymenodictyon parvifolium*	T	0.00	1.00	0.00	0.00
105	*Hyphrrania filipendula*	G	0.77	0.00	0.00	0.00
106	*H. rufa*	G	2.00	8.40	0.00	0.83
107	*Hypoestes forskaolii*	G	0.00	0.13	0.00	0.00
108	*Indigofera arrecta*	G	0.19	0.07	0.00	0.25
109	*I. cuneata*	H	2.48	0.00	0.00	0.50
110	*I. rhynchocarpa*	S	0.13	0.13	0.00	1.50
111	*I. volkensii*	H	2.94	0.00	0.00	0.58
112	*Ipomoea cairica*	C	0.00	0.47	0.00	0.00
113	*I. obscurea*	C	0.00	1.00	0.00	0.00
114	*I. sinensis*	C	0.00	0.13	0.00	0.00
115	*Jubernadia globiflora*	T	**15.29**	0.00	0.00	0.00
116	*Justicia salvadois*	H	0.00	0.00	**15.00**	0.00
117	*Kigelia africana*	T	0.16	0.33	0.00	1.67
118	*Kylinga alata*	Sg	0.81	0.00	0.00	0.00
119	*Landolphia kirkii*	C	0.81	0.00	0.00	0.17
120	*Lannea fulva*	T	0.55	0.93	0.00	1.67
121	*L. humillis*	T	0.03	0.00	0.00	0.00
122	*L. schimperi*	T	1.61	0.33	0.00	2.25
123	*Launnea cornuta*	H	0.00	0.73	0.00	0.00
124	*Lonchorcarpus bussei*	T	0.32	0.33	0.00	0.00
125	*L. capassa*	T	0.74	0.00	0.00	0.00

Appendix 4continued

156	*R. resinosa*	S	0.87	1.40	0.00	0.00
157	*Schrebera trichoclada*	T	1.68	0.00	0.00	0.00
158	*Sclerocariya birrea*	T	1.61	0.67	0.00	0.00
159	*Senna singueana*	S	0.32	0.87	0.00	1.25
160	*Sesamum angustifolium*	H	0.58	0.13	0.00	0.00
161	*Setaria sphacelata*	G	0.16	0.00	0.00	0.00
162	*Solanum incanum*	H	0.00	1.00	0.00	0.33
163	*Spirostachys africana*	G	0.00	0.00	0.00	0.42
164	*Sporobolus panicoides*	G	1.13	0.00	0.00	0.00
165	*S.stapfianus*	G	0.97	0.07	0.00	0.00
166	*Strophanthus eminii*	S	0.42	0.47	0.00	0.00
167	*Strychonos madagascariensis*	T	0.97	0.00	0.00	0.00
168	*S. potatorum*	T	1.55	0.00	0.00	0.00
169	*Tephrosia pumila*	H	0.71	0.07	0.00	0.17
170	*T. virgata*	H	0.06	0.00	0.00	0.00
171	*T. brownii*	T	0.00	0.67	0.00	3.75
172	*T. mollis*	T	0.26	0.67	0.00	0.42
173	*T. sericea*	T	1.94	1.33	0.00	7.67
174	*Tragia brevipens*	C	0.00	0.00	0.00	0.17
175	*Tricalysia ruandensis*	G	0.32	0.00	0.00	**8.75**
176	*Tridax procumbens*	H	0.00	3.80	4.50	0.00
177	*Triumfetta rhomboidea*	H	0.00	0.33	0.00	0.00
178	*Vangueria infausta*	S	1.06	0.13	2.00	0.00
179	*V. madagascariensis*	S	0.23	0.00	0.00	0.00
180	*Vitex doniana*	T	0.65	0.67	0.00	0.00
181	*V. keniensis*	T	0.32	0.67	3.50	0.00
182	*V. mombassae*	T	0.06	0.00	0.00	2.08
183	*Xeroderris stuhlmannii*	T	2.13	0.33	0.00	2.08
184	*Ximenia cafra*	S	0.90	0.00	0.00	0.00

Appendix 4continued

156	*R. resinosa*	S	0.87	1.40	0.00	0.00
157	*Schrebera trichoclada*	T	1.68	0.00	0.00	0.00
158	*Sclerocariya birrea*	T	1.61	0.67	0.00	0.00
159	*Senna singueana*	S	0.32	0.87	0.00	1.25
160	*Sesamum angustifolium*	H	0.58	0.13	0.00	0.00
161	*Setaria sphacelata*	G	0.16	0.00	0.00	0.00
162	*Solanum incanum*	H	0.00	1.00	0.00	0.33
163	*Spirostachys africana*	G	0.00	0.00	0.00	0.42
164	*Sporobolus panicoides*	G	1.13	0.00	0.00	0.00
165	*S.stapfianus*	G	0.97	0.07	0.00	0.00
166	*Strophanthus eminii*	S	0.42	0.47	0.00	0.00
167	*Strychonos madagascariensis*	T	0.97	0.00	0.00	0.00
168	*S. potatorum*	T	1.55	0.00	0.00	0.00
169	*Tephrosia pumila*	H	0.71	0.07	0.00	0.17
170	*T. virgata*	H	0.06	0.00	0.00	0.00
171	*T. brownii*	T	0.00	0.67	0.00	3.75
172	*T. mollis*	T	0.26	0.67	0.00	0.42
173	*T. sericea*	T	1.94	1.33	0.00	7.67
174	*Tragia brevipens*	C	0.00	0.00	0.00	0.17
175	*Tricalysia ruandensis*	G	0.32	0.00	0.00	**8.75**
176	*Tridax procumbens*	H	0.00	3.80	4.50	0.00
177	*Triumfetta rhomboidea*	H	0.00	0.33	0.00	0.00
178	*Vangueria infausta*	S	1.06	0.13	2.00	0.00
179	*V. madagascariensis*	S	0.23	0.00	0.00	0.00
180	*Vitex doniana*	T	0.65	0.67	0.00	0.00
181	*V. keniensis*	T	0.32	0.67	3.50	0.00
182	*V. mombassae*	T	0.06	0.00	0.00	2.08
183	*Xeroderris stuhlmannii*	T	2.13	0.33	0.00	2.08
184	*Ximenia cafra*	S	0.90	0.00	0.00	0.00

Appendix 5: A schedule for semi-structured interviews

A: General information

1 Village..... Ward.....

2 Name of the respondent.....

3 Gender· M / F

4 Age.....

5 Level of education [1]Higher...[2]Middle...[3]Lower.....None.....

Key: [1]High (diploma, degree level); [2]Middle (Certificate of ordinary secondary school) and [3]Lower (up to primary level).

B: Preferred wild vegetables

1 Knowledge on wild vegetables: Yes .....No....

2 Listing of known wild vegetables:

No.	Vegetable	Part used	No.	Vegetables	Part used
1			11		
2			12		
3			13		
4			14		
5			15		
6			16		
7			17		
8			18		
9			19		
10			20		

4 Harvesting methods: Only useful parts.....; Uprooting ..... ; Other methods.....

5 Reasons for using wild vegetables: Famine.....; Food scarcity.....; Lack of normal vegetables.....Culture.....; Other reasons.....

6 Season of collection: Wet season.....; Dry season.....; All-the-year round.....

7 Vegetable collectors: Women.....; Men.....; Children.....; Others.....(Specify)

8 Place of collection: Home gardens.....; Fallowed land.....; Arable land.....; In the forest.....; Other places.....(Specify)

9 Reasons for collection: Home consumption.....; For sale.....; medicinal use.....

10 Amount collected: Per meal.....; Per day.....

11 Availability as compared the past: More.....; Same.....; Less.....

12 Less availability: Reasons? (i).....; (ii).....; (iii).....; (iv).....; (v).....

13 Solutions/ measures: Cultivate.....; Domesticate.....; Preserve.....; Conserve.....; Seed storage.....; Other strategies.....

14 Initiatives to ensure availability: Conserve.....; Cultivate/domesticate.....; Seed storage.....

15 Marketing places: Local.....; Towns.....; Other places.....

16 Income: Per day.....; Per week.....; Per year.....

17 Other uses apart from food: Medicine.....; Cultural values (specify).....; Others.....

C: Trends

1 Easy availability:

Jan...Feb...Mar...Apr...May...Jun...Jul...Aug...Sep...Oct...Nov...Dec...

2 Constraints to collection: (i).....; (ii).....; (iii).....; (iv).....; (v).....

3 Threats: (i).....; (ii).....; (iii).....; (iv).....(v).....

4 (a) Cultivated wild vegetables: (i).....; (ii).....; (iii).....; (iv).....; (v).....

(b) Collected in the wild: (i).....; (ii).....; (iii).....; (iv).....; (v).....

(c) Managed in the fields: (i).....; (ii).....; (iii).....; (iv).....; (v).....

D: Market survey

1 Local marketplace .....

2 Collector: .....Collection number: ..... Date: .....

Information on the vendor:

Name.....

Type of vendor: Permanent stall.....Temporary stall.....Ambulatory.....

Village of vendor: ..... Gender: Male....Female.....Estimate age.....

Frequency of selling: In present market?.....In other markets?.....

E: Information on the collection:

Local name: ..... Life form: .....

Village: .....Vegetation type: .....

Cultivation status: Cultivated...Managed...Wild...

Market status: Gathered by vendor...Resold.....

Number of species in collection: Single...Mixture of....plants

Conditions of plants: Fresh...Dried...Preserved in....

Price/ unit: ..... Brought to market: Daily...Weekly...On occasion....

Estimated quantity: Vendor...Whole market...

Availability: Jan...Feb...Mar...Apr...May...Jun...Jul...Aug...Sep...Oct...Nov...Dec...

How much sold now compared to the past: More...Same...Less...

Why? Less available for harvest.....Less demand by buyers.... Others.....

Use: .....

Plant part used: .....

Preparation: .....

Notes: .....

Herbarium information:

Botanical family: ..... Scientific name.....

Preparation: Herbarium specimen.....Spirit collection...

Others.....Total number of duplicates...

F: Suggestions on how to conserve wild vegetables

.....

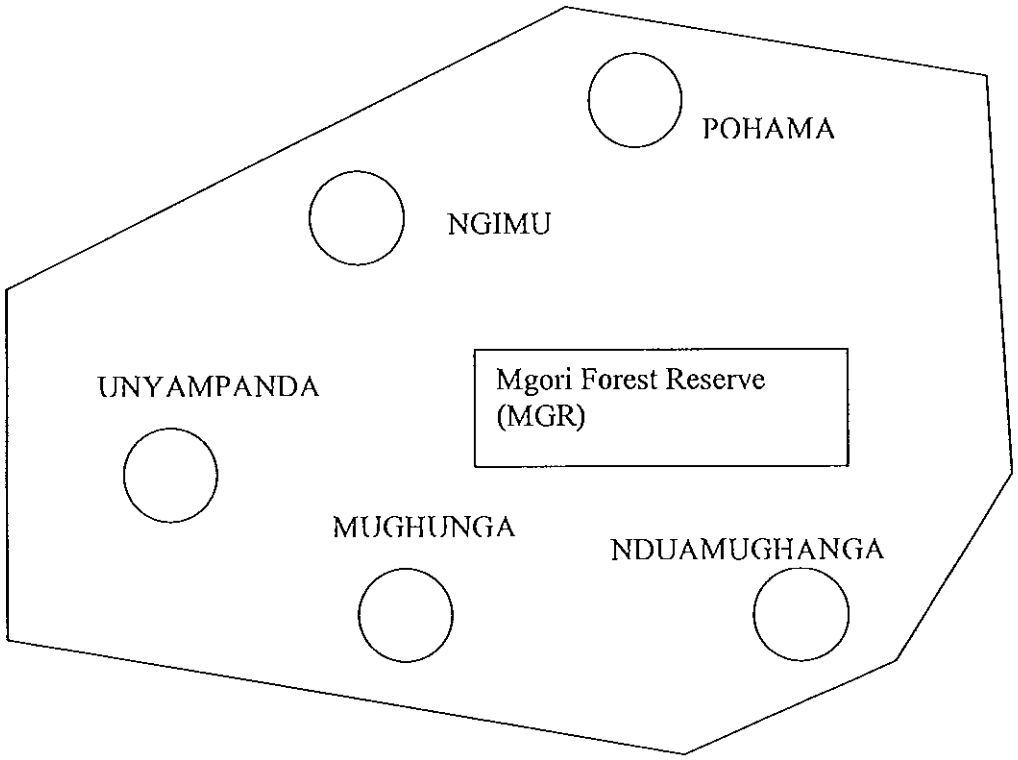
.....

Appendix 6: Factors associated with scarcity of some vegetable plant species by villages

	Number of respondents by village					
Reasons	**Pohama**	**Unyampanda**	**Ngimu**	**Mughunga**	**Nduamughanga**	**Total**
Famine	6 (3.3)	5(2.7)	11(6.0)	17(9.3)	17(9.3)	56(30.8)
Easy availability	10 (5.5)	9(4.9)	15(8.2)	16(8.8)	27(14.8)	77(42.3)
Cheap	4(2.2)	17(9.3)	11(6.0)	23(12.6)	34(18.7)	89(48.3)
Culture	4(2.2)	2(1.1)	10(5.5)	15(8.2)	11(6.0)	42(23.1)
Palatability	2(1.1)	5(2.7)	12(6.6)	25(13.7)	26(14.3)	70(38.5)
Easy of preparation	12(6.6)	6(3.3)	15(8.2)	21(11.5)	21(11.5)	75(41.2)
Income generation	3(1.6)	1(0.5)	7(3.8)	4(2.2)	13(7.1)	28(15.4)
Easy processing & storage	2(1.1)	1(0.5)	7(3.8)	8(4.4)	189.9)	36(19.8)
Total	42(23.1)	41(22.5)	33(18.1)	31(17.0)	35(19.2)	182(100)

(Figures outside the brackets represent number of mentions/counts and those in brackets represent percent of totals on respondents)

Appendix 7: A layout of villages involved in the managament of Mgori Forest Reserve (MGF).



Appendix 8: Constraints to collection of vegetables in Mgori Division

Reasons	Number of respondents by village				
	Pohama	**Unyampanda**	**Ngimu**	**Nduamughanga**	**Total**
Accident, thorns	17(40.5)	18(43.9)	13(38.2)	14(45.2)	78(42.6)
Insects and snakes	25(59.5)	21(51.2)	22(64.7)	21(67.7)	98(53.6)
Storage facilities	12(28.6)	16(39)	8(23.5)	14(45.2)	61(33.3)
Long distances	28(66.7)	30(73.2)	30(88.2)	29(93.5)	145(79.2)
Bad weather	36(85.7)	38(92.7)	29(85.3)	27(87.1)	161(88)
Wild games	11(26.2)	19(46.3)	5(14.7)	9(25.7)	58(31.7)
Barbaigs (Tatoga tribe)(muderers)	3(7.1)	7(17.1)	5(14.7)	5(14.3)	31(16.9)
Total	42(23)	41(22.4)	34(18.6)	31(16.9)	183(100)

Appendix 9: List of key informants contacted during the study.

S/N	Name	Gender	Age (Years)	Marital status	Educ. Level	Village
1	Adija Seifu	F	50	Married	Lower	Nduamughanga
2	Amina Hassan	F	70	Married	Lower	Pohama
3	Amina Mungwabi	F	80	Married	None	Nduamughanga
4	Andrea Juma	M	40	Married	Lower	Unyampanda
5	Athumani Juma	M	40	Married	Lower	Unyampanda
6	Berita Makiya	F	61	Married	None	Pohama
7	Christina Ibrahimu	F	32	Married	Lower	Unyampanda
8	Costansia Iddi	F	53	Married	None	Pohama
9	Danford Ibrahim	M	53	Married	Middle	Pohama
10	Elias Mwangu	M	71	Married	Lower	Pohama
11	Eliwaja Paulo	F	40	Single	Middle	Ngimu
12	Estalina S. Kilemwa	F	43	Married	Lower	Pohama
13	Fatuma Ally	F	80	Widowed	None	Pohama
14	Flora Athumani	F	31	Married	Lower	Ngimu
15	Grace Njoka	F	30	Married	Lower	Ngimu
16	Grace Selemani	F	51	Married	Lower	Unyampanda
17	Hadija Athuman	F	56	Married	Lower	Pohama
18	Hadija Hango	F	48	Married	Lower	Unyampanda
19	Halima Ally	F	50	Married	Middle	Pohama
20	Hawa Ramadhani	F	43	Married	Lower	Unyampanda
21	Helena Bakari	F	57	Married	Lower	Nduamughanga
22	Jacobo Haji	M	63	Married	None	Pohama
23	Joyce Rajabu	F	45	Married	Lower	Ngimu
24	Juma Mangu	M	75	Married	Lower	Pohama
25	Jumanne Hassan	M	58	Married	None	Nduamughanga
26	Levina Rajabu	F	36	Married	Lower	Ngimu
27	Magdalena Monko	F	50	Married	Lower	Pohama
28	Martha Ntunge	F	60	Married	Lower	Pohama
29	Mary Nkumbi	F	60	Widowed	None	Pohama
30	Michael Issango	M	75	Married	None	Pohama
31	Mustafa Buko	M	45	Married	Lower	Ngimu
32	Mwajuma Ibrahim	F	51	Widowed	Lower	Pohama
33	Mwajuma Rajabu	F	48	Married	None	Nduamughanga
34	Mwanaharusi Shabani	F	52	Married	Lower	Nduamughanga

Appendix 9 continued

35	Mwanaidi Lissu	F	45	Divorced	Lower	Unyampanda
36	Mwanaidi Saidi	F	52	Married	Lower	Unyampanda
37	Mwanaidi Salim	F	60	Married	Lower	Pohama
38	Mwasiti Mohamedi	F	48	Married	None	Nduamughanga
39	Mwiru Ghambeda	M	60	Married	None	Pohama
40	Nathali Sulumbi	M	54	Married	Lower	Ngimu
41	Raphaeli Ntandu	M	58	Married	Lower	Unyampanda
42	Rosemary Juma	F	45	Married	Lower	Unyampanda
43	Saidi Rajabu	M	52	Married	Lower	Nduamughanga
44	Samweli Aron	M	38	Married	Lower	Pohama
45	Samweli Ghuliko	M	65	Married	None	Nduamughanga
46	Samwelui Madoro	M	45	Married	Lower	Ngimu
47	Sesilia Mariseli	F	44	Married	Lower	Nduamughanga
48	Tatu Abedi	F	50	Married	Lower	Ngimu
49	Tatu Mantidi	F	25	Divorced	Lower	Ngimu
50	Zainabu Sombi	F	63	Married	None	Pohama

Education level: High (diploma, degree level), Middle (Certificate of ordinary secondary school) and Lower (up to primary level).