The Role of Indigenous Fruit Trees in Farming Systems in North Central Region Namibia

Summer Desertification Programme 11
Desert Research Foundation of Namibia

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Executive Summary

The Summer Desertification Programme (SDP) is a research-training course aimed at enhancing environmental problem solving capacities for sustainable development amongst Namibian tertiary students from University of Namibia, the Polytechnic of Namibia and the College of Agriculture. The Desert Research Foundation of Namibia (DRFN) has conducted this course for eleven consecutive years with generous funding from Sida.

The topics of the course have always been selected to reflect current, environmental issues in Namibia and in certain years the topic has been controversial, such as the SDP6 investigation of the impact of illegal fencing in eastern Oshikoto. This year's topic for SDP11 was directed toward assessing the importance of indigenous fruit trees in the northern central regions of Namibia.

This year, fourteen students and eight facilitators from the Desert Research Foundation of Namibia took part in the research. The study was carried out in the Okahao district of the Omusati region and the Ondobe district of the Ohangwena region. During two separate field sessions, the participants interviewed farmers to gain information about indigenous fruit tree uses, management practices and traditional knowledge surrounding the different species. Participants also surveyed the fruit tree populations on farms to determine the diversity and abundance of each of the fruit tree species.

Results show that the most abundant indigenous fruit trees in both areas were the Makalani Palm tree and the Marula tree. While many farmers valued crops and livestock more than fruit trees, most farmers do rely upon fruit trees as a supplementary food source and as a source of extra, off-farm, income. While we noted that many of the indigenous fruit tree species are capable of regeneration, livestock often destroy the saplings before they can become established and grow into mature individuals. We found that fruit trees grow primarily on farms, indicating that human intervention is highly important in the successful growth of many fruit tree species.

We also found that marketing opportunities for indigenous fruit tree products is limited. Many farmers wish that there were more avenues of opportunity for selling fruit tree products such as the raw fruits, juices, oils and baskets.

Based on our research, we recommend that future research explores opportunities for marketing of indigenous fruit products. By creating a market, the value of fruit trees to farmers will increase. We also recommend that awareness education be emphasised in the rural areas, providing farmers with information on how to best plant and manage fruit trees and how to sustainably harvest the fruits.

A note to readers

The following table provides the names, in English, Oshiwambo and Latin, of the fruit tree species this paper focuses on. It also provides a 5-letter abbreviation for each species. Throughout the paper, species will be referred to by their common English name wherever possible. However, for graphs and figures, the 5-letter abbreviation may be used for formatting reasons.

Oshiwambo name	English name	Scientific name	Abbreviation
Omwandi	Jackal berry	*Diospyros mespiliformis*	*Dio me*
Omugongo	Marula	*Sclerocarya birrea*	*Scl bi*
Omulunga	Makalani palm	*Hyphaene petersiana*	*Hyp pe*
Omuye	Bird plum	*Berchemia discolor*	*Ber di*
Omumbu	Mountain medlar	*Vagneria infaasta*	*Vag in*
Oshipeke	Sour plum	*Ximenia caffra, americana*	*Xim ca*
Omukekete	Buffalo thorn	*Ziziphus mucronata*	*Ziz mu*
Omushegele	Rasin tree	*Grewia species*	*Gre spp.*
Omunkunzi	Shepherds tree	*Boscia albitrunca*	*Bos al*
Omukwiyu	Wild fig	*Ficus sycomorus*	*Fic sy*
Omukwa	Baobab	*Adansonia digitata*	*Ada di*

1. Introduction

A group of 14 students from Namibian tertiary institutions, including University of Namibia (UNAM), Polytechnic, Neudamm and Ogongo Agricultural Colleges, participated in the Summer Desertification Programme (SDP 11) which took place between November 2002 and February 2003. Funded by Sida, this year's Summer Desertification Programme is the eleventh program sponsored by the Desert Research Foundation of Namibia (DRFN), which aims to promote sustainable development by improving environmental problem solving through research. Training in research methodologies, field techniques, problem-solving, and scientific analysis is the primary goal of SDP. To provide realistic research conditions, topics for SDP are different each year, always focusing on current environmental issues.

This year's SDP 11 topic was *The Role of Indigenous Fruit Trees in Farming Systems in North-central Namibia*. Research for this course was based in the North Central Regions (NCR's) of Namibia at two study sites: in Okahao (Omusati district) and Ondobe (Ohangwena district). These two sites were selected because of their differing rainfall patterns and geomorphological characteristics.

This year's topic was chosen based on discussions with people in the Directorate of Forestry and other NGO's. Indigenous fruit trees are viewed as an important aspect in the lives of people living in the north central regions of Namibia, yet little research has been conducted, and large gaps exist in information about indigenous fruit trees, traditional knowledge of fruit trees, and the uses of fruit trees. This study aims to learn more about indigenous fruit trees and their uses, in hopes of providing basic information about the fruit trees to encourage further study.

The main objectives of SDP 11 were to:

- Find out more about the relationship between indigenous fruit trees and farming systems based on indigenous knowledge and observation
- Look at the current distribution of indigenous fruit trees
- Learn more about indigenous fruit trees in relationship to environments and landforms
- Understand the economic and cultural values of indigenous fruit trees, and
- Make wise recommendations for future use to Extension Officers and other stakeholders

North Central Namibia was a main area of armed conflict for over 20 years before independence in 1990. Consequently, little development work to benefit local communities could be undertaken, and the area remained largely neglected until after independence. (Verlinden and Dayot, 1999)

People in the North Central Regions focus primarily on subsistence agriculture for their livelihoods, supplemented by pensions and migrant labour. The farming system in the

North-Central Regions is classified as agro-silvi-pastoral system, which consists of three components: crop production, livestock production and tree tending and use.

The two study areas chosen for this research are part of the marginal farming areas where indigenous fruit trees play an important role and people are still highly dependent on crops and livestock production.

Fruit trees are perennial species that depend on ground water. They have high survival rate during periods of drought because they are able to reach groundwater unavailable to other types of vegetation. They also require less intensive management and labour input. Fruit trees benefit people by providing shelter, firewood, fodder, fencing, and fruits. Some people create employment among themselves by selling fruit trees products and by-products to generate income.

During the research, 43 farmers were interviewed after the team received permission from the traditional leaders to do a survey in the selected villages. Both socio-economic (involving questionnaires and discussions) and biophysical (involving measurements, surveying, sampling and observation) research was done.

1.1 The study site

Two study sites were chosen, instead of only one, so that a comparison between the two areas would be possible. The study was done in the Okahao constituency in Omusati region and the Ondobe constituency in Ohangwena region. Okahao is approximately 73 km south-west of Oshakati town, while Ondobe is situated 25 km east from the Ondangwa and Oshikango road.

The farmers were selected through official channels. We worked with the traditional councils and local authorities to select the farms that we surveyed. The farms we surveyed were located in 14 different villages in the two areas: Omuthitu, Onakaheke, Oniimwandi, Iilambo, Uukuvu, Okaloko, Oshilulu, Iitapa and Ongozi in Okahao constituency and Onailonga A, Onailonga B, Ondaanya, Ondobe and Omunyekadi in Ondobe constituency. People at forty-three farms were interviewed and 2496 fruit trees were measured.

Rainfall

Namibia is the driest country in Sub-Sahara Africa, and rainfall in Namibia is highly variable throughout the country and between years. In the North Central Regions, average yearly rainfall decreases from the east to west (Marsh *et al* 1992). Okahao, situated in the west of the NCR, receives less rainfall than Ondobe, which lies on the eastern part. These two sites were chosen for SDP 11 in part because rainfall has an influence on vegetation distribution and could be an interesting comparison.

Soil and Vegetation types

Differences in elevation, soil, and vegetation have created a distinct landscape in the two regions of Okahao and Ondobe. Okahao is situated on the west of Cuvelai while Ondobe is on the transition between western Kalahari woodland and Cuvelai.

The soil types at Okahao are primarily loams and sand while at Ondobe deep Kalahari sand prevails. The concentration of salt in the soil at Okahao is high compared with Ondobe. Variation in salt content between the two study areas is one reason for differences in vegetation. The depth of the soil hardpan at Ondobe is also deeper than at Okahao, contributing to the difference in vegetation. Mendelsohn (1997) supports

this, noting that many plants in the two areas are adapted to local soils and are therefore quite different from plants growing in the other area.

Another distinct difference between the two study sites is the presence of oshanas in Okahao, a system of shallow rivers and vleis typical of the North Central region of Omusati (Pallet and Mbenzi, 1994).

The differences in soil, climate, rainfall patters and geology of the two regions chosen for study combined to make the vegetation in these two areas distinctly different. Because of these differences, which lead to a difference in vegetation, we postulated that the use of fruit trees might also be different in these two areas.

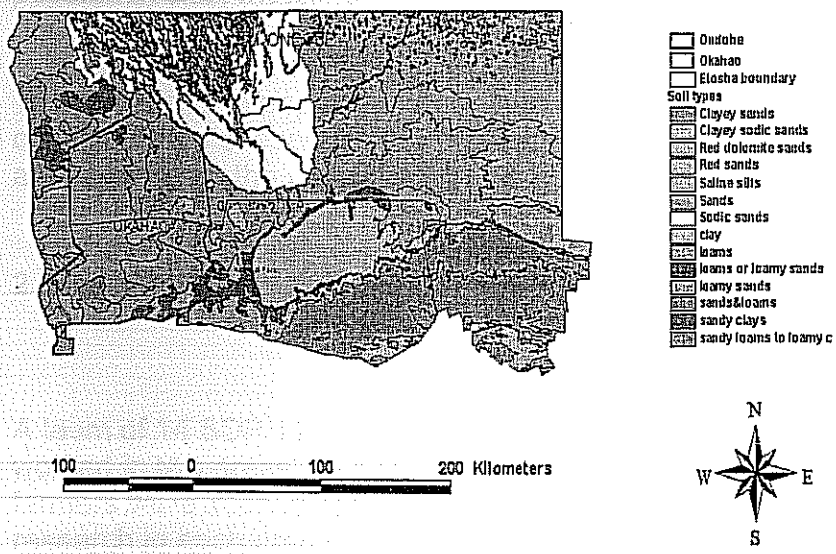

Figure 1: The distribution of soil types in the North Central Regions. The two constituencies that our study took place in, Ondobe and Okahao, are outlined in red and blue on the map. Difference in soil types between the two areas was a factor in site selection. Source: Mendelsohn, 2000.

The most common fruit tree species in the Okahao area is the Makalani palm (*Hyphaene petersiana).* At Ondobe, the Jackal berry (*Diospyros mespiliformis*) is the most dominant fruit tree species.

Population

The North Central Regions are the most densely populated areas in Namibia. The National Census conducted in 1991 estimated a growth rate of over 3% per annum.

As Figure 1 shows, the Ondobe constituency is much smaller than the Okahao constituency. However, populations of the two constituencies are nearly equal, as Table 1 shows. Therefore the population density of the Ondobe constituency is far larger than that of Okahao. People in Ondobe are much more closely settled, with little or no area in between farms, as is found in Okahao. This difference in population densities may be explained by the many oshanas in Okahao, where people cannot settle. Okahao is also a newer settlement area, meaning that some infrastructure is still not as developed as it is in more established areas such as Ondobe (i.e. roads, schools, clinics, etc.) People have only recently started settling in the Okahao area.

Constituency	Area square (km)	Number of people	Population Density
Ondobe	737	34,700	47.08
Okahao	13,972	29,100	2.08

Table 1: Area and population of both constituencies, as well as population densities for each constituency. Okahao is much larger than \ondobe, but has a comparable population size, meaning its population density is much lower. Source: Mendelsohn, 2000.

This difference in population density is also an important difference in the two constituencies chosen for this research, and it was wondered whether this would have an influence on the use of fruit trees in the two areas.

2. Methodology

2.1. Socio-economic methodology

A team of 14 SDP 11 students with 8 DRFN facilitators (to be referred to as participants) worked in two areas (Okahao and Ondobe) during the research program. Forty-three farmers were interviewed for this research, 23 in Okahao and 20 in Ondobe. The research in each area started with discussions with traditional and political community leaders, to introduce ourselves to relevant authorities and explain our intentions. In each community, the tribal leaders organised for us a guide who accompanied us to the different farms, helping to explain our purpose and assisting us in finding farmers to interview. Although farm selection was not random, both old and new farms were

visited, and we attempted to survey a cross-section of the population as much as possible.

A team of 4 to 5 participants visited identified farmers at their farms to conduct interviews. Upon arrival at the farm, we introduced ourselves briefly, identifying who we were, where we were from, what we would be doing, and the objectives of our project. The persons interviewed were farm owners or members of the family. Sometimes two people from the same farm were interviewed at the same time. It was necessary for members of SDP 11 who speak Oshiwambo to translate questions to the farmers and also translate answers to other SDP participants who do not speak the language. Participants created a questionnaire to use during interviews before fieldwork began (Appendix 1). The questionnaire was used as a guide to ensure that all relevant information was obtained from each interview. Farmers were asked a number of questions about their knowledge on the use and management of the indigenous fruit trees that they have access to. They were also asked a set of questions about their farming practices, what the relationship of landforms to fruit trees growing in their farms is, and what the uses of different indigenous fruit trees are. Some broad social questions were asked to identify income generation possibilities on the farm. People who depended more on crops without generating income from outside sources were thought to be more likely to manage and protect their indigenous fruit trees on their farms than people who have other alternate sources of income. Farmers were also given an opportunity to ask questions, to facilitate a group discussion and participate rather than to be strictly interviewed.

The interviewers took comprehensive notes of the discussion. Some of the anecdotal information that was of interest or importance was included, although it was difficult to derive quantitative or statistical analyses from these data. After each farm interview, participants met to discuss their interview and combine the information into a spreadsheet of socio-economic data. When participants repeatedly obtained the same answers from different farmers on the same question, such questions were omitted from subsequent interviews and answers from previous farmers in the same area were used as reliable information. Observations were also an important component of the survey. Literature reviews from both scientific and indigenous studies were used during the data analyses.
The data were broken up into 8 main topics:

1. General interviewee information (name, village, gender, age, status)
2. Tree species found on farm (past and present)
3. Plant establishment (how new trees were obtained)
4. Plant protection (whether farmers protected individual trees)
5. Plant removal (whether trees were intentionally felled)
6. Agro-Silvi-Pastoral relationships (how fruit trees were inter-related with the overall farming systems in the area)
7. Indigenous fruit trees and their uses (which fruit trees were used, and what processing was done to fruit tree products for informal and formal market use)

8. Landforms (the landform, or soil, types found on each farm were recorded whenever possible)

This socio-economic information was incorporated with the biophysical data when possible, and the data were analysed as per the topics above. The results were then summarised in tables and graphs using actual numbers, percentages or frequency. A critical assessment and discussion of these results with the team helped in making the conclusions and recommendations.

2.2. Biophysical methodology

To obtain information on population size and density of indigenous fruit tree species, all indigenous fruit trees within the selected farms were sampled and different variables were recorded (Appendix 2), including:

1. Tree number: Each tree on a farm was given an identification number.
2. Waypoint number: To mark the co-ordinates of every tree sampled.
3. Species and gender
4. Plant sample number: If identification was not possible, samples were taken to the NBRI.
5. Landform: Soil and landform types that each tree was growing on was recorded whenever possible, usually with the help of the farmer.
6. Height: Approximation methods were used.
7. Canopy diameter: This was measured for all individuals in all species except *Hyphanae petersiana* (Palm tree), because we observed that most branches were cut, making the canopy diameter irrelevant.
8. Trunk diameter: Instead of using the standard measure of diameter at breast height (DBH), the diameter at 50 cm from the ground was recorded. This was done for comparative purposes since measurements from previous studies were also done at this height. Another reason was due to the fact that most trees start bifurcating close to one meter, below the DBH. For *Hyphanae petersiana*, DBH was used, as it was difficult to measure at 50 cm due to heavy vegetation surrounding the trunks.
9. Remarks: Physical condition of trees and other features, such as whether the tree was fruiting were noted.

In Ondobe, the boundary of each farm was also identified and was mapped by marking points along the farm border using a GPS. This was done to determine the farm size and borders of every farm. Farm boundaries in Okahao were determined by using aerial photographs provided by the National Remote Sensing Centre.

Other biophysical aspects were measured included soil types on a few farms. When this was done, 1 to 1.5 meter deep pits were dug to determine the depth of the hardpan and to observe the different soil layers. This was only done in few farms, primarily for training purposes for the participants.

After daily fieldwork while in Okahao and Ondobe, co-ordinates of trees and boundaries from the farms were downloaded and edited on an Excel spreadsheet. The data collected was later analysed at the Gobabeb Training and Research Centre (Gobabeb Centre), using descriptive statistics and statistical tests in Microsoft Excel. Arc view GIS Version 3.1 software was also used to create maps of the selected farms. This provided insight on identifying location of fruit trees on selected farms.

3. Results

3.1 Species accounts

Participants interviewed 43 farmers in the two areas, and measured almost 2,500 trees. *Berchemia discolor* (Bird plum), *Sclerocarya birrea* (Marula), and *Hyphaene petersiana* (Makalani palm) were found to be common species in both Okahao and Ondobe. *Diospyros mespiliformis* (Jackal berry) was also a common species in Ondobe (Table 2). These trees were found mostly in the cultivated fields within a farm, but sometimes also outside the cultivated land on the area of the farm referred to as Ekove.

Oshiwambo name	English name	Scientific name	Number of trees, including seedlings	
			Okahao	Ondobe
Omwandi	Jackal berry	*Diospyros mespiliformis*	2	358
Omugongo	Marula	*Sclerocarya birrea*	297	326
Omulunga	Makalani palm	*Hyphaene petersiana*	618	309
Omuye	Bird plum	*Berchemia discolor*	53	179
Omumbu	Mountain medlar	*Vagneria infaasta*	0	109
Oshipeke	Sour plum	*Ximenia caffra, americana*	0	75
Omukekete	Buffalo thorn	*Ziziphus mucronata*	16	63
Omushegele	Rasin tree	*Grewia species*	20	47
Omunkunzi	Shepherds tree	*Boscia albitrunca*	0	9
Omukwiyu	Wild fig	*Ficus sycomorus*	1	4
Omukwa	Baobab	*Adansonia digitata*	8	2
		TOTAL	1015	1481

Table 2: Oshiwambo, English and Scientific names of Indigenous fruit tree species, as well as their abundance and distribution in Okahao and Ondobe constituencies.

Our study found that in most sampled farms in Okahao, Makalani Palm and Marula were almost equally common. All the 19 established farms sampled had both these fruit trees. In the Ondobe area Jackal Berry and Bird Plum trees were also common.

Figure 2 indicates the number of farms in both Okahao and Ondobe that indigenous fruit tree species were found at. The three most common species in Okahao, Bird Plum, Jackal Berry and Marula, were found on most farms (n=23), while the majority of indigenous fruit tree species were not found on most farms. In Ondobe, many farms had a variety of species present.

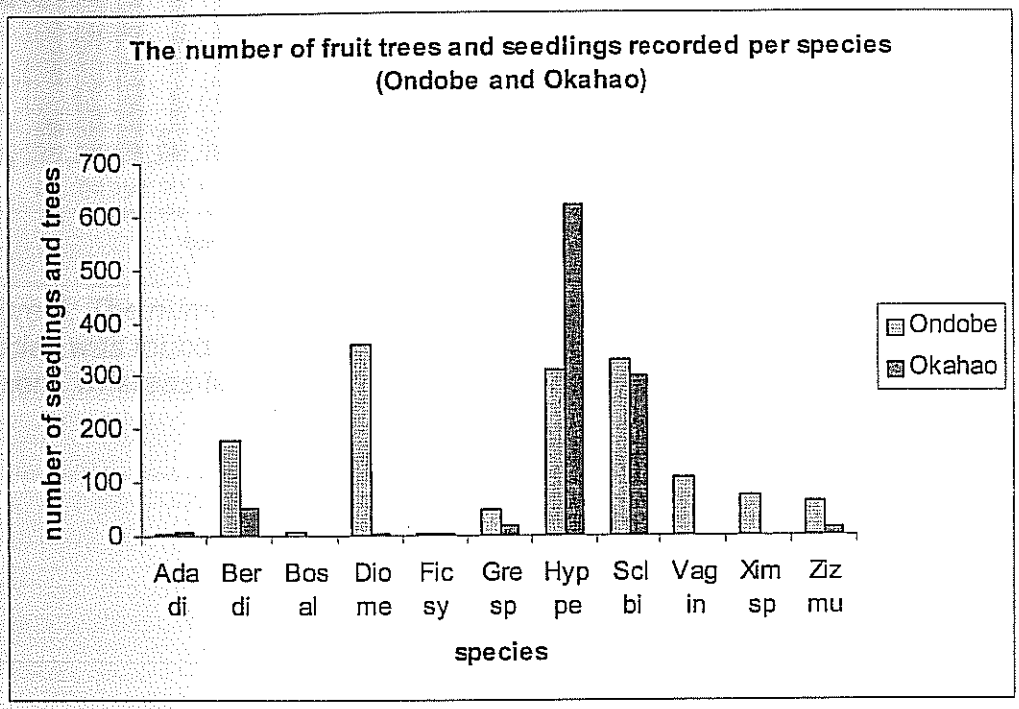

Figure 2: The number of fruit trees of each species found on farms in Okahao (n=1015) Ondobe (n=2481). Palm trees (Hyphaene)were overwhelmingly the most common species found in Okahao, while Ondobe had more diversity and many species of relatively equal abundance.

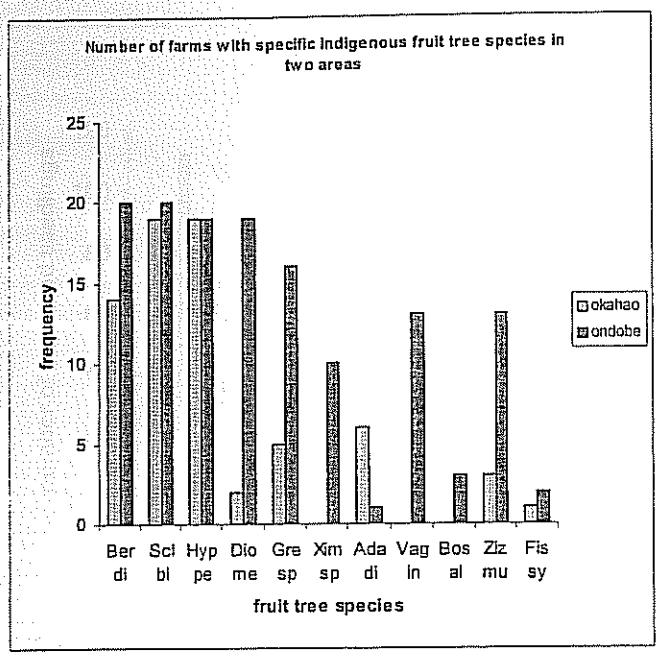

Figure 3: The number of farms in Okahao and Ondobe where at least one individual of a species was found. Farms in Okahao tended to have only a few different species present, whereas farms in Ondobe had many different species represented.

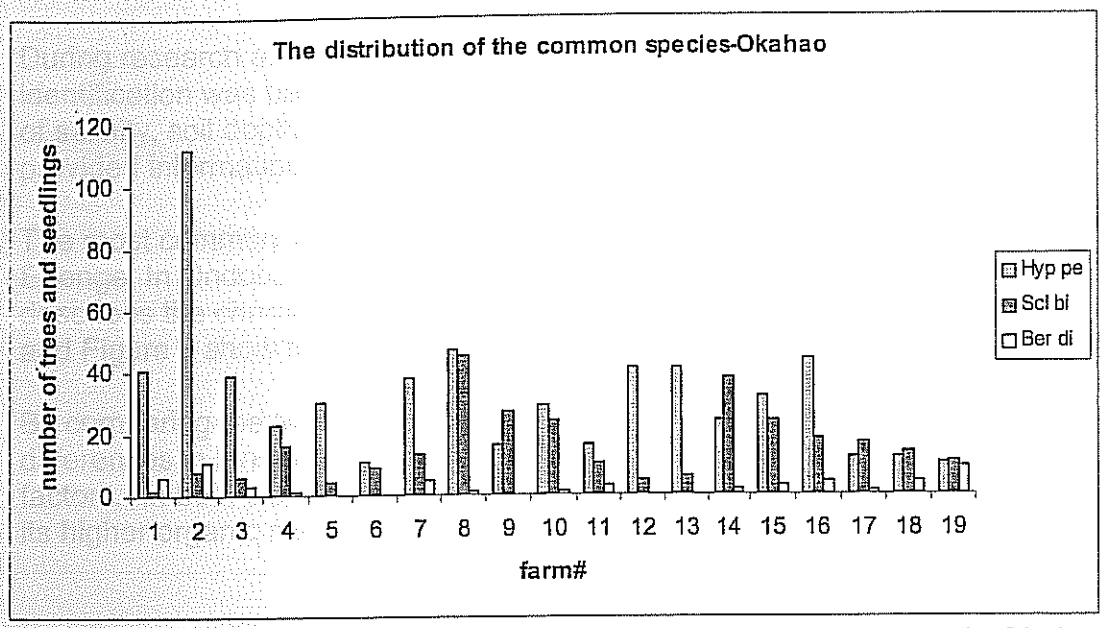

Figure 4: The distribution of common species in the sampled farms in Okahao (n=19).

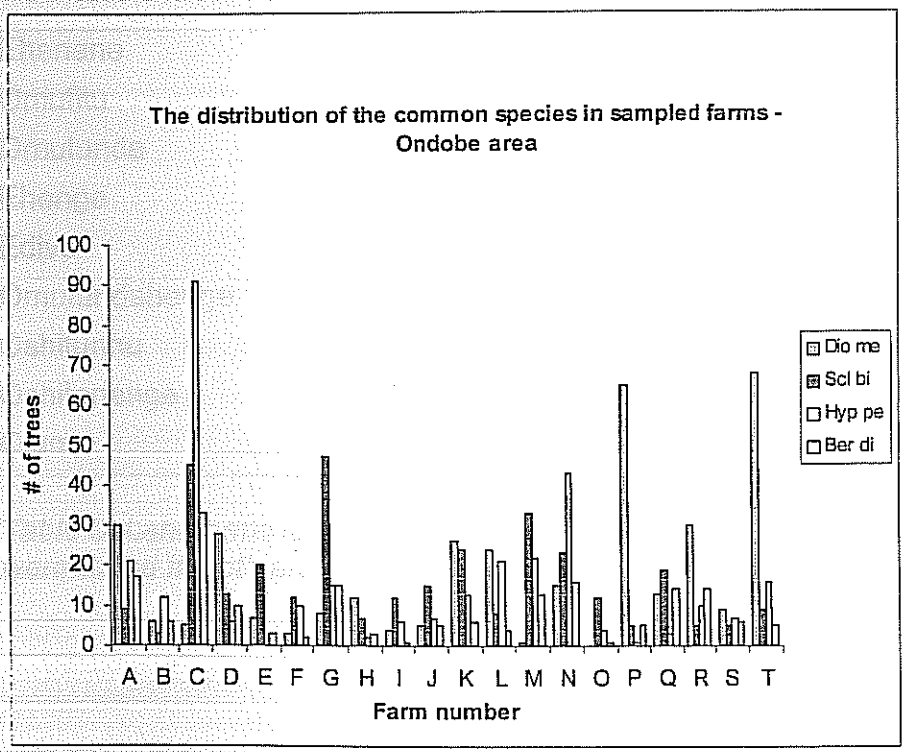

Figure 5: The distribution of common species in the sampled farms in Ondobe (n=20)

3.2 Landforms

During research at Okahao and Ondobe, different land unit were identified. Land unit identification was based upon several factors, including soil structure, soil texture, level of salinity, soil depth and fertility. Local farmers, extension officers and soil experts provided information about land units and assisted in identification.

The most common land units found at Okahao were: Ehenene, Omutunda, Omufitu and Ehenge. In Ondobe, Omufitu, Omutunda and Ehenge were most common. Appedix 3 describes the characteristics of each of these landforms (also called land units). Table 3 and Figure 6 show the abundance and types of the landforms found.

By comparing the two study areas we found that there are both similarities and differences in landforms present. Such differences are based upon soil fertility and other factors. In both study areas, Omufitu is known to be the land unit that farmers prefer for its higher organic matter content and its suitability for good crop production.

Landforms Identified in Okahao	Landforms Identified in Ondobe
Ehenene	Ehenene
Omufitu	Omufitu
Omutunda	Omutunda
Ehenge	Ehenge
Ediva	Ediva
Omutundahenge	Omutundathitu
Oshitunhu	Etunu
Oshitenenge	
Oluma	

Table 3: Landforms found in the two regions of our study. Many landforms, or soil types, were found in both areas, but more types of landforms were found in Okahao.

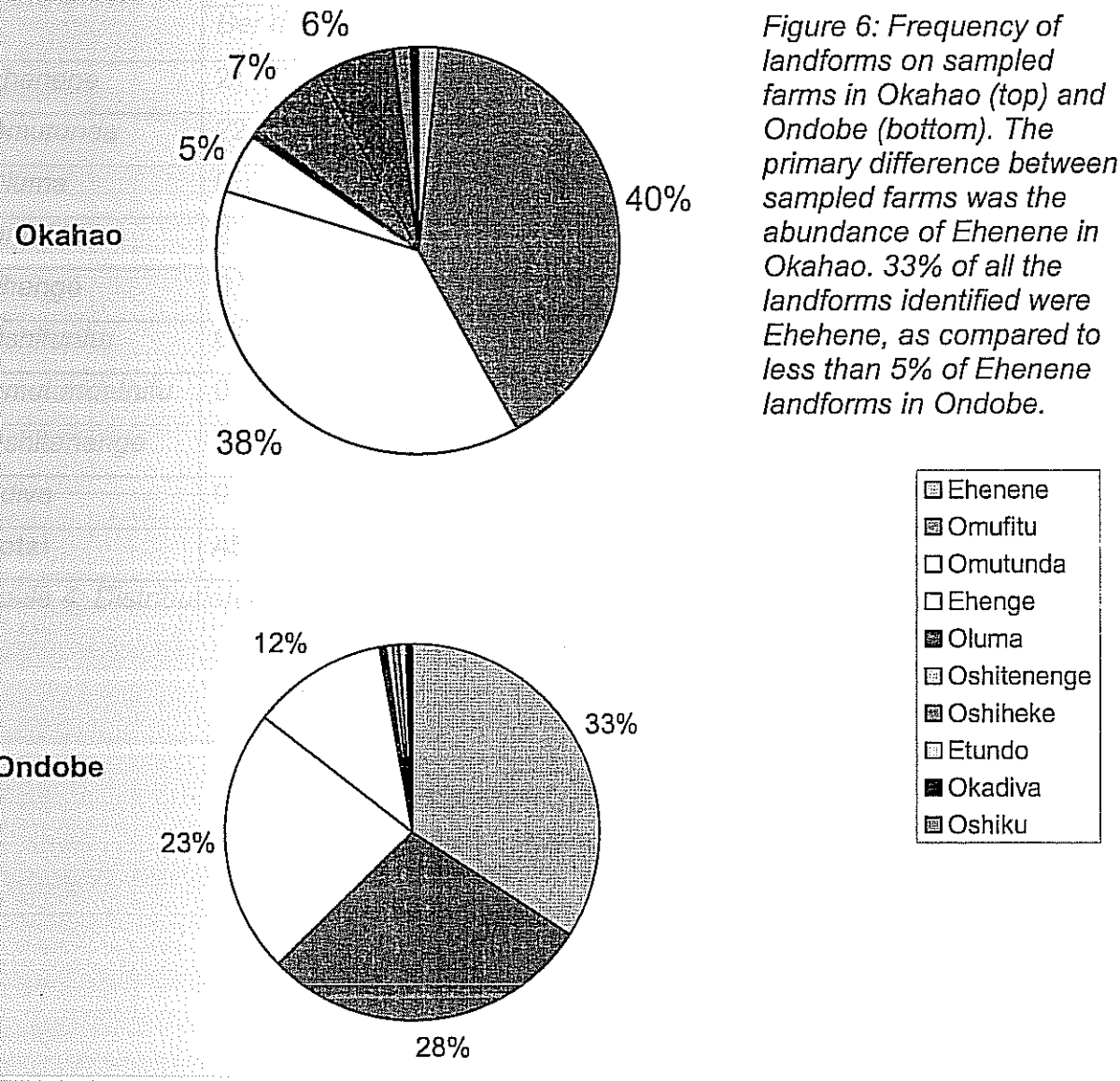

Figure 6: Frequency of landforms on sampled farms in Okahao (top) and Ondobe (bottom). The primary difference between sampled farms was the abundance of Ehenene in Okahao. 33% of all the landforms identified were Ehehene, as compared to less than 5% of Ehenene landforms in Ondobe.

There was a difference in tree distribution on landforms identified in Okahao and Ondobe area. This may be due to different properties of landforms, and requirements of different fruit trees. The following tables illustrate the distribution of indigenous fruit trees by land units in the two study areas.

Land units	Species							Total
	Ber di	*Ada di*	*Hyp pe*	*Scl bi*	*Ziz mu*	*Dio me*	*Gre spp.*	
Ehenene	21	1	198	64	4	1	3	**292**
Omutunda	22	2	80	37	5	0	1	**147**
Oluma	0	0	4	0	0	0	0	**4**
Omufitu	2	2	136	107	0	0	7	**254**
Ehenge	0	0	93	41	4	0	0	**138**
Oshitunhu	0	0	7	0	0	0	1	**8**
Omutundathitu	0	0	42	7	0	0	0	**49**
Oshitenenge	0	0	6	2	0	0	0	**8**
Ediva	0	0	11	0	0	1	0	**12**
Total	**45**	**5**	**577**	**258**	**13**	**2**	**12**	**912**

Table 4: Distribution of 912 indigenous fruit trees in different land units in Okahao.

Land units	Species											Total
	Berdi	*Adadi*	*Hype*	*Sclbi*	*Zizmu*	*Diome*	*Grespp.*	*Zimca*	*Vagin*	*Bosal*	*Ficsy*	
Ehenene	5	1	20	10	5	12	0	1	0	0	1	**55**
Omutunda	83	0	120	100	38	210	15	8	18	3	1	**596**
Omufitu	44	1	80	150	9	11	29	65	81	3	0	**473**
Ehenge	21	0	53	50	6	15	5	0	2	3	0	**155**
Ediva	12	0	26	5	5	90	0	0	0	0	1	**139**
Omutunda-henge	14	0	11	11	0	21	0	1	7	0	0	**65**
Total	**179**	**2**	**310**	**326**	**63**	**359**	**49**	**75**	**108**	**9**	**3**	**1483**

Table 5: Distribution of 1483 indigenous fruit trees in different land units in Ondobe.

	Okahao		Ondobe	
	n=	Common Landform placement	n=	Common Landform Placement
Berchemia	45	Omutunda, Ehenene	179	Omutunda
Adansonia	2	Omufitu, Ehenene	5	Omutunda, Omufitu
Hyphaene	577	Ehenene, Omufitu	310	Omufitu
Sclerocarya	258	Omufitu	326	Omufitu
Ziziphus	13	Omutunda	63	Omutunda
Diospyros	2	Ehenene, Okadiva	359	Omutunda
Grewia	12	Omufitu	49	Omufitu

Table 6: The landforms that individuals from each species were most commonly found on. In Okahao, Ehenene was the most common landform, but most species were found often on Omutunda or Omufitu. In Ondobe, Omufitu was the most common landform, but Omutunda was also common. In this area, most species were most often found on both Omufitu and Omutunda.

By comparing two tables from the two-study areas we found that Makalani Palms grow on all landforms, indicating that the Palm can adapt to all land units, although they prefer Ehenene, a type of landform found near pans or in depressed areas where water accumulation occurs, although run-off is high. Okahao has much of this landform, in part because of the extensive system of oshanas well-known in the area. The lack of Ehenene in the Ondobe area, but relative abundance of palms supports the hypothesis that palms can adapt to other landforms and soil types.

Sclerocarya, (Marula) was one of the more common indigenous fruit tree species in both study areas, although we found more individulas in the Ondobe area. Distribution throughout landforms varied between the two areas, possibly due to rainfall variation in two areas or the rate of adaptability of *Sclerocarya* to different landforms. The highest population of *Sclerocarya* was found in Omufitu landform in both areas.

Ondobe has more *Diospyros* (Jackal Berry) than Okahao, possibly due to rainfall variations. Omutunda, the landform it was most commonly found on in Ondobe, is present throughout the Okahao area, and the lack of Jackal Berry in Okahao cannot be explained by a lack of suitable landform.

Of interest is what landform types homestead were found on the farms in both areas. As said, most farmers concurred that Omufitu was the most valued landform, due to high soil fertility and thus good crop productivity. Farmers in both areas tended to place their current homesteads on either Omufitu or Omutunda (Figure 7).

Farmers explained that they chose such homestead placement primarily because they feel safe from flooding. Water does not pond in Omutunda because the landform is associated with high elevation, but instead runs to the lower areas. Omufitu is associated with high filtration capacity.

Farmers often grow fruit trees within the boundaries of the homestead, claiming they grow better there. This is likely because of the protection from livestock and plowing granted by the homestead fences.

Most farmers we interviewed has previous homesteads elsewhere within the farm before they built homesteads in their current locations. Crops and fruit trees in their former settlement areas were of good quality and according to farmers such areas are highly fertile (this is probably a function of the fallow system—after decades of low pressure, the soil has regained fertility).

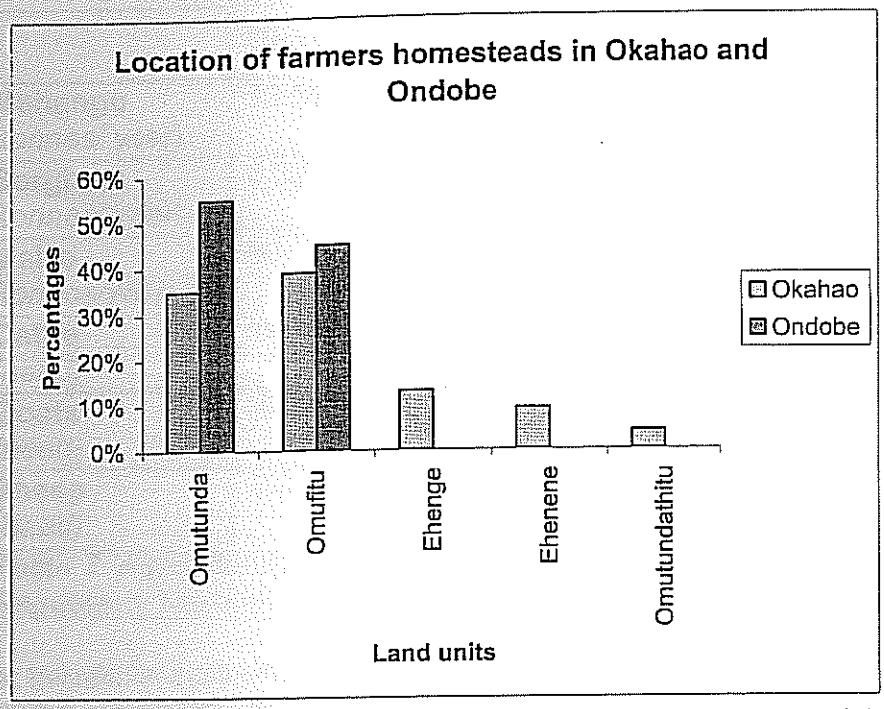

Fig 7: Land units used for location of homestead in Okahao (N=23) and Ondobe (N=20)

3.3 Farming System in Okahao and Ondobe

Because of Nambia's semi-arid climate, most of the land is unsuitable for agriculture. What land that is proper for agricultural production is highly utilised. Namibia's NCR's receive more rainfall than most of the rest of the country, and are therefore much more suited to agriculture. A majority of the Namibian population lives in these northern parts of the country, and is highly dependent on agriculture for their livelihoods. Agriculture in the north central region is mainly rain-fed and the farmers practice subsistence farming.

Population growth, development of private interests, privatisation and commercialisation of a large portion of the communal land are affecting the traditional farming systems in the north central region as the communal land areas become more limited. Agriculture, supplemented by income from migrant labour and pensions, is the basis of the economy of the north central region. (Marsh and Seely, 1992).

The agricultural conditions, such as the quality of soil and rainfall patterns in Ohangwena region (i.e. Ondobe) are better than at Okahao in the Omusati region (Schade et al, 2000). The Ohangwena economy is based on subsistence cropping and livestock farming. In contrast to livestock farming, crop production in the Ohangwena region is less than in other regions such as Omusati region. Mahangu is the main crop in the two regions, followed by sorghum and maize. The latter is of minor importance (Schade et al, 2000).

	Ohangwena	Omusati
Mahangu *(tonnes/ year)*	12.562	43.164
Sorghum *(tonnes/ year)*	4.363	6.564
Maize *(tonnes/year)*	60	184
Cattle *(head)*	198.920	113.819
Goats *(head)*	374.690	265.587
Sheep *(head)*	2.293	16.753

Table 7: Agricultural production in the two regions for the most common crops. Source: Republic of Namibia, 1998 cited in Schade et al 2000.

In traditional agriculture men are often the heads of households, but during our study we found out that women also head households in some villages.

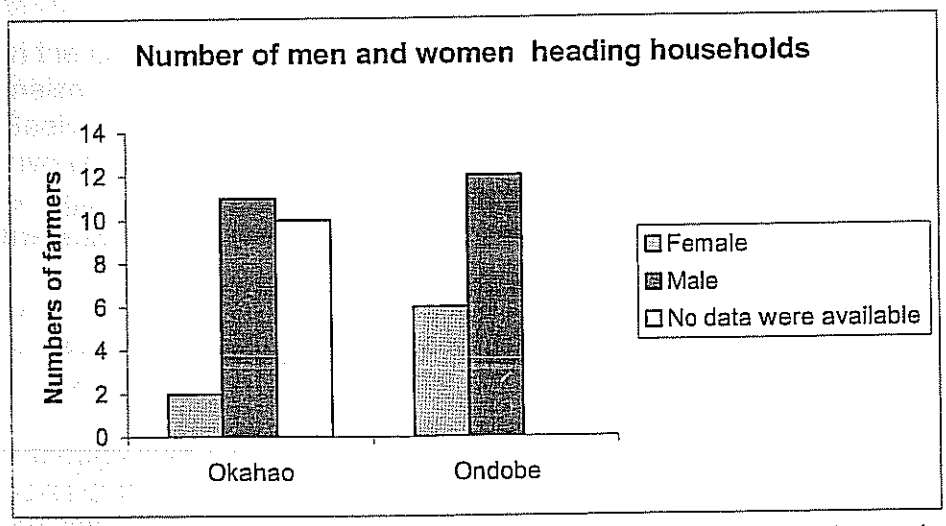

Figure 8: Comparison of number men and women heading households in the study area (Okahao, N=23 and Ondobe, N=20)

Agro-Silvi-Pastoral System

In Okahao and Ondobe, the farming systems are characterized as agro-silvi-pastoral farming systems. The agro-silvi-pastoral system is an integrated farming system practice where trees, crops and livestock interact and benefit from each other in the system.

Farming activities take place at farms with an average size of 16 hectares and approximately 4 hectares of land per farm was under cultivation during the study period.

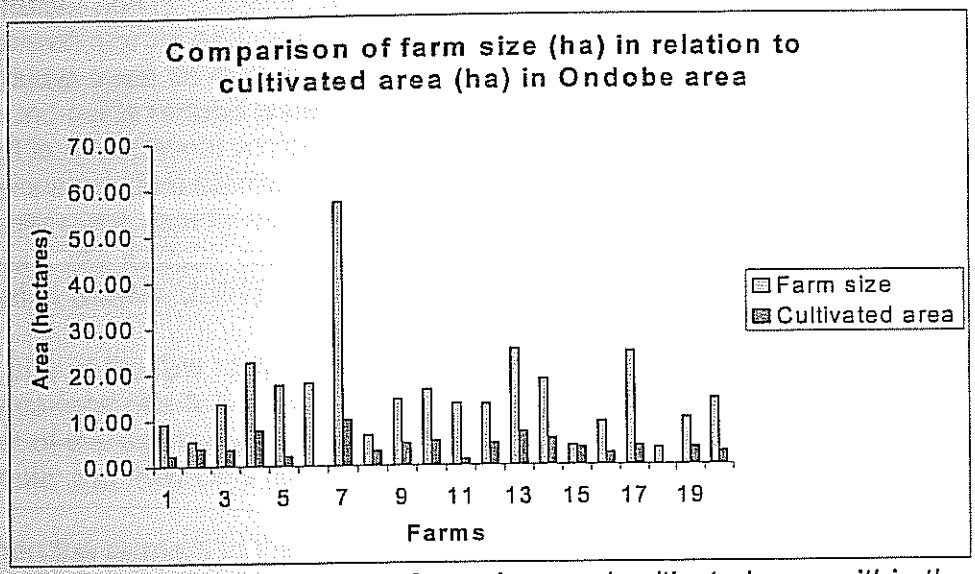

Figure 9: Comparison between farm sizes and cultivated area within the farm in Ondobe area (N=20). In none of the farms is cultivated area a notably large portion of the whole farm area.

In the Okahao area, the crop component consists primarily of mahangu, sorghum and maize. Livestock holdings consist of cattle, goats, sheep and donkeys (Marsh and Seely, 1992). Pigs were also found in the area. Farmers in the Ondobe area are mainly involved in five agricultural activities, mahangu, maize and sorghum growing, and cattle and goat farming. Mahangu growing is the most important agricultural activity. Maize is the least popular because it is not as drought resistant as sorghum and mahangu.

Goat farming is more important than cattle farming in the two areas and it is a major source of meat. Most cattle are kept at cattle posts, especially in Ondobe, often located far away from the homstead and farm.

Although less well-documented, trees play a crucial role in these systems. In many parts of the world, millions of people use a wide variety of products from forests, including fruits, nuts, fibres, resins, wood and oils, to meet their daily requirements for food, medicine, energy and construction materials (DFID). In north central Namibia indigenous fruit trees grow mostly were people settle. People use indigenous fruit trees as a source of food and for building materials, and fodder for livestock. Older farmers are also aware of a strong link between trees and soils. Some farmers say that trees improve soil fertility. The leaves that fall from trees contain nutrients (plant foods) that enrich the soil when the leaves rot (Marsh, 1994). The gathering and storing of wild plant resources is an important means of coping with drought and marginal agricultural production throughout the oshana area (Marsh and Seely, 1992). They also highlighted the value of marula fruits in maintaining nutritional intake among children and the importance of marula kernels as food for old people unable to cultivate large fields.

Marula constitutes not only an important resource in its own right, but also provides important linkages between the daily needs of family life, livestock and crop production (Bottelle, 2001). Experienced farmers in north central are very aware of the relationship between marula and crops and practice a variety of agroforestry techniques. They consider trees as important windbreaks. According to Botelle (2001) marula trees in and around fields reduce water loss, buffer temperature extremes (shade on hot days and frost in exceptional winters) and protect delicate flowers, leaves and young fruits from desiccating dust storms. Some trees like *Ficus sycomorus* have "bad roots" as one farmer put it, rapidly mining moisture and nutrients from soil and harming crops while others, like marula, are favoured because of their less deleterious effects (Kreike, 1995 cited in Botelle, 2001).

As one of the few really big trees in Owambo land—on occasions up to 20 metres tall—the canopy of a full-grown marula tree provides a large expanse of solid shade. In the heat of the day this shade is a welcome resting place for birds, domestic livestock, people and their cars (Botelle, 2001).

When the farmers in the two regions were asked to rank crop farming and indigenous fruit trees, crop farming was ranked first followed by livestock farming and fruit trees were ranked as a last priority.

Relationship between Indigenous fruit trees and farming practices

In North Central Namibia people use indigenous fruit trees as a source of food and for building materials, as well as fodder for livestock. Farmers in both study areas are aware of the relationship between indigenous fruit trees and crop and livestock farming.

There are marked differences in tree biodiversity in the two areas. This can be partially attributed to the differences in rainfall patterns. In the Okahao area the tree component consists of indigenous multipurpose species including Marula, Makalani palm and Bird plum. Palm is the dominant species in the area although Marula is considered the most important of the three because of the valuable fruits it produces and some other uses. *Berchemia* is not abundant in the area but it is considered highly desirable by the residents.

In the north-central fruit trees grow where people settle, particularly in the crop fields. Indigenous fruit trees are established mainly through casual seed dispersal.

	Okahao		Ondobe	
	Yes	No	Yes	No
Do you plant crops under trees? (n=20)	12	8	15	5
Do you allow livestock to browse on trees? (n=21)	15	6	7	12
Do trees improve soil fertility? (n=20)	4	16	2	16
Is there competition for water between crops and trees? (n=21)	12	9	2	17
Is there water enhancement at canopy edge of trees? (n=21)	4	17	1	18
Is there Competition for light? (n=21)	11	10	3	16
Do you apply manure on trees? (n=22)	2	20	2	17
Do you prune trees? (n=20)	12	8	9	9

Table 8: Responses of selected farmers to particular questions in Okahao and Ondobe in the Omusati and Ohangwena regions.

There is a clear relationship between indigenous fruit trees and field crops. Most fruit trees grow in cultivated fields. In Okahao 12 of the 23 respondents grow crops under trees and preferably under male marula and palm trees compared to 15 out of 20 in Ondobe. Male trees are preferred simply because they don't bear fruits, which can cause damage to crops when they fall on crop or when they are harvested. Maize and mahangu are the main crops, which are planted under trees.

Trees are very important as they provide fodder and shade for livestock. In Okahao 15 out of 23 farmers said that they allow livestock to browse on trees during dry periods. Only 5 farmers didn't allow livestock to browse on trees in the crop fields in Okahao.

Farmers in Ondobe believe that Marula leaves are not good fodder for goats and can kill livestock. Only 7 farmers allow livestock to browse on trees compared to 12 who don't.

It was observed that livestock in the Okahao area readily browse on fruit trees as compared to Ondobe area. This is probably because Okahao is drier than Ondobe and grazing is limited.

It is believed that trees improve soil fertility and protect soil from erosion. Trees improve the fertility of the soil when the leaves that fall from the trees rot and add nutrients to the soil. The roots improve the aggregate stability of the soil. Only 4 out of 23 farmers in Okahao said that trees improve soil fertility as opposed by 16 farmers that differed. Only 2 farmers out of 20 in Ondobe indicate that trees improve soil fertility. The reason for this cannot be elucidated by this research.

In Okahao there is little variation between the number of farmers who said that trees compete with crops for water and those who said there is no competition (12 and 9 farmers respectively). Trees have very deep roots compared to field crops and the competition for water between trees and crops is questionable. 17 out of 20 farmers in Ondobe, which said that there is no competition, support this idea.

With regard to water enhancement of soil by trees, 17 out 23 of the farmers in Okahao and 18 out of 20 in Ondobe indicated that there is no enhancement of water at the canopy edge of the trees, which could improve crop yield. Water enhancement can be described as when water intercepted by the canopy drops off slowly after most water has run-off after rain. The drops fall slowly and water penetrates into the soil efficiently. Only 4 farmers in Okahao and 1 in Ondobe said that there is improved yield around the canopy of trees.

Maintenance of soil fertility is very important in the north central. A considerable number of farmers both in Okahao and Ondobe indicated that they don't apply manure to trees (20 out of 23 and 17 out of 19 respectively.) Only 2 farmers in both Okahao and Ondobe apply manure to trees. This can be attributed to the scarcity of manure in the area, because most cattle are herded away from the homestead at the cattle post. Manure is applied to the soil just before the rainy season in preparation for planting and it is obvious that trees also benefit because crops are grown around them even though the farmers said they don't apply it to trees.

Sunlight is an important factor for plant growth. 11 out of 21 farmers in Okahao said that trees compete with field crops for light and as a result there is a poor yield in field crops grown under trees particularly mahangu. In contrast, 10 farmers don't experience a problem with trees with regard to light competition and crop yield. A considerable 16 out 19 of the farmers in Ondobe said trees do not compete with crops for sunlight. Only 3 said that there is competition.

Trees are also a source of fodder for livestock and farmers prune trees occasionally and allow livestock to browse on the branches. In Okahao 12 out of 20 indicated that they prune trees for browse, good canopy cover for shade and for ploughing. In contrast, 8 farmers do not prune trees. In Ondobe there is no variation between farmers that prune trees and those, who don't.

with hot water for 24 hours for better results, however none of the interviewed farmers revealed that they had any knowledge of these practices.

Marula grow easily when treated in the right way. Marula seedlings grow best when sown, but it was not recorded whether Palm or Jackal Berry seeds were sown in the two areas. Palms prefer hardpan type of landform where water can accumulate to ensure enough water for the seed. It can be sown all year round and takes more than two years to germinate. Burning the seed coat or soaking it into water for 24 hours improve germination.

Planting cuttings

This is a practice whereby branches are cut from the mature trees and planted to grow into an individual tree. This method was not reported in Ondobe but at Okahao one of the farmers we spoke to planted two Marula trees from cuttings. According to farmer, one sapling established itself successfully and the other did not survive. Both Marula and Bird Plum can be planted from cuttings but use of bird plum cuttings was not recorded in both areas. Cuttings are collected and planted in early September to October.

Transplanting wild seedlings

Some farmers collected fruit tree seedlings that germinated under mature female trees, or anywhere outside of the cultivated land, and planted them either within the homestead or on the field. This practice was not reported in Ondobe but was mentioned when talking to farmers in Okahao. About 22% of the interviewed farmers employed it. According to *Forestry Awareness and Trees Planting Project* manual, Marula and Bird palm can be transplanted while they are small.

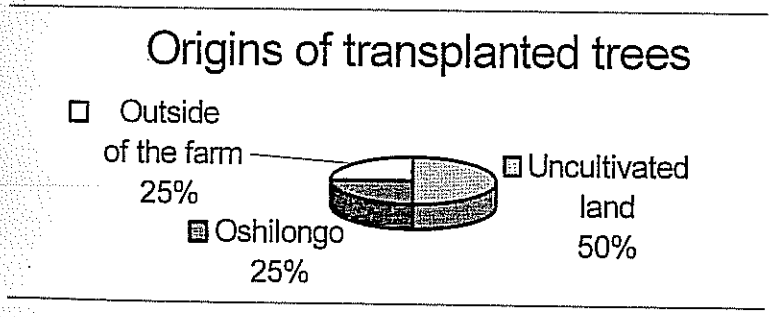

Figure 13: Illustrating origins of transplanted fruit trees in Okahao constituency (n=23).

Recruitment

There are many seedlings that germinate from casual seed dispersal in some fields, especially Palm, Marula and, to a lesser extent, Bird Plums. Many of the seedlings that germinate do not grow into mature trees. Farmers remove most of them during ploughing and domestic animals (goats, donkeys and Cattle)

destroy the rest during browsing. Many Oshivales (palm shrubs) seem not to grow into Palm trees, because livestock browse on them when they are young.

Another factor may be that women collect leaves from young palms for baskets making. This actually damages the young palm trees and may prevent them from becoming mature trees.

For Marula, browsing by livestock is a major impediment to establishment and recruitment. Goats and donkeys, as well as cattle in Okahao, often browse on saplings and browse the lower branches of mature trees, possibly hindering their productivity.

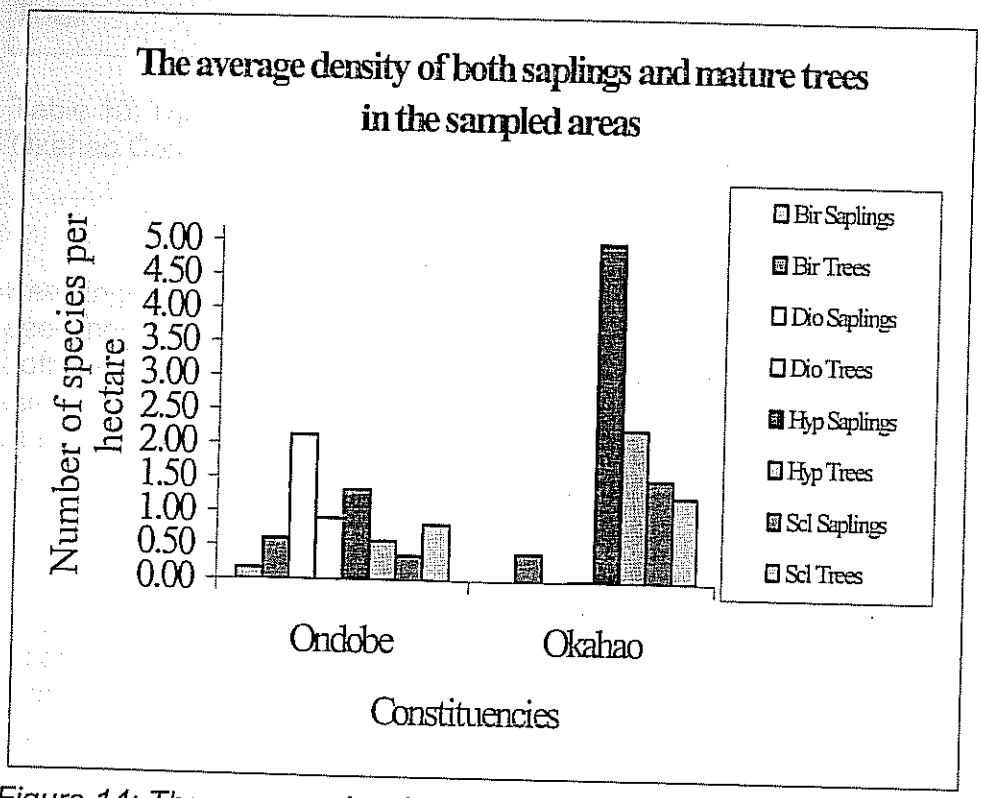

Figure 14: The average density of species on farms studied in both areas.
Keys: Bir= *Berchemia*, Dio= *Diospyros*, Hyp= *Hyphaene* and Scl= *Sclerocarya*.

	Ondobe			Okahao		
Species	**Juveniles**	**Saplings**	**Trees**	**Juveniles**	**Saplings**	**Trees**
Berchemia	8	13	158	4	4	45
Diospyros	40	120	189	0	0	2
Hyphaenea	101	108	100	147	155	317
Sclerocarya	21	36	269	11	80	206
Ziziphus	0	29	46	0	8	8
Total	**170**	**306**	**762**	**162**	**247**	**578**

Table 10: The number of juveniles, saplings and mature trees on farms in Ondobe and Okahao Constituencies.

3.6 Management of seedlings and saplings

Seedlings are defined as plants that are less than 0.3 meters tall and saplings are seedlings that are taller than 0.3 m but less than 1.5 m in height. Generally, farmers in both study areas are known to be doing little on direct management of seedlings and saplings. In north central indigenous fruits are used in various ways for traditional practices. Most protected seedlings and saplings in our study areas were Bird Plum and Marula, as these trees play any important role in nutrition of rural people.

Okahao

Most farms visited have indigenous fruit trees except those farms that have only recently been settled. We found out that new settlers are trying to plant some fruit trees in their fields. In the Oshilongo areas (areas that have been settled for many years and thus have more developed infrastructure, such as roads, schools, piped water and shops), small Palms known as "Oshivale" in Oshikwanyama are found all over in the fields. People in Oshilongo are afraid that palms will become too abundant and compete with their crops, thus farmers are not protecting them.

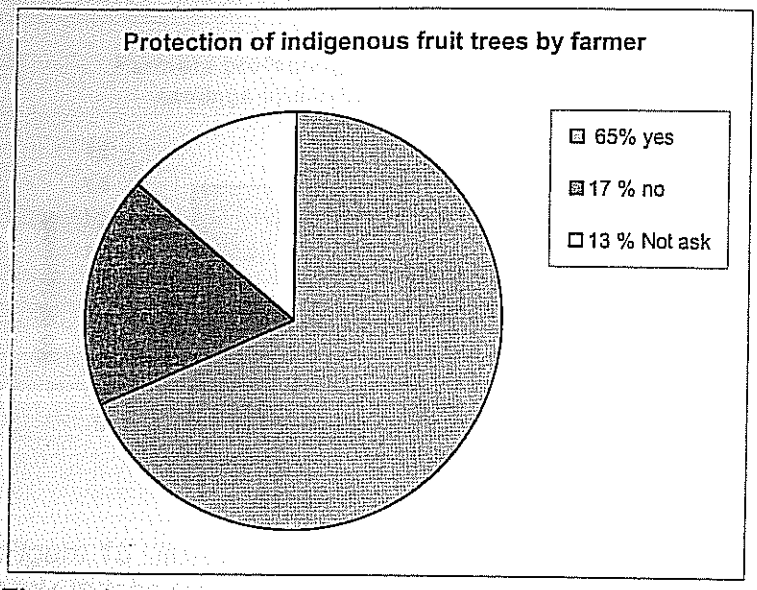

Figure 15: Showing the percentage of farmers (n=23) that protect their fruit trees.

Most people showed interest in protecting their indigenous fruit trees seedlings/saplings. The limiting factor is water and most seedling die or wilt after the rainy season. Some farms have few fruit trees in their fields and they encourage seedlings/saplings growth. In farms with many fruit trees people do not protect seedlings/saplings because they have to secure enough space for crop production. If the seedlings are not protected, livestock will most likely destroy them through browsing.

Ondobe

We observed that farmers in Ondobe are not heavily involved with seedlings/saplings protection. Many fruit trees have grown on the cultivated field and some of them were protected in the homestead until they became mature enough to cope with the browsing pressure. All the directly protected seedlings and saplings were found either on the cultivated field or in the homestead. This may be because farmers in Ondobe do not have livestock browsing their fruit trees as frequently as farmers in Okahao since livestock in Ondobe usually remain at distant cattle posts.

Some farmers are selling Marula nuts and Ombike (liquor made from fermented fruit like Jackal Berry, Ziziphus and Bird Plum fruit) at informal markets. We found that the farmers selling these products were managing seedling/saplings more than those who were not selling any fruit products.

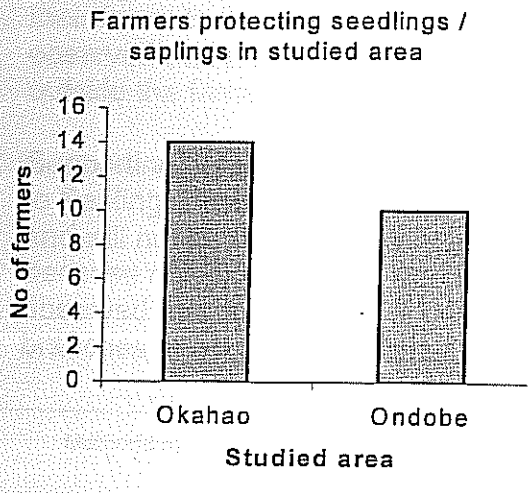

Figure 16 :Illustrating the number of farmers protecting seedlings and saplings Okahao and Ondobe (n= 42).

Comparison of tree protection in the two areas.

Many seedlings emerge annually, but not all of them can grow because some are not protected from browsing by livestock. Twenty-nine out of forty- two interviewed farmers are not doing any direct management activity to protect or encourage seedling/saplings growth. Generally, large proportions of seedlings and saplings in study areas are unprotected. We found that protection usually occurs when farmers want more fruit trees.

Methods of seedlings/saplings management observed in study areas.

- Thorn branch protection: Seedlings germinating in fields are covered with thorn branches to protect them from livestock browsing.
- Applying manure: Manure is applied to seedlings/ saplings to encourage growth; however the practice is not common in the area. Only nine farmers said they apply some manure on their seedlings/saplings.
- Growing trees inside the homestead: This is a common practice in both study areas. Direct and casual seed dispersal is the common method of sowing. Some farmers, especially in Okahao, have transplanted some seedlings from outside the farm to the homestead.
- Pruning: This involves cutting off low branches from sapling to encourage growth. This practice is mostly observed in Ondobe.
- Making wire or wood fence surrounding the saplings: This is mainly done to saplings in the cultivated and uncultivated area within the farm to protect them from livestock

browsing. Some farmers are protecting seedlings/saplings indirect by fencing off their farms to keeps livestock away. This could be one of the reasons why we observed that more indigenous fruit trees are found within the farm boundaries than outside the farms.

- Supporting poles: Staking is one of the management methods used to give support to Saplings. This will help ensure that seedling and sampling are growing straight and will not be damaged by animals during browsing. This practice is not common because only four farmers out of forty-two visited farmers have done it. We have observed that this method is usually associated with pruning and tying some branches to control the canopy shape.

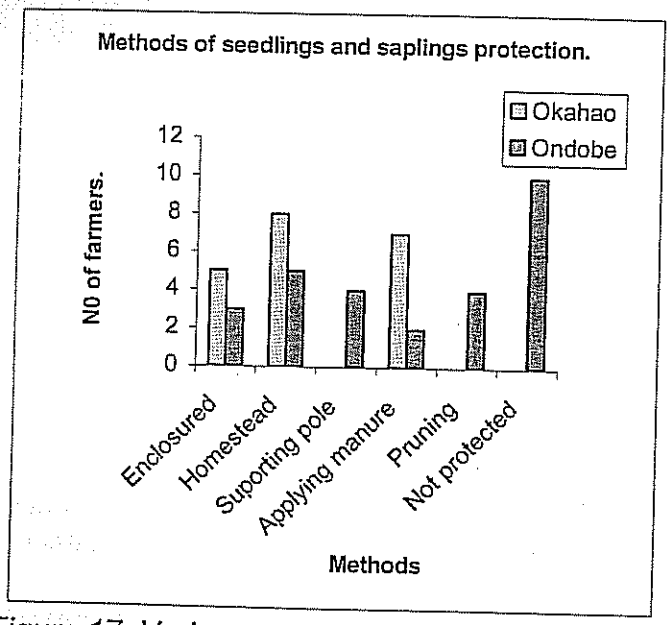

Figure 17: Various methods of seedlings and saplings management (N=42).

Household heading and seedlings/saplings protection

We found no difference in seedling/saplings management whether the family is male or female headed. Protection of seedlings/saplings depends on how many fruit trees are already available in the field. Farmers without fruit trees do more protection of seedlings/saplings compared to those with many fruit trees.

3.7 Fruit tree removal

Many farmers we interviewed said they do not remove fruit trees, citing cultural value or financial benefit. However, those who feel they have enough mature fruit trees do removes seedlings or some mature male trees (mostly Palm). Among 42 farmers interviewed in the surveyed areas, 17 stated that they don't cut fruit trees when ploughing due to their importance. Many farmers

interviewed said that they still need additional fruit trees in their farms. Sixteen farmers out of 42 indicated that they cut down the male trees to manage the sex ratio, because the male trees have no benefit to fruit production. Some stated that they removed those infected by the mistletoe parasite *Tapinanthus oleifolius*. Some farmers find it appropriate to remove trees that do not bear fruits, or to cut non-bearing trees to feed livestock.

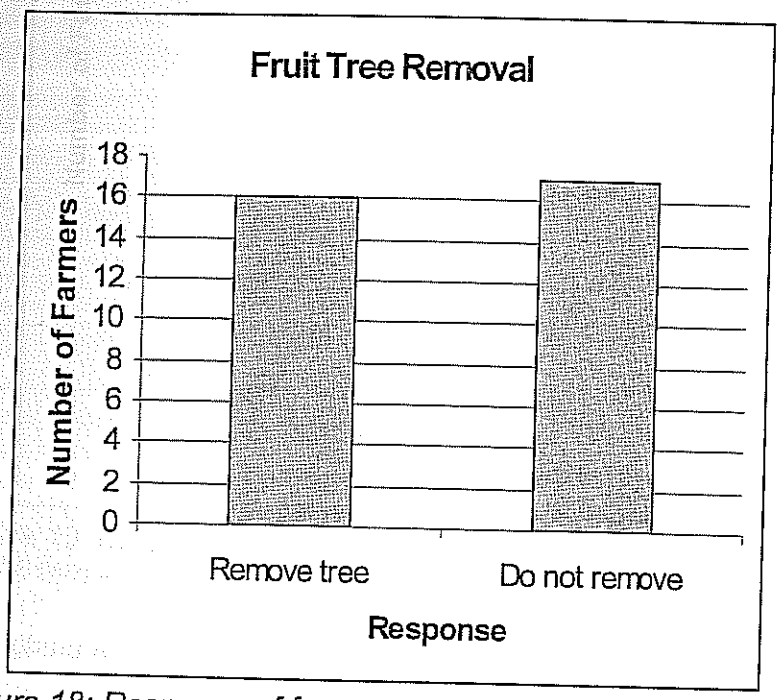

Figure 18: Response of farmers on the removal of fruit trees in Ondobe & Okahao Constituencies (N = 33 farmers).

We observed two ways in which fruit trees were removed, mainly uprooting and cutting down trees. Uprooting is a process whereby farmers remove the whole tree including the roots to prevent re-growth. Seedlings and saplings are uprooted in farms to create space for crops.

Cutting down trees refers to the removal of most of the trunk, but leaving the stump, allowing the possibility of re-growing. Male palm trees are cut to reduce competition with crops. This is primarily done when preparing fields for cultivation.

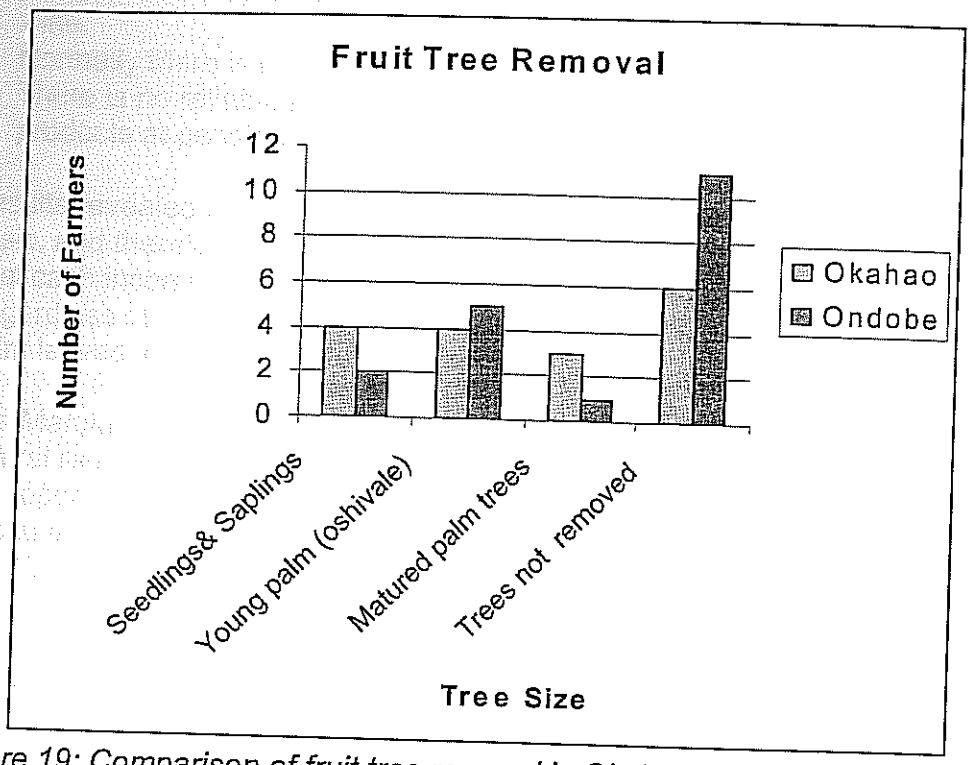

Figure 19: Comparison of fruit tree removal in Okahao and Ondobe constituencies (n=36 farmers)

Ploughing Methods and Fruit Trees

Animal draught power is one of the common methods of ploughing used by many farmers in North Central region. This is a less labor-intensive method, and reduces burden on farmers, while increasing the crop yield by speeding up the work. Large areas can be cultivated in a relatively short time. This method does less damage to fruit trees. Some farmers do field work using hand hoes, which requires high labor input and results in low yields as the method is slow. Many farmers who use hand hoe do not remove fruit trees, as they don't hinder the process of land preparation. Some farmers use tractors for ploughing which is the faster but much more expensive method. Farmers who utilise tractors tend to remove fruit trees to facilitate ploughing.

3.8 Uses of fruit trees

Farmers rank crop production higher in importance than indigenous fruit trees, although they consider indigenous fruits a supplemental food source. Some farmers stated that indigenous fruits are gifts from God and should not be sold. Therefore, many only use fruit tree products for home consumption. Farmers shared fruits with their neighbors instead, especially marula wine. Other reasons for not selling are:

- It is prohibited by their religion to sell alcohol such as ombike (fermented liquor) or wine.
- Normally there is no surplus for sale
- There is no reliable market for fruit tree products and most farmers sell their products at pension distribution, community meetings and at homes on request.

Results revealed that the majority of farmers do not sell their products on a regular basis, and therefore income from fruit tree products constitutes a small proportion of the total cash income. Amongst the most important fruit trees products sold are Ombike (regardless of the religion prohibitions on selling it), Marula nuts and oil, baskets from palm leaves, bird plum fruits and Marula wine.

The Marula tree is regarded as the most important indigenous fruit tree in the north central region. It is valued because of the various products obtained from its fruits. This is supported by Botelle's findings (2001) that state, "Marula is the most important tree because it produces so many things. With marula anything and everything can be used". Almost all the farmers who owned marula trees make use of them.

Marula wine is one of the important products that farmers derive from marula fruits. It has a high cultural value and is traditionally regarded as a drink for men, although women also drink it. Marula juice is meant for children. Other products from marula fruits include nuts and oil. Marula trees also provide shade, shelter, fencing materials and fodder. All farmers who were interviewed stated that marula trees provide good shade. This is also indicated in CRIAA SA-DC report (2001), that "the canopy of a full-grown male or female marula trees provides a large expanse of solid shade to people, animals and also to their cars".

We observed that Marula is the most important tree in both areas because:
- All farmers have them
- They hold a strong cultural value
- They produce lots of fruits
- They are the most non-grain source of agricultural income

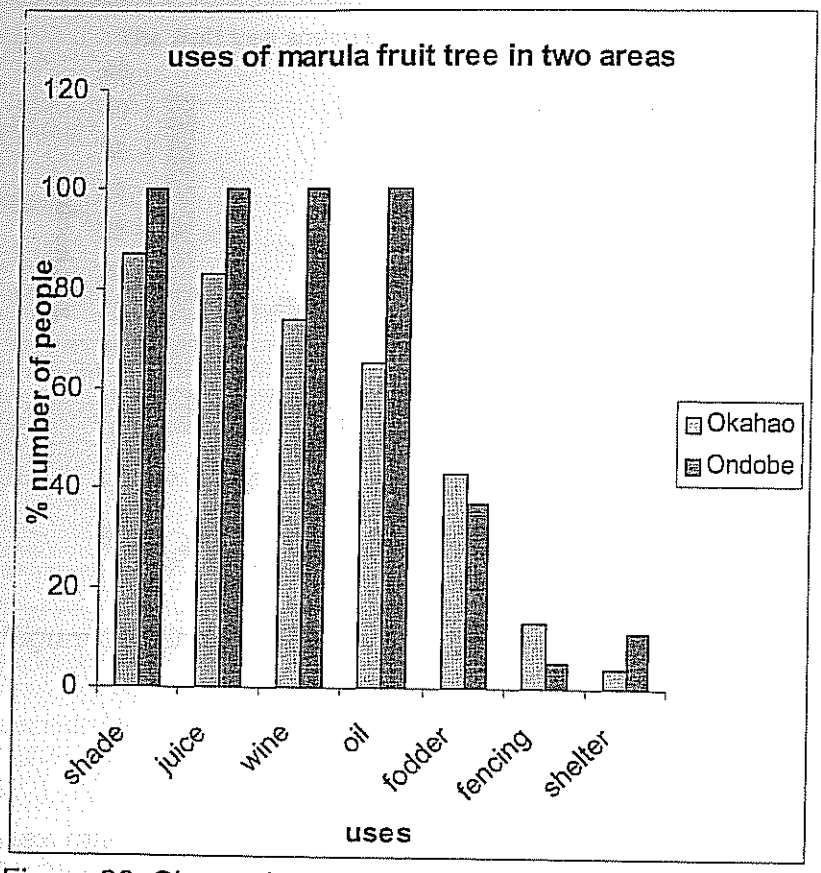

Figure 20: Shows the uses of Marula species in the two areas.

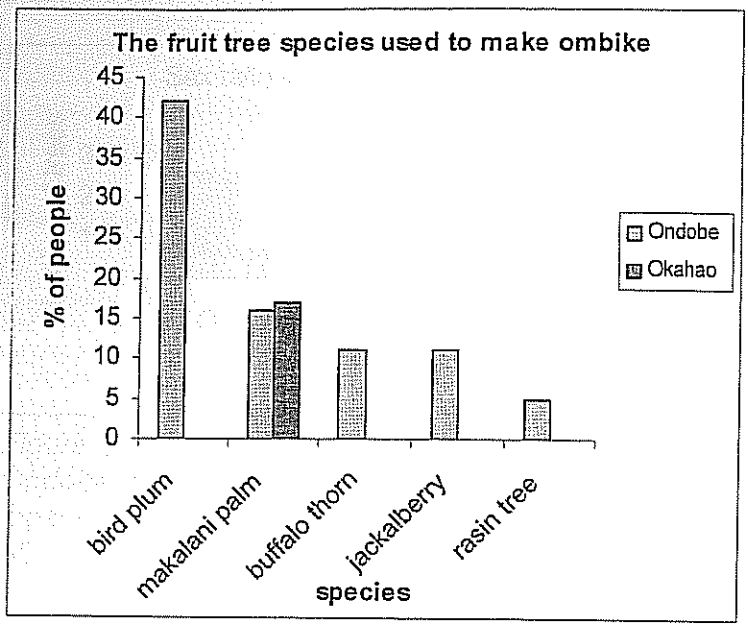

Figure 23: Shows the different fruit tree species used to make Ombike.

3.9 Sex ratio

Sex ratios of the dominant species in Okahao and Ondobe were investigated. In Okahao we found that the number of female Marula outnumbered the males, whereas in Ondobe, the number of males outnumbered the females (Fig 1).

The sex ratio of Palms was also investigated. In Okahao we found that the number of females outnumbered the number of males and in Ondobe the males outnumbered the females. Some interviewed farmers stated that they usually cut down the male trees because they do not produce fruit.

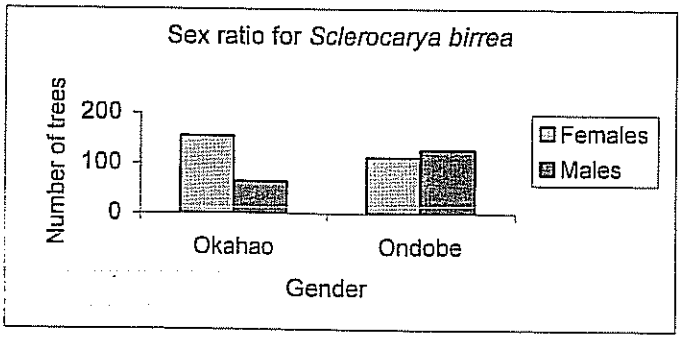

Figure 24: Comparison of sex ratio for Sclerocarya birrea in Okahao (N = 218) & Ondobe (N= 239).

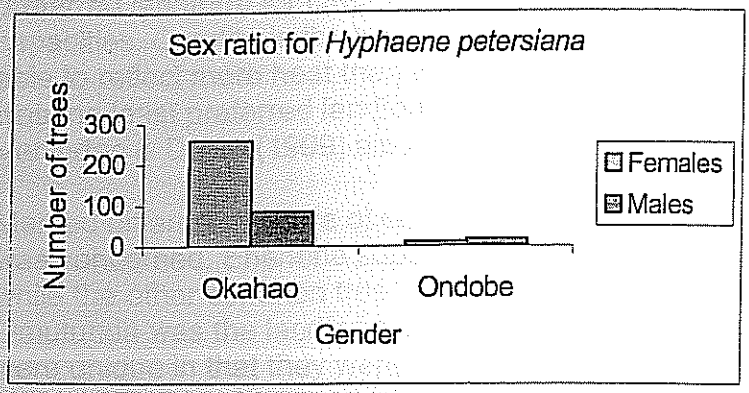

Figure 25: Comparison of sex ratio for Hyphaene petersiana in Okahao (n = 344) & Ondobe (N = 30). The relatively few individuals at Ondobe are resultant of the fact that most palm trees in Ondobe were juvenile, thus impossible for us to determine the sex of.

4. Discussion

Research identified the relationship among fruit trees, landforms and farming systems in north central region of Namibia. This process included data collection in North central Namibia and analysis on both biophysical and socioeconomic aspects in the two study areas.

4.1 Species account

Results indicate that Ondobe may have more indigenous fruit trees than Okahao. Although we sampled fewer farmers in Ondobe, we encountered more trees on the farms than as compared with Okahao. In Ondobe, we found 1483 trees on the farms surveyed, as compared to 1015 trees found on the Okahao farms surveyed. However, we do not know the amount of area surveyed in Okahao, and cannot determine whether Ondobe does have a higher density of fruit trees than Okahao.

From scatter graphs prepared (see fig2, ch.3), for Ondobe and in particular looking at Bird plum and Marula, diameter at 50cm increases with height up to a certain point when the diameter becomes constant. There are many trees with small diameter hence indicating regeneration. Scatter graphs for Marula in Okahao indicate that diameter at 50cm increases very little with increasing height this can be attributed to rainfall differences in the two areas. Large diameter show that most trees are old with very few young trees, consequently little regeneration is observed in Okahao.

4.2 Landforms

Similarities and differences in landforms are evident in the two study areas, with Okahao having more identified land units than Ondobe as recorded in Table X and X. According to the farmers interviewed, a mixture of Omutunda and Omufitu is the

preferred landform for crop production due to its high fertility and different water holding capacities. Omufitu is the preferred soil type under very hot conditions as it is lighter and able to reflect more heat than the darker Omutunda that absorbs much heat. Ehenene was the least preferred landform for crop production. Previous studies on landforms by Verlinden & Dayot (1999) also support this statement.

Marked differences were observed as far as tree distribution on landforms in both areas was concerned. Ehenene supported the highest number of Makalani palm in Okahao while the other common tree, Marula was found mainly in the crop fields. In Ondobe, Omutunda was the landform that supported the highest number of fruit trees. Palm trees were unique in that they were found to be occurring in all the landforms observed in Okahao. The landforms which had a shallow or surface hardpan, supported the least number of tree species in both areas.

This supports the work of Verlinden & Dayot (1999) who first recorded detailed information about indigenous landforms in northern central Namibia. The landforms found here are also much more detailed than those portrayed in atlases as it includes indigenous knowledge on landforms from the farmers interviewed.

4.3 Farming Systems in Okahao and Ondobe

The two areas studied exhibit farming practices characterized by interactions among trees, crops and livestock. Previous research done by Schade et al (2000) indicates that agricultural conditions such as soil quality and rainfall patterns in Ohangwena region (Ondobe) are better than Omusati region (Okahao). Omusati region is suitable for crop farming as evidenced by the results. Mahangu production measured in tones per year is almost four times in Omusati region than in Ohangwena (Schade et al 2000). Livestock production, particularly cattle and goats, is larger in the Ohangwena area than in the Omusati area (Table 7).

There are marked differences in tree diversity in the two areas. This can be partially attributed to differences in rainfall patterns and landforms. In Okahao, dominant species (defined here as species with the most individuals) include Marula, Makalani palm and, less numerous, Bird plum. In Ondobe there is a large variety of indigenous fruit tree species and, apart from the three already mentioned, other fruit trees found include Jackal Berry, *Vagneria infaasta* (Mountain medlar), *Ziziphus mucronata* (Buffalo thorn), *Ximenia caffra* (Sour plum) and *Grewia sp.* (Raisin bush). The dominant species is Jackal berry.

4.4 Farmer typology

Our results indicate that males head most of the households. Female members headed thirteen of the households we interviewed, usually an older woman whose husband had passed away, lived on another household with another wife, or was working in another part of the country.

are those of bird plum and Marula due to increased use of their products in comparison to other fruit trees. Fruit trees were numerous particularly in the cultivated fields in the two areas .In the newly settled farms in Okahao, there were no trees but a few saplings have been established in the fields and protected mostly by building enclosures around them. Most people showed interest in promoting growth of seedlings and saplings. We observed many fences that were put up as a way of protecting fruit trees. However, one limitations in protecting and managing juvenile fruit trees mentioned by some farms was a shortage of water. Others mentioned that cropping is more important, and although they may want to protect juvenile fruit trees to ensure their survival, they will remove small trees found in cultivated areas to ease plowing.

In Ondobe many fruit trees occur on cultivated fields, while some are protected in the homestead until such a time that they are mature enough to withstand browsing or stand on their own. Farmers selling Ombike (liquor made by distilling fermented fruits) and Marula nuts were found to manage seedlings and saplings in contrast to those who don't sell these products, this could be due to the economic importance of these fruit trees to their livelihoods. (Fig4, ch, 3), (Shikongo, pers.comm.)

We recommend that further research should be aimed at identifying the economic importance of fruit tree products as alternative sources of income to farmers. This may directly influence the rate at which seedlings and saplings are protected.

4.7 Tree removal

According to most farmers interviewed in the two study areas, they do not cut down fruit trees already established, citing cultural and economic benefits. Farmers in Okahao however expressed the need for more fruit trees. Farmers are sometimes forced to remove trees when they hinder crop cultivation in order to facilitate ploughing especially by tractors. They may remove trees infested by plant parasites and may also remove male trees due to the fact that they don't produce fruit. This latter approach leads to many more female trees than male trees possibly affecting pollination and genetic diversity negatively.

4.8 Tree uses & Marketing

In both study areas, crop production is given more priority that fruit trees, and fruit trees are seen as an alternative source of income, especially during periods of food scarcity. The different fruit trees have various uses. Some of the uses for Makalani palm include harvesting fruit for eating and also for feeding donkeys, leaves for weaving baskets, hats, and mats. Cut trunks are used to make water troughs for livestock, and other uses include using the wood for fencing and fuel. In Ondobe most palms are young and not widely used. Bird plum trees are used for shade, fodder, fencing and shelter. Fruits of the Bird plum are used to make Ombike and dried fruits can also be crushed to make porridge called Oshihendendemba.

Some farmers considered fruit trees to be gifts from God, and therefore felt they should not sell such products but only use them for home consumption or for sharing with neighbors. This view was evident especially for Marula wine. According to Botelle (2001), the Marula tree stands out as the most important indigenous fruit tree in North central region due to various products that can be made from the fruits and tree products. At the moment, the majority of research on indigenous fruit trees focuses on Marula. Uses of the Marula tree include shade, juice, wine, oil, fodder, fencing and shelter. (Fig11).

Currently, the market of fruit tree products is very limited. One cooperative exists that markets Marula nuts, but we found no other official markets for any other fruit tree products in the area. Some may gain income from Marula through the sale of Ombike through unofficial markets to neighbors or other village residents. Farmers in both areas often only produce Marula byproducts for home consumption. Only a few farmers interviewed sell products on regular basis. As a result, income from fruit tree products constitutes only a fraction of farmers' income. Further research on marketing of other fruit tree products might prove beneficial to farmers in the two regions.

5. Conclusions

- Although less well documented, indigenous fruit trees play a crucial role in the farming systems in north central Namibia.
- Most fruit trees were found inside farm boundaries. We conclude that fruit trees grow where people have settled and are thus in the hands of farmers.
- The markets for fruit tree product are limited, apart from Marula nuts, and there is a need for intensifying a market for indigenous fruit tree products.
- Marula constitutes not only an important resource in its own right, but also provides important linkages between the daily needs of family life, livestock and crop production (Bottelle, 2001). Experienced farmers in the Owambo area are very aware of the relationship between Marula and crops and practice a variety of agroforestry techniques.
- Farmers are not aware of the importance of male fruit trees and they are cutting down male trees. This could have long-term repercussions for pollination success if the few male trees are distant from most of the female trees. It could also degrade genetic diversity.
- Local landforms influence the distribution of Indigenous fruit trees in the north central regions.
- This research has made a step of identifying and recording the value and utility of different indigenous land units found within farmer's boundary in Okahao and Ondobe. Such skills and knowledge are important for understanding the

- The Farm Forestry Programme should be intensified. This could include organisation of education and outreach supporting the planting, protection and management of fruit trees.

In conclusion, we believe that fruit trees are dependent on farmers for establishment and survival. Due to the growing importance of the cash economy in many of these rural areas, fruit trees are becoming less important to the farmer because they may not provide direct sources of off-farm income.

What fruit trees do offer farmers are a form of security for drought or other times when crops may fail. Fruit trees then become more important as foodstuffs, and the sale of byproducts made from these trees becomes a larger part of the income generated. It is therefore essential that these indigenous fruit trees continue to exist. There is question as to whether regeneration of many of these species occurs naturally, to which we cannot answer. Our results indicate that regeneration is still happening, but most likely due to the casual dispersal of seeds by humans. More research is needed, but indigenous fruit tree populations may be almost entirely dependent upon humans for their survival.

Therefore, farmers and communities are responsible for ensuring the sustainable use and management of this valuable indigenous resource. From talking with numerous farmers from the areas our study focused on, indigenous fruit trees have cultural and historical value to the communities. This is seem mostly in the vast knowledge held by elders of the population on the fruit trees. These trees are also valuable for the stability and diversity of income generation they offer their owners. On the whole, indigenous fruit trees signify an untapped market which can provide farmers with off-farm income from the sale of juice, oil, fruits, baskets and other byproducts. The Marula market initiated by CRIAA and the Eudaphano Women's Cooperative is an excellent example of how infrastructures can be developed to market indigenous fruit tree resources, providing people in rural areas with alternative income opportunities.

We encourage others to continue research on these topics in the North Central Regions of Namibia. As already stated, future research could explore the potential of expanding current markets and establishing new markets for current and new fruit tree products. Conservation of indigenous fruit trees will depend upon farmers making a decision to keep such trees on their farms. If such trees have a market value that the farmers would easily be able to tap into, they may be more willing to keep fruit trees on their farms.

One could also study the causes of the differences in quality of fruit trees and thus fruit tree products. Many farmers claimed that some of their trees produced very low quality fruits. If ways could be found to propagate high quality fruits, many farmers would benefit. Similarly, the genetics of indigenous fruit trees should be researched. Because of the intense cutting down of male trees, genetic diversity of many species may be falling. This could be related to poor quality fruits, or could have many other potential repercussions.

Most importantly, more research should be conducted on effective and efficient planting and management techniques. Determining the best method of planting fruit trees (casual seed dispersal, planting cuttings, grafting, etc.), as well as the best place to plant fruit trees could provide valuable information to farmers. This study has done some preliminary work in determining what landforms fruit trees grow in. This work should be followed up with research looking specifically at landforms and fruit tree interactions. This information, along with basic information on watering, pruning and protecting fruit trees, should be shared with farmers.

Indigenous fruit trees are a valuable under-developed resource in the North Central Regions of Namibia. Indigenous fruit trees are beautiful symbols of Namibia, and care should be taken to preserve them. We hope this research has added information to the larger effort to study and preserve indigenous fruit trees and the traditional knowledge and practices surrounding them.

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9. Appendices

Appendix 1: Socio-economic questionnaire

HISTORY

- How long have you (or your family) been living here?
- What kinds of fruit trees do you have access to?
- Did you find all the fruit trees here or have you planted some?
- How long is it from planting to fruit production?
- Was the land chosen because of the fruit trees on the land?
- What trends have you noticed in the fruit trees since you started living here?
- Is there any form of ownership of fruit trees?
- If yes, who owns the trees?
- If there is ownership of trees, do the owners share the fruits?
- Is there any permission needed to harvest the fruits?
- Is there any management of trees outside the farm?
- Are fruit trees managed at the community level?
- How do people in the area conserve indigenous fruit trees?
- Who has access to the trees (men/women)?
- What is the relationship between farming practices and fruit trees?
- Do you clear all the fruit trees when preparing land for cultivation?
- What season do different trees start fruiting?
- What types of landform are found on this farm?
- How does the landform influence the distribution and growth of the fruit tree?
- Is the soil where fruit trees grow more productive, less productive or the same as soil where crops grow?
- How does rainfall influence the fruiting of indigenous fruit trees?
- Are fruit trees a more or less reliable source of food than field crops?
- What season do different trees start fruiting?
- Is there annual variation in fruit production? What do you think contributes to this variation?
- What is the harvesting season?

MANAGEMENT:

- How do fruit trees interact with crops? Is this interaction good or competitive?
- Which trees regenerate and how?
- How often do you plant trees? What type of fruit trees?
- Do you encourage trees sprouting on their own?
- Have you, do you or would you protect young fruit trees? Which species? How (protection, water, manure)? Where?
- Do you cut any fruit trees? Which species? Which gender? Why?

PRODUCTIVITY

- Are individual trees ranked for productivity? Quality?
- How do you measure productivity, i.e., by bags or in other ways?
- What is high and low productivity for each tree species?

HARVESTING /USES

- What do you get from your fruit trees?
- Do you market fruit tree products?
- Are there other uses for these fruit trees?
- What is the harvest season for each fruit tree species?
- How often do you harvest?
- Who harvests?
- What are the harvesting techniques?
- What time of day is harvesting done?

Appendix 2: Bio-phyisical questionnaire

Biophysical Data Collection Sheets: SDP 11

Vehicle: _____ Data collectors:

_____

Date: _____ Location:

_____

Tree #	Way Point #	Species & Gender	Sample #	Land-form	Oshivale?	Height (m)	Canopy Diam. (m)	DBH @ 50 cm	Remarks

Appendix 3:Characteristics of Indigenous Land Units in Okahao and Ondobe

Ehenene
From Okahao and Ondobe farmers defined Ehenene as the type of land unit that is low lying and it is mostly found along pans and depressed areas. This land unit is considered unsuitable for crop production and it usually has fewer grasses that cannot support animals for long. Soil in this land unit is found to be light grey in colour and it is sandy with little organic matter content. In Ehenene soils hardpan is only a few centimetres below the surface. The area is subjected to sheet erosion and runoff.

Ehenge
The area is even in texture. It lies on higher ground than Ehenene but much lower than Omutunda. The colour of Ehenge topsoil is light grey with soft sand dominating the area. Ehenge has a low level of organic matter content. Farmers in Okahao and Ondobe add manure on the Ehenge to supplement soil fertility of their fields. The level of hardpan in Ehenge is deeper than in Ehenene. It is 1-2 m below the surface.

Omufitu
Farmers in Okahao and Ondobe define Omufitu as the type of land unit that is covered by a great proportion of loose, well drained sandy soil. Soil in Omufitu is yellowish in colour and it is associated with less clay and silt particles. Omufitu soil has less water holding capacity and higher leaching percentage than Omutunda. This land unit provides the highest crop productivity with high rainfall.

Omutunda
The Omutunda type of land unit is characterised by sandy loamy soil. It has a moderately loose soil and it is suitable for crop production. Omutunda land unit has high organic matter content. It is moderately drained with dark brown soil colour. Soil is well aerated with moderate moisture content and the hardpan is known to be a bit deep at a depth of more than 1m. This land unit provides the highest crop productivity with lower rainfall.

Ediva/Okadiva
This is a widely open water catchments area landform. Ediva is commonly covered by *Cyperus spp* and it is prevalent in the study areas.

Oshitunhu/Etunu
It is on higher elevated areas. Its soil is hard and compacted. The soil colour of Oshitunhu varies from reddish to dark greyish with higher organic matter content. Farmers in two-study area use Oshitunhu soil for clay bricks making. Oshitunu is known as termite mound area as termites make it up and it is where they live. Some farmer explained, "Crops planted in Oshitunhu yield much better than those planted in other parts of the field".

Omutundahenge

Omutundahenge is the transitional zone between Omutunda and Ehenge elevation. This land unit comprises of less sand with more organic matter than pure Ehenge. Hardpan in Omutundahenge is found a few metres below the surface as compared to Ehenge where the hardpan is deeper.

Omutundathitu
Omutundathitu is the transitional zone between Omutunda and Omufitu elevation. This land unit is comprised of less sand and has more organic matter than pure Omufitu. Hardpan in Omutundathitu is found a few metres below the surface as compared to Omufitu where the hardpan is deeper.

Oluma
These are clay soils that accumulate in depressions (Alex *et al.* 1999). The hardpan is also called Oluma. This suggest that the hardpan is made out of clay particles. The colour of Oluma soil particles is dark grey. The area collects water during wet seasons and produces surface crust and finally cracks in dry seasons. The area has higher organic matter contents, higher water holding capacity and higher potential for water logging. Due to different characteristics of Oluma farmers explained the area as suitable for sorghum production.

Oshilongo is the area where people have settled after many years and there is more developed infrastructure such as schools and clinics. The opposite of this term is **Okuti.**
Uncultivated land is a portion within a farm premises where the farmer doesn't cultivate for crop production but is left mostly for grazing.
Oshimolo is the area (now in Angola) where Kwanyama people take their cattle for grazing purposes.
Out of farm **is the unenclosed communal area, for public use.**