THE ENVIRONMENT OF THE OKAVANGO REGION:
AN ASSESSMENT
FOR THE CANAMCO/OXFAM-CANADA DEVELOPMENT PROGRAMMES

PREPARED FOR: CANAMCO
P.O. BOX 50261
WINDHOEK
NAMIBIA

BY: C. F. LEE
ENVIRONMENTAL INFORMATION SERVICES
P.O. BOX 22527
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CONTENTS

1. INTRODUCTION .................................................. 1
   1.1 THE STUDY .................................................. 1
   1.2 DISCUSSION OF THE TERMS OF REFERENCE ............ 1
   1.3 METHODOLOGY .............................................. 2
       1.3.1 Desk Study ........................................... 2
       1.3.2 Field Survey .......................................... 2

2. THE BIOPHYSICAL ENVIRONMENT ............................. 3
   2.1 NATURAL RESOURCES ...................................... 3
       2.1.1 Geographical position and topography ............ 3
       2.1.2 Geology ............................................... 5
       2.1.3 Climate ............................................... 5
       2.1.4 Hydrology ............................................ 12
       2.1.5 Soils ................................................. 15
       2.1.6 Vegetation ........................................... 17
       2.1.7 Fish .................................................. 25
       2.1.8 Wildlife .............................................. 26
   2.2 HUMAN RESOURCES ........................................ 27
       2.2.1 Population distribution and density ............ 28
       2.2.2 Land tenure ........................................ 28
       2.2.3 Infrastructure ...................................... 30
2.3 AGRICULTURAL RESOURCES ............................................. 32
2.3.1 Livestock production .................................................. 32
2.3.2 Crop production ....................................................... 36
2.3.3 Vegetable farming ..................................................... 39
2.3.4 Fish farming ............................................................ 40

3. THE CANAMCO/OXFAM-CANADA PROJECTS ............................ 42
3.1 THE CANAMCO/OXFAM-CANADA PROGRAMME ....................... 42

3.2 AGRICULTURAL DEVELOPMENT ....................................... 43
3.2.1 Livestock farming ....................................................... 45
3.2.2 Dryland crop farming ................................................ 47
3.2.3 Vegetable farming ..................................................... 52
3.2.4 Fish farming ............................................................ 56

3.3 DEVELOPMENT OF FOREST RESOURCES ............................ 57

3.4 EMERGENCY BOREHOLE PROGRAMME ............................... 59

3.5 EMERGENCY SEED DISTRIBUTION .................................... 62

4. CONCLUSIONS .............................................................. 63

REFERENCES ........................................................................ 66

APPENDIX 1 ........................................................................... 70
1. INTRODUCTION

1.1 THE STUDY

The CANAMCO/Oxfam-Canada programme was initiated soon after Independence in 1990. The programme has focused support on food self-sufficiency through agricultural development within the Okavango Region. The programme was formulated through a consortium of Canadian aid agencies, led by Oxfam-Canada and was launched in late 1991 on a two year basis. A part of the funding requirements of the programme was that an environmental assessment of the programme interventions be carried out.

Initial Terms of Reference (ToR) were drafted by programme staff (specifically Peter Meisenheimer) and a draft proposal from Environmental Information Services was submitted in January 1993. The ToR was revised and the Consultant was appointed in late March 1993. Final ToR (Appendix 1) were received on 7/5/93.

1.2 DISCUSSION OF THE TERMS OF REFERENCE

The final ToR were formulated over sever months of informal discussion and proposals with the CANAMCO/Oxfam-Canada programme staff. The staff member most involved with this process was Mr. Peter Meisenheimer, the Programme Manager up until March 1993.

The ToR were formulated using the guidelines laid out in “Namibia's Environmental Assessment Policy” (Anon. 1993). The basic departure point of this document is that there is a fundamental need for economic and social development in Namibia, that any development should recognise (and plan accordingly) the requirement for responsible management such that the environmental base of the development is not degraded in any way. The term Environment in this report is broadly interpreted to include the biophysical, social, economic and political factors pertaining to the development area.
The study has been broadly divided into two main sections. The first section (Chapter 2) is a review of the biophysical environment of Okavango and the influence this has on the agricultural and socio-economic systems of Okavango. The second section (Chapter 3) is an assessment of the environmental implications of the CANAMCO/Oxfam-Canada projects in Okavango, and recommendations are made under each sectoral review.

1.3 METHODOLOGY

1.3.1 Desk Study

The desk study was primarily involved with the collection and collation of published information on the Okavango Region. Aerial and satellite photographs were also assessed with regard to relevance to the current study. Although there is a large body of information available on the region, only selected references are cited as many of the reports are outdated and of little relevance to the current situation. For an exhaustive listing of references relevant the Okavango region refer to:

Unpublished MA thesis, Department of Geography, University of Stellenbosch.

1.3.2 Field Survey

The field survey of the CANAMCO/Oxfam-Canada projects was undertaken from 13/05/93 to 08/06/93. The principal undertakings during this phase were:

- review of all relevant project documents and files at the Rundu office
- review current and proposed project interventions with staff and in the field
- visit all project sites where interventions were underway
- discussions with programme staff
- discussions with programme participants
- discussions with non-participant members of the public
- discussions with other NGO staff
- discussions with government agency staff.
2. THE BIOPHYSICAL ENVIRONMENT

2.1 NATURAL RESOURCES

2.1.1 Geographical position and topography.

The region under review in this report constitutes the entire region formerly known as Kavango (Figure 2.1). This area of 4.6 million hectares is generally flat with an average altitude of c. 1100 m a.m.s.l. The slope is north-east trending with a fall of c. 190 m from the highest point in the south-west to the lowest point on the Okavango River in the north-east (Page 1980).

Four major topographic units can be defined. These are:

1. The Okavango River with its associated floodplains. The floodplains can range in width from a few metres to a few kilometres. The floodplains is seasonally inundated by floods which start in December and reach their peak in March/April.

2. The river terraces, which lie above the level of seasonal flooding. These terraces are comparatively fertile and represent some of the best agricultural soils in Okavango. In some areas erosion, due to deforestation and poor agricultural practices is a problem.

3. The omarimba are fossil drainage lines with a generally west-east orientation (some are north-south, e.g. the Omuramba Omatako), dissecting the Kalahari sand deposits.

4. The extensive Kalahari sand deposits which form a broad "plateau" south of the Okavango River. These sands are nutrient poor and there is little surface water in the Kalahari sand areas.
The lack of surface water, the nutrient poor conditions and problems of access in the Kalahari sand areas has determined to a large extent the fact that human settlement is highest along the Okavango River and certain omarimba where surface water and arable land are available.

2.1.2 Geology

The geology of Okavango is largely obscured by the extensive windblown Kalahari sands. These deposits can be in excess of 300 m deep in parts (Hegenberger 1982). Apart from limited outcrops of Nosib quartzites (Damara sequence) around Andara and Popa Falls, there is little surface expression of pre-Kalahari deposits in Okavango.

The regional geology, therefore, has little influence on settlement patterns and agricultural practices in Okavango. Certain features of the Kalahari deposits, such as hard pan calcrites and ferricretes (ouklip), affect drainage characteristics of soils and hence agricultural practices, but this is usually localised.

2.1.3 Climate

The climate of Okavango can be described as being sub-humid with an average annual rainfall of between 450-600 mm. The climatic year is broadly divided into a long cool, dry season (7-8 months) and a shorter hot, wet season (4-5 months). As outlined, rainfall is markedly seasonal with about 90% of the annual total falling between November and March, and is further characterised by a high degree of spatial and temporal variability, both within and between years. This pattern of rainfall has a direct impact on the growth of vegetation, the flooding patterns of the river and patterns of groundwater recharge. This, in turn, determines to a large extent the biological and cultural cycles in Okavango.
Figure 2.2. Wet season rainfall totals (mm) expressed as a deviation from the mean (589.3 mm) for Rundu for the recording period 1940-1992.
Rainfall usually occurs as a discrete seasonal event and superimposed on this is a high level of spatial and temporal variation. As rainfall is the factor limiting the rate of plant production in these systems (grazing resources as well as crops), the seasonality and variability of rainfall has important implications for the management and improvement of agricultural practices. Rainfall is "patchy" and so inputs are not constant in any one place thus complicating the agricultural year. There are a number of climatic factors important in determining the annual production of crops and grazing, these are total rainfall per season, number of rain-days and the distribution of rain on these rain-days.

Figure 2.2 shows the total annual rainfall totals (wet season May-May) for Rundu for the length of the recording period. It is clear that there is a considerable amount of interannual variation in total rainfall and that "droughts" are a feature of the region. This in itself is difficult for a farmer to deal with (cannot rely on the rainfall), but far more important for the farmer is the distribution of the rainfall within any one year as this affects how crops will grow (how it falls determines the length of the growing season).

Table 2.1 shows the distribution of monthly rainfall, number of rain days per month and total rainfall and rain days for three stations in Okavango in the 1963/64 rain season. This rainfall season is used here as an extreme example of the considerable variation in these parameters between the three stations within a single wet season.

<table>
<thead>
<tr>
<th></th>
<th>SEPT</th>
<th>OCT</th>
<th>NOV</th>
<th>DEC</th>
<th>JAN</th>
<th>FEB</th>
<th>MAR</th>
<th>APRIL</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ANDARA</strong></td>
<td>1.1</td>
<td>40.0</td>
<td>197.6</td>
<td>72.6</td>
<td>24.0</td>
<td>23.5</td>
<td>31.5</td>
<td>0.0</td>
<td>329.7</td>
</tr>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(10)</td>
<td>(8)</td>
<td>(4)</td>
<td>(2)</td>
<td>(5)</td>
<td>(9)</td>
<td>(31)</td>
</tr>
<tr>
<td><strong>RUNDU</strong></td>
<td>0.0</td>
<td>42.0</td>
<td>74.1</td>
<td>108.3</td>
<td>47.1</td>
<td>7.5</td>
<td>76.0</td>
<td>3.0</td>
<td>351.2</td>
</tr>
<tr>
<td></td>
<td>(0)</td>
<td>(2)</td>
<td>(9)</td>
<td>(10)</td>
<td>(7)</td>
<td>(3)</td>
<td>(8)</td>
<td>(1)</td>
<td>(41)</td>
</tr>
<tr>
<td><strong>NKURENKURU</strong></td>
<td>10.5</td>
<td>7.9</td>
<td>111.4</td>
<td>72.3</td>
<td>109.5</td>
<td>47.6</td>
<td>10.1</td>
<td>10.7</td>
<td>650.0</td>
</tr>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(19)</td>
<td>(9)</td>
<td>(11)</td>
<td>(10)</td>
<td>(11)</td>
<td>(3)</td>
<td>(60)</td>
</tr>
</tbody>
</table>
Figure 2.3. The number of rainfall days per rainy season at Rundu expressed as a deviation from the mean (65 days), for the length of the recording period 1940-1992.
Figure 2.4. Peak rainfall months in different years, illustrating the rainfall peak variability at Rundu.
In Figure 2.3 the number of rain-days per year can be clearly seen to be highly variable, but more important for the farmer is the monthly distribution of rainfall within any one year. Figure 2.4 illustrates the distribution of monthly rainfall in Rundu for a number of years. The peak rainfall month can differ from year to year. At Rundu November had the highest rainfall in 6% of 51 recorded rainy seasons, December 14%, January 13%, February 39%, March 14% and April 2%. This variability has a great effect on crop success, productivity and harvest. The upper two graphs (1983/1984, 1970/1971) illustrate years with a good distribution of rainfall for crop production. The 1959/1960 and 1971/1972 graphs illustrate rainy seasons where rainfall peaked late probably resulting in depressed yields. The lower graph (1950/1951) illustrates another extreme which farmers have to deal with - late rains, which affects the harvest of mature plants.

Potential evaporation rates are high in Okavango (Table 2.2) (Crerar & Church, 1988) and exceeds average annual rainfall by up to five times. Using these data an approximation of potential evapotranspiration of plants can be determined. Table 2.2 shows that at Rundu there is a nett water deficit for all months of the year except February. With a nett annual water deficit of c. 1 200 mm it would be true to say that dryland cultivation of crops is a high risk undertaking, even in years of average and above rainfall (calculations in Table based on long term averages). This risk is moderated through the adoption of adaptive strategies in farming systems.

From the above discussion, the patchy nature of the resource (in this case rainfall) is clearly illustrated, the implication being that farmers in Okavango require a great deal of flexibility and adaptability within their farming systems if they are to maximise their chances of realising a reasonable crop. Farmers in the region do have systems that make allowances for the variability of rainfall. For example, several types of grains are grown, and within those a number of varieties with different growth characteristics are grown. This strategy allows for at least some of the crop to be harvested in poor rain years. Care should be taken in development projects not to undermine the basis of the flexible farming systems through the promotion of a single practice at the cost of the multiple option approach to traditional agriculture.
Table 2.2  Average monthly rainfall (mm), potential evapotranspirational loss (mm) and excess/deficit (mm) statistics for Rundu (from Page 1980).

<table>
<thead>
<tr>
<th>Month</th>
<th>Average monthly rainfall</th>
<th>Potential Evapotranspiration</th>
<th>Excess/Deficit</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>143.7</td>
<td>149.7</td>
<td>-5.9</td>
</tr>
<tr>
<td>February</td>
<td>140.7</td>
<td>121.1</td>
<td>+19.6</td>
</tr>
<tr>
<td>March</td>
<td>98.2</td>
<td>134.0</td>
<td>-35.8</td>
</tr>
<tr>
<td>April</td>
<td>39.7</td>
<td>118.9</td>
<td>-79.2</td>
</tr>
<tr>
<td>May</td>
<td>2.6</td>
<td>119.4</td>
<td>-116.8</td>
</tr>
<tr>
<td>June</td>
<td>0.0</td>
<td>94.7</td>
<td>-94.7</td>
</tr>
<tr>
<td>July</td>
<td>0.1</td>
<td>120.2</td>
<td>-120.1</td>
</tr>
<tr>
<td>August</td>
<td>0.3</td>
<td>150.3</td>
<td>-150.0</td>
</tr>
<tr>
<td>September</td>
<td>2.2</td>
<td>189.5</td>
<td>-187.3</td>
</tr>
<tr>
<td>October</td>
<td>17.7</td>
<td>211.7</td>
<td>-194.0</td>
</tr>
<tr>
<td>November</td>
<td>57.7</td>
<td>222.9</td>
<td>-165.2</td>
</tr>
<tr>
<td>December</td>
<td>97.7</td>
<td>226.6</td>
<td>-128.9</td>
</tr>
<tr>
<td>TOTAL</td>
<td>600.6</td>
<td>1859.0</td>
<td>-1258.3</td>
</tr>
</tbody>
</table>
2.1.4 Hydrology

The hydrological cycle of the Okavango River is the dominant feature determining the ecology and productivity of the floodplains and associated grasslands, and this in turn determines to a large extent how and when people exploit these resources (see Section 2.1.8). The principal catchments of the river lie in Angola and there is little local inflow into the river in the Namibian section of the river course as rainfall is seldom greater than the soil absorption capacity in this area (Bethune 1991). Rainfall peaks in Angola in January (Bethune 1991) and the floodwaters start rising at Rundu in late January/February and continue to rise until April (Table 2.3). Water levels generally rise 3.0-4.5 m, but Fisch (1987) states that floodmarks at least 6.0 m above the average low water level have been recorded at Mukwe.

The mean annual runoff at Rundu (5 767 m\(^3\)) is about half of the runoff at Mukwe (10 289 m\(^3\)) and this is also reflected in the monthly runoff figures given in Table 2.3. The difference in flow can be attributed to the inflow from the Cuito River.

Table 2.3 Monthly average runoff of the Okavango River at Rundu and Mukwe. Data from 1945/46-1988/89.

<table>
<thead>
<tr>
<th>MONTH</th>
<th>RUNDU (m(^3))</th>
<th>MUKWE (m(^3))</th>
</tr>
</thead>
<tbody>
<tr>
<td>October</td>
<td>121 784</td>
<td>408 048</td>
</tr>
<tr>
<td>November</td>
<td>131 540</td>
<td>395 955</td>
</tr>
<tr>
<td>December</td>
<td>273 280</td>
<td>557 582</td>
</tr>
<tr>
<td>January</td>
<td>513 922</td>
<td>784 616</td>
</tr>
<tr>
<td>February</td>
<td>710 254</td>
<td>1 013 269</td>
</tr>
<tr>
<td>March</td>
<td>1 004 840</td>
<td>1 412 800</td>
</tr>
<tr>
<td>April</td>
<td>1 068 035</td>
<td>1 581 162</td>
</tr>
<tr>
<td>May</td>
<td>735 648</td>
<td>1 330 791</td>
</tr>
<tr>
<td>June</td>
<td>387 502</td>
<td>884 935</td>
</tr>
<tr>
<td>July</td>
<td>289 196</td>
<td>715 605</td>
</tr>
<tr>
<td>August</td>
<td>228 645</td>
<td>593 238</td>
</tr>
<tr>
<td>September</td>
<td>163 432</td>
<td>480 733</td>
</tr>
</tbody>
</table>
Groundwater resources have been extensively researched in Okavango and are reviewed in Simmonds & Schumann (1987) and Namibian Groundwater Development Consultants (1991).

Groundwater is relatively abundant and of good quality in Okavango and is generally associated with the extensive Kalahari geological sequence. Most of the presently utilised groundwater is abstracted from Kalahari Strata and it is only in a limited number of places that sources in shallow, fractured bedrock strata are being exploited. Due to the fact that nearly all the groundwater is hosted by Kalahari sediments the aquifer is assumed to be continuous (Simmonds & Schumann 1987).

Groundwater elevation is shown in Figure 2.5 and from this it is clear that water levels are not very deep. Recharge is thought to be largely through direct infiltration of rainfall. A narrow zone along the western most part of the Okavango River receives direct recharge from the river. Some recharge from groundwater from the Tsumeb/Grootfontein Karst area is indicated by both water level contours and hydrochemistry (Simmonds & Schumann 1987).

Groundwater quality is high and of drinking quality standard. Total dissolved solids are usually less than 1000 mg/l. There are isolated occurrences of high levels in excess of 5000 mg/l (e.g. along the Kaudom omuramba). The success rate of striking exploitable groundwater in excess of 1 m³/hr is about 90% in Okavango (Simmonds & Schumann 1987).
Figure 2.5. Ground water level contours for the Okavango Region. Elevation is given as metres above mean sea level. Adapted from Simmonds & Schumacher (1987).
2.1.5 Soils

The soils of Okavango are generally nutrient poor, deep, windblown sands and alluvial deposits with low organic content. The poor nature of the soils together with the sub-humid climate limits the suitability of the area for dryland cropping. Extensive research has been done on the soils of the river terraces with a particular emphasis on the suitability of soils for irrigation (AOC Technical Services 1967; Coetzee 1978; Page 1980; Schneider 1986 & 1987; Department of Water Affairs (1986). Some soils with high irrigation potentials have been identified near the river, but these are limited in extent (< 900 ha, AOC Technical Services 1967; 3 200 ha, Page 1980). The commonly held belief that the alluvial and river terrace soils have high crop production potentials is incorrect as the majority of these soils are nutrient poor sands.

The most common soil forms (sensu MacVicar et al. 1977) occurring in Okavango are:

**Arcadia Form:** These are clay soils of limited in extent (< 100 ha) and are found in poorly drained areas along omarimba and near the river. They are characterised by a high clay content (> 50%) and are unsuitable for irrigation due to waterlogging and salt accumulation. In certain areas they may be suitable for dryland cropping.

**Fernwood Form:** These soils are alluvial sands and are limited in extent in Okavango. They are characterised by very low nutrient values, a clay content of less than 4% and low water retention capacity. These soils are unsuitable for both irrigation and dryland cropping.

**Avalon Form:** These soils are sandy loams of limited occurrence in Okavango and are generally found only where there is seasonal elevation of the watertable. They are often characterised by a soft plinthite layer and are suitable for dryland cropping only.
*Oakleaf Form:* These soils are sandy loams of wide occurrence. A number of series of this form occur are all suitable for dryland cropping as they have good internal drainage and moderate nutrient levels. These soils have moderate irrigation potential.

*Mispaḥ Form:* These soils are sands or sandy loams of aeolian origin very often overlying a calcrete pan layer. They are of limited occurrence and are unsuitable for both dryland cropping and irrigation due to their low water retention capacity and low nutrient levels.

*Clovelly Form:* These soils are widely distributed through Okavango and are sands or sandy loams. The majority of series of this form have a low irrigation potential and are moderately suitable for dryland agriculture. Loamy sands of this form (Makuya series) are some of the best soils occurring along the river terraces and have high dryland cropping potentials. They are moderately suited to irrigation as some are susceptible to salinisation. These soils are susceptible to erosion due to their unstructured nature.

*Hutton Form:* Together with Clovelly soils, these soils represent by far the most extensively distributed form in Okavango and are sands derived from aeolian deposits. Most soils of this form are poorly suited to irrigation and dryland cropping due to low moisture retention characteristics and low nutrient levels. However, the Zwartfontein series (extensive in the Mabushe area) of this form is regarded as having high irrigation potential. Zwartfontein soils are sandy loams.

Traditional methods of soil classification have not been studied in Okavango, but it was clear in this study that people are able to recognise soils likely to produce good crop yields. The nutrient deficient nature of most soils is recognised as a limiting factor in crop production and this is reflected in the rapid cropping cycle particularly in areas away from the river. Crop yields can be depressed within two years in many areas, through
exhaustion of soil fertility (Masdar 1993). Depletion of soil fertility is common, because soil improvement practices, such as manuring and intercropping with legumes is rare.

2.1.6 Vegetation

The vegetation of Okavango is poorly known and few studies have attempted to define vegetation units and determine the livestock carrying capacities of these units. The studies of AOC Technical Services (1976), Page (1980) and Correia & Bredenkamp (1987) are the most useful reviews of the vegetation resources in Okavango. There are a number of reviews of the forest resources of Okavango, but these are largely descriptive and of little value outside the fields of commercial forestry (Keet 1950; Erkkila & Siiskonen 1992).

The classifications proposed by the different authorities differ considerably. AOC Technical Services (1976), for example, proposed only 4 major vegetation units, whereas Page (1980) describes 10 units with 19 sub-units within these. Correia & Bredenkamp (1987) proposed a classification of 15 land-use units determined on the basis of vegetation composition and structure. Bethune (1991) gives a detailed account of the vegetation associated with the Okavango River floodplains and terraces.

The vegetation units described below are based on Page (1980). Figure 2.6 illustrates the boundaries of the vegetation units. The very uniform nature of the sand overburden to a large extent dictates that there are a number of species which are widely distributed within Okavango (e.g. *Burkea africana*) and as Okavango is largely flat, vegetation units are often defined on the basis of small changes in topography, drainage and soil conditions. The structure (height and density of different strata) is an important descriptive parameter in the outlines of the vegetation types listed below. The carrying capacities given below are from Page (1980) and should be treated with caution as they were determined using total green biomass (including shrubs and trees) within a given area. It should be noted, however, that the term "carrying capacity" is ambiguous and estimates should not be treated as unequivocal. The most important problem in communal areas where there is a mixed agricultural economy is that carrying capacities are generally calculated on the basis of beef production objectives (using "western" breeds as the model), which fails to
Figure 2.6. Vegetation map of the Okavango Region. Type numbers correspond to the text. (Adapted from Pape, 1980).
recognise the fact that cattle serve a number of different economic functions. Additionally, carrying capacities do not take into account the fact that stock-owners on communal lands tend to take advantage of "patchy" resources on a spatial and temporal level, and that indigenous breeds of cattle also eat a far broader range of food plants.

The vegetation types are listed to provide a broad outline of the vegetation of Okavango, as it provides an important base to the village level economies within the region.

Vegetation Type 1: *Acacia-Combretum-Terminalia* short bush savanna. This vegetation unit occurs in south-western Okavango and occurs on a generally flat plain which gives way to well defined dunes in the East. Soils are Hutton and Clovelly Forms. Trees are generally 3-4 m in height with isolated dense stands of larger *Terminalia prunioides* a feature. Characteristic species include *Terminalia sericea*, *Lonchocarpus nelsii*, *Combretum collinum*, *Bauhinia petersiana* and *Baphia massaiaensis*. *Acacia mellifera* forms dense stands in depressions and where overgrazing has occurred. The grass layer has a moderate to good basal cover and is dominated by *Schmitia pappophoroides*, *Eragrostis rigidior*, *Aristida stipitata* and *Aristida meridionalis*. Unpalatable species make up a relatively high proportion of the grass layer (10-22%). Page (1980) gives the carrying capacity of this vegetation type as 1 Large Stock Unit (LSU) per ha. This likely to be too high for an area with sparse grass cover. Where boreholes have been established there is noticeable degradation of the grass-layer and encroachment by *Dichrostachys cinerea*, *Acacia mellifera* and *Maytenus* sp.

Vegetation Type 2: *Baikiaea-Pterocarpus-Burkea-Combretum* dry woodland. This vegetation type is well defined in the central western portion of Okavango and cover about 530 000 ha. It generally occurs in areas with well defined large dunes and differences within this vegetation type can usually be ascribed to small changes in topography and soil conditions. Soils are regic sands of the Fernwood and Hutton Forms. Characteristic species are tall trees (> 10 m) *Baikiaea plurijuga*, *Pterocarpus angolensis*, *Burkea africana*, *Combretum collinum*, *Ricinodendron rautanenii*, *Combretum collinum* and *Guibortia colosperma*, with a well defined
understorey of shrubs *Bauhinia petersiana* and *Baphia massaiensis*. The grass cover is poor and is made up largely of unpalatable species such as *Aristida striptana*, *Aristida meridionalis* and *Eragrostis pallen*. Where the dunes are not well defined *Baikiaea plurijuga* becomes uncommon and is generally replaced by *Burkea africana* as the dominant species. Page (1980) gives the carrying capacity as 1 LSU/14 ha. With the low palatability and friable soils the grazing in these area can be rapidly degraded and where overgrazing has occurred around boreholes there has been noticeable encroachment of *Dichrostachys cinerea* and *Acacia ataxacantha*.

Vegetation Type 3: *Acacia-Dichrostachys-Combretum* bush savanna.

This vegetation type occurs in 2 discrete units, one in the south-central region and one in the Northwest where it is associated with the Namungundu, Mpuku, Dikweya and Ekuli omarimba. It covers an area of about 420 000 ha and is generally associated with sandy, nutrient poor Hutton and Fernwood Form soils. Dunes are not well defined in this area and so there are no distinct interdune sub-units within this vegetation type. The sub-unit occurring in the south-central region is a dense bush savanna, dominated by large *Acacia erioloba* trees, with a well defined understorey of *Terminalia sericea*, *Lonchocarpus nelsii*, *Combretum collinum*, *Combretum celastroides*, *Bauhinia petersiana*, *Baphia massaiensis* and *Ochna pulchra*. The vegetation sub-unit in the Northwest has a very similar composition and both have moderate to poor grass cover dominated by *Schmidtia pappophoroides*, *Eragrostis rigidior* and a number of unpalatable *Aristida* species. The boundary between this vegetation type and Type 2 is often obscured in the Northwest as *Baikiaea plurijuga* can be locally common. The carrying capacity is given as 1 LSU/14 ha (Page 1980), but as the grasses are largely unpalatable and the basal cover low this estimate is too high. An assessment of the grazing capacity near Ekuli done during this study gave estimates of between 1 LSU/22-27 ha. The areas covered by this vegetation type are poorly suited to agricultural development, due to the poor quality grazing and nutrient poor soils for cultivation. A number of areas are badly degraded along the omarimba (between Ekuli and Nepara especially) and encroachment of woody species is noticeable.
Vegetation Type 4: *Pterocarpus-Burkea-Combretum* dry woodland.

This is by far the most extensive vegetation type within Okavango (2 12 0000 ha). It is quite variable in the relative abundances of different species, as can be expected. This is due to minor changes in topography, soils and patterns of utilisation. However, the main constituent species are largely constant in their occurrence. There is little dune formation in the area covered and soils are mainly poor quality Hutton and Fernwood Forms. The dominant woody species are *Pterocarpus angolensis*, *Burkea africana*, *Terminalia sericea*, *Combretum collinum*, *Ochna pulchra*, *Baphia massaiensis*, *Bauhinia petersiana*, *Guibortia coleosperma*, *Erythrophleum africanum* and *Diplorhynchus condylocarpon*. *Baiklea plurijuga* is of variable occurrence within this vegetation type, in some areas being completely absent. There is a well developed shrub layer and consequently the basal cover of the grass is low. Palatable species contribute less than 40 % to the grass cover.

Page (1980) gives the carrying capacity as 1 LSU/20 ha, but determinations made during this study in the vicinity of Xay-Xay and Mutorwa give carrying capacities of 1 LSU/30 ha. This vegetation type is very important for the commercial and artisanal forestry industries Okavango, but regrowth of important species such as *Pterocarpus angolensis* is poor due to the high incidence of uncontrolled fires in the area. Where disturbance has taken place shrub form *Terminalia sericea* and *Baphia massaiensis* become established in thickets, which are almost impossible to clear.

Vegetation Type 5: The Omatako and Fontein Omarimba and associated areas.

This vegetation type includes the distinct vegetation of the omarimba bottom lands, as well as the surrounding areas which may form part of the catchments for these drainages. Soils are variable as may be expected in an area of changing topography. Hutton and Clovelly Form soils are the most important, but Fernwood and Arcadia Form soils also occur. As can be expected the vegetation on the margin of the omarimba is dominated by species common in Type 4. Common species include *Terminalia sericea*, *Combretum collinum*, *Baphia massaiensis*, *Bauhinia petersiana*, with large *Burkea africana* being the dominant tree species. The poisonous plant *Dichapetalum cymosum* is common on the
omarimba margins and is particularly noticeable in disturbed areas. Where they are well drained, the omarimba bottom lands are dominated by dense stands of Acacia erioloba, Acacia hebeclada and Dichrostachys cinerea. Most of the grasses in the bottom lands are unpalatable species capable of surviving waterlogging and some salinisation. Cynodon dactylon a highly palatable species does occur in patches along the omarimba. Grass cover along the margins is generally good, but as these areas are favoured for cultivation they are relatively unimportant for grazing. Carrying capacities are estimated at 1 LSU/20 ha (Page 1980).

Vegetation Type 6: Terminalia-Baphia-Bauhinia-Commiphora short scrubland.
This vegetation type occurs in the South-east around the Nhoma omurumba and associated minor drainages. It is an extension of a vegetation type common in Bushmanland to the south and covers an area of about 200 000 ha. There is little topographic variation in this area, except for the poorly developed system of omarimba. Soils are largely Hutton and Fernwood Forms. The vegetation is generally short (< 3 m) and common species include Terminalia sericea, Baphia mussudensis, Bauhinia petersiana, Ochna pulchra and Commiphora africana. Tall trees are sparsely distributed, Pterocarpus angolensis, Burkea africana and Combretum collinum being the commonest. Page (1980) does not describe the grass layer but assigns a carrying capacity of 1 LSU/8 ha. This is highly unlikely in an area of dense understorey, poor soils and low rainfall. Estimates of carrying capacities in similar habitat in Bushmanland indicate that 1 LSU/25 ha are more realistic.

Vegetation Type 7: Terminalia-Combretum-Burkea-Baikiaea dry woodland. This vegetation type is similar to Type 2 described above, but occurs on a far more broken landscape of well defined dunes, interdune slacks and drainage lines. Soils are variable but are largely Fernwood Form on the dunes and Hutton and Clovelly in the interdune areas. The species composition is very similar to Type 2, but Baikiaea plurijuga has a much more defined distribution in that it only occurs on the crests of large dunes. Other common tree species are Burkea africana, Pterocarpus angolensis, Guibortia coleosperma, Ricinodendron rautanenii and
*Combretum spp.* The basal cover of grasses varies from 1-2% on the dunes to more than 3% on the interdune slacks. As this area is relatively heavily settled the interdune areas are generally heavily cultivated or grazed and vegetation is very often secondary. The interdune areas are subject to bush encroachment and this can be clearly seen in the vicinity of Shividzi and Korokosho. Page (1980) gives a carrying capacity of 1 LSU/10 ha, which is likely to be too high given the poor nature of the dune soils.

**Vegetation Type 8: The Okavango River floodplains and terraces.**

Although these habitats are by far the most important vegetation resources in Okavango there is little information regarding the most important species, their utilisation and the degradation of habitats. The people living along the river derive tremendous benefits from the riparian vegetation in the form of food, construction materials, medicines and grazing resources and so it is surprising that these are poorly described and defined in Page (1980) and other authorities. Bethune (1991) defines a number of sub-habitats/vegetation types along the river. These include: the river margins with their dense reed beds and floating grass mats; the riparian forests and thickets; the floodplain which is seasonally inundated; and, the alluvial terraces. Probably the most important species are: the grasses, *Cynodon dactylon*, which forms the floodplain lawns so important as a grazing resource and *Echinochloa stagnina* which is usually found as a floating mat and is also an important grazing resource; *Phragmites spp.* reeds (construction material); *Vetiveria spp.*, *Miscanthus junceus* (thatching grass); *Hyphaene ventricosa* (basketry palms); and, a number of large trees used for construction of watos (traditional canoes). Page (1980) gives a carrying capacity of 1 LSU/15 ha for the upper terraces but gives no figures for the floodplain grasslands. These grasslands are heavily utilised and although they seem to withstand these pressures relatively well there are definite signs of degradation in certain areas. There has been widespread clearing of riverine vegetation along the Okavango River for cultivated land as well as access and some areas are heavily bush encroached where lands have been left fallow.
Vegetation resources are widely used in Okavango. The value of wild plants lies in their being well adapted to local conditions and so being able to meet many basic human needs under a range of conditions. They provide low-cost construction materials, food supplements, fuelwood, household utensils and traditional medicines. They also provide a source of income and employment through the use of materials to make carvings, baskets, beer and other products for resale. As such wild plants provide an essential buffer against absolute poverty (Cunningham et al. 1992). Children eat the greatest variety of wild plant foods and these provide important vitamins and nutrients which may be lacking in the staple starch diet of mahangu (pearl millet).

Even though the use of wild plants by the Kavango peoples is well established, there has been a decline in the acceptance of the use of wild plants as the population becomes urbanised and "western" cultural practices become established. With a change in emphasis from subsistence farming to a cash economy in Okavango there has been a loss of interest in traditional recipes and foods. This includes the development of a social stigma against the gathering or conservation of wild foods, resulting in a decreased value being placed on wild fruit-bearing trees which are then no longer conserved as a communal resource. There is a need to promote the conservation of wild plant resources (food, construction materials, financial resources, etc.) throughout Okavango as they play such a vital role in the overall economy of the region.

Vegetation resources are important in that they provide a base to the mix of agriculture, crafts and food products which constitute the subsistence economy in Okavango. However the long term viability of these resources are threatened by two factors: fire and overgrazing. Fires are an integral part of the ecology of the woodlands of northern Namibia but the frequency (annual) and timing (early dry season through to onset of rains) of burns tends to have negative effects on the vegetation. The indiscriminate setting of fires during the dry season severely affects recruitment of woody species (important as construction materials), as well as causing the loss of palatable grass species (Geldenhuys 1977). Most livestock farmers interviewed during the course of this study held that fires were not good for grazing resources, but were important in controlling tick numbers. None admitted to setting fires themselves and most stated that the fires "came from
Botswana. There is a need to provide an extension service regarding fire and its effects on the grazing and forestry resources.

Overgrazing is a problem along the Okavango River and around boreholes largely as a consequence of the lack of any form of rotational grazing. Systems of transhumance do not seem to have been as well established in Okavango as they are in Owambo and livestock herds are largely resident through the year, either along the river or at borehole sites. An extension programme linking livestock management systems and environmental degradation is required if grazing resources are to be maintained. The Veterinary Services Report for 1990 put the case strongly, stating "Erosion and soil compaction are far advanced. The riverine area along the Okavango is severely damaged through overgrazing", and "the time has come for a nation-wide agricultural law for the control of field fires, overgrazing and deforestation". Laws, however, are unlikely to be effective as the enforcing organisations (traditional leadership, regional and national government) do not have the man power or the will to administer the controls. The best solution to these problems is through community mobilisation and the evolution of an ethic of collective responsibility for basic resources.

2.1.7 Fish

The fish fauna of the Okavango River has been well studied in recent years (Skelton & Meron, 1984, 1985 1986) but most of this research has been focused on the taxonomy and biogeography of the fish, rather than the development, management and utilisation of the fish resources. The only research done on this aspect of the fisheries is that of van der Waal (1991).

The paucity of information on fisheries management in this region is surprising as fish constitute the major protein source for most people in Okavango (van der Waal 1991; Bethune 1991; Yaron et al. 1992). Exploitation of the fisheries is intense and is likely to escalate in the future. Careful management of this resource is required if it is to continue to contribute to the regional subsistence economy.
Regular fishing is an activity in which most women in Okavango participate (women constitute about 80% of the fishing community) and most catches are for direct consumption only. According to Yaron et al. (1992) and v.d Waal (1991) fish funnels and fish corrals are the commonest traditional fishing techniques with hook and line, and nets the most important modern methods. The fish funnel method was by far the most efficient technique (200 g/hr), with catch per unit effort being twice that of corrals and nets. On average women fish for about 2 hours a day and this would bring in a daily catch of between 200 and 500 g, enough protein for about 3 people. An important aspect of the traditional fishing techniques is that they are largely non-selective (virtually all species occurring in the river are caught). A noticeable feature of the survey done by v.d. Waal (1991) is that most fish caught were juvenile or sub-adults, indicating that the adult population is under pressure through selective capture techniques such as gill- and seine nets. About 840 000 kg of fish are caught annually with a commercial value of c. R 1.8 million. This figure is misleading as the real value of the resource lies in the fact that the population is not protein deficient which is of considerable importance for the local economy.

There is a definite impression within the fishing community that the river system is becoming less productive over time. There is a need to manage the river as a system such that the overall productivity is maintained, even in the face of increasing pressures. The most pressing problems are: overgrazing and overutilisation of the vegetation along the river; poor agricultural practices on the dune slopes leading to slumping and siltation of the river course; degradation of fish breeding sites; and, continued and unrestricted use of selective fishing techniques. Restrictive laws are unlikely to succeed in conserving fisheries resources - again, the answer to these problems lies in developing an ethic of collective responsibility amongst those people using the resource.
2.1.8 Wildlife

Wildlife populations are restricted in their distribution within Okavango and as such are largely unimportant in the regional economy. There are three proclaimed reserves within Okavango to which access is restricted. Wildlife is "state property" under the Nature Conservation Ordinance and few Okavango residents have ever been able to legally utilise game, with the consequence that the value of wildlife to most people (as a communal resource) is nil.

There is considerable conflict between wildlife and farmers around the Mahango Game Reserve, where crop raiding elephant and stock raiding lion are a constant problem in the surrounding villages. As people are not able to legally hunt game and have to carry the costs of stock and crop losses without recompense, wildlife is viewed as a liability, game reserves as wasted grazing lands and seldom viewed as a positive resource or source of potential income.

The Ministry of Wildlife, Conservation and Tourism are currently working on new legislation that will give game ownership rights to individuals with land rights within communal lands in much the same way as farmers on commercial farms. This may open the way to positive developments in the field of nature conservation in Okavango, as avenues will certainly develop where individuals and communities will be able to benefit directly from game populations in their areas. Once this legislation is promulgated, new opportunities in tourism related industries are sure to develop. The tar road east from Rundu is going to link Maun in Botswana and Victoria Falls in Zimbabwe and tourist traffic through eastern Okavango is expected to rise sharply. Village level tourism developments (camp sites, huts, curio sales) have proved to be very successful in Zambia and Zimbabwe and there is considerable potential for these types of enterprises to make a significant contribution to the cash economies of villages throughout eastern Okavango.
2.2 HUMAN RESOURCES

Okavango is Namibia's second most populated region with a high growth rate, which has been boosted in recent years by an influx of Angolan refugees. The most recent population census (1991) gives the total population as 136,592, of which about 19,000 people are resident in urban areas. Adams et al. (1990), NEPRU (1991) and Yaron et al. (1992) provide reviews of historical and current trends in the population of Okavango.

2.2.1 Population distribution and density

The population of Kavango is centred on the river and about 90% of the population is settled within 10 km of the river course. The area to the south of the river is sparsely inhabited with most settlements established along the diffuse system of omarimba in the western and central parts of the region. Widespread settlement south of the river in the Kalahari sand areas has not taken place for a number of reasons. Water is the most important factor limiting development in this area, but people also perceive the area to have a much poorer resource base (grazing and soils are poor) than the riverine area, and so are reluctant to settle here if required to give up land already occupied near the river. There are areas with relatively fertile soils and potable water south of the river and successful settlement has taken place in many of these areas. However, resettlement of people and their livestock away from the river is unlikely to any significant reduction in the demand for resources along the river. The strip along the Okavango River has some of the highest rural population densities in Namibia and the demand for riverine resources (water, grazing, fisheries, reeds) has led to a certain amount of degradation of these resources. Small shifts in population away from the river, while ultimately being beneficial and expanding the agricultural base of the region, are unlikely to ameliorate resource demand. It is the opinion of the Consultant that statements relating alleviation of environmental degradation through shifting people away from the river are unfounded and unlikely to result in any measurable improvement of environmental conditions. The problems associated with high human and livestock densities along the river are not going to be resolved by attempting to shift the population away from the river, but by developing adaptive strategies of resource use along the river based on a strong ethic of
communal tenure not individual rights.

2.2.2. Land tenure

Land tenure is governed by both traditional law and the recently established Regional Authorities in accordance with laws enacted by National Government. Okavango is divided into 5 tribal areas: Kwangali, Mbulu, Gciriku, Sambiyu and Mbukushu. The system of traditional authorities is essentially the same in each of the five areas and is reviewed by Yaron et al. (1992).

In interviews conducted during this study, most respondents stated that land allocation was done in a number of different ways depending on the residence status of the applicant. Long time residents of a village know which pieces of land have not been allocated and are often given permission to use a piece of land without a review process by the village headman. Recent arrivals and outsiders are, however, subjected to some sort of questioning by the headman and villagers and the land allocation may be referred to higher authority (tribal chief).

However, these traditional systems of land allocation may be breaking down as the role of traditional authorities seems to be weakening. Many respondents said that they had cleared and ploughed fields without permission and that they were unlikely to ask permission to expand holdings in the future. This is also reported by Yaron et al. (1992). The environmental implications of this are manifold. Traditional systems of resource use have in the past been based on community ownership of resources and transgressions can lead to social stigmatisation. As the traditional systems break down resources are being used on the basis of individual propriety rather than communal ownership. For example, certain respondents stated that they cut certain food/fruit trees down because they make good firewood and then went further to say that although they knew it was bad practice ("the old people would be angry"), it was too much effort to go further for wood. This may indicate two things: firstly, that younger people feel less bound by traditional authority (because it is no longer enforced); and, the use of traditional foods is seen as unimportant and/or there is a social stigma (amongst younger people) attached to using
these foods. As the system of land tenure moves toward one of individual "ownership" so problems of fencing and land grabbing will become more evident. Fencing is seldom done as an aid to modern, scientific commercial farming operations, but rather as a way of excluding others or to compensate for the problems of finding competent herders. The nett result of this change in land tenure is that the rural "poor" will be precluded from using resources so important in the subsistence economy of the region, becoming more marginalised and food insecure as the system of "individualisation" becomes more entrenched. This is already happening in parts of Ovambo and care should be taken to prevent a similar process occurring in Okavango.

2.2.3 Infrastructure

The infrastructure of Okavango is not well developed and this places a strong restriction on the implementation of development projects.

The road system is limited and only three major sections have any form of surfacing. Tar roads constitute less than 300 km of road at present, with hard cap gravel roads comprising some 600 km. The main road east from Rundu to Katima Mulilo is currently being tarred and there are plans to tar the main road from Rundu to Oshikango. Other than this the access network is made up of a maze of unserviced bush tracks which are difficult to drive on and are costly in both time and on vehicles.

Water provision is largely controlled through the state. In Rundu the bulk water supply is controlled and administered by the Department of Water Affairs. Borehole schemes are administered through the Department of Rural Development and are heavily subsidised by the State at present. There is a high degree of dependency on the provision of diesel, parts supply and maintenance services by communities supplied with a borehole. As the pumps and equipment are State property no-one on site is allowed to undertake routine maintenance or repair work. This has to be done by a contractor appointed by the State. When a pump installation breaks down communities can be without borehole water for extended periods of time as service units are stretched to their limit at present. Government subsidy expenditure on water supply schemes is likely to decrease in the
future and the onus placed on users to pay for the resource. There is, therefore, an urgent need to train and involve communities dependant on boreholes for water supply, in maintenance, cost recovery and monitoring of water supply.

Electrical supply is being expanded considerably in Okavango. The Ministry of Local Government and Housing is providing a subsidy towards connection fees and construction costs and demand in the region is expected to be high. Unit tariffs will be in line with supply elsewhere in Namibia and users will buy units on a prepaid meter basis.

The education system in Okavango has suffered from severe neglect for several decades and the process of upgrading and supplying education facilities is a slow process. Little information is available on educational facilities and levels of education in Okavango. Yaron et al. (1992) give a brief outline of the educational environment in Okavango.

Health (here only "western" services are referred to) and welfare services are, like education, rudimentary in certain parts of the region and fairly well developed elsewhere. Yaron et al. (1992) give an overview of the problems involved with the health system in Okavango. The Education and, Health and Welfare systems suffer from much the same problems, these being: lack of sufficiently trained and motivated personnel; lack of a service infrastructure (some schools are supplied only once a year); insufficient teaching and medical materials (no blackboards, no sterilisation equipment); and, there is often insufficient space to satisfy the demand for services.

2.3 AGRICULTURAL RESOURCES

Agricultural production provides the base of the subsistence economy of Okavango, as well as being an important cultural influence. Agriculture may be described as agro-silvi-pastoral - a system where crop production, traditional tree and bush foods and cattle all play a role. Yaron et al. (1992) provide a broad outline of agricultural practices in Okavango as well as detailed analyses of limits on grain production. Certain aspects of the agricultural systems of Okavango are not covered in this study and an attempt has
been made here to address these. The most important of these is the nature of the agricultural strategies designed to reduce risk in a highly variable biophysical environment.

2.3.1 Livestock production

Livestock, principally cattle, are an important cultural and economic focus in the Kavango. Discussion on the development of rural livestock herds in Okavango has often centred on the low productivity of herds, poor management practices and the environmental degradation precipitated by overgrazing. This approach is simplistic and does not recognise the fact that cattle fulfil a number of different functions in the adaptive livelihood strategy of the majority of communal farmers in Okavango. For example, cattle provide draught power for ploughing, are a source of milk, are a status symbol and provide important income security for extended families. As pointed out by NEPRU (1991) livestock productivity and valuation of output should be determined by household objectives, not by measures derived from completely different production systems (usually commercial beef production). Cunningham et al. (1992) emphasise the fact that under traditional systems of agropastoralism there is often a subtle mix of different forms of resource use which generate greater benefits for the communities than a focus on a single resource such as cattle. Low off-take rates (3.5% of total herd; Yaron et al. 1992) for cattle, in conjunction with other forms of land use may be the most sustainable and beneficial form of resource use.

Stock ownership patterns and herd sizes are summarised in Table 2.4. The majority of stockowners have less than 30 cattle which according to Yaron et al. (1992) is too few to have a sustainable commercial cattle farming enterprise (herd size to be 35 or more). However, this is a misinterpretation of the information supplied by Veterinary Services. The figure of 35 is given as a sustainable subsistence herd for pastoralists (assumed not to practise any cultivation) and the figure for agro-pastoralists (as farmers are in Okavango) would be considerably lower as their dependence on income generated by cattle would be less (pers. comm., Dr. R. Paskin, Veterinary Services, Windhoek). About 80% of stock owners (> 10 units) could, therefore, be assumed to have herds that would allow some
off-take annually and cattle may play a more important role in the cash economy of the region than outlined by Yaron et al. (1992).

Table 2.4  The size of cattle herds, stock owner numbers and total number of cattle per herd size in the Kavango in 1992. Source: Department of Veterinary Services, Rundu.

<table>
<thead>
<tr>
<th>HERD SIZE</th>
<th>No. of OWNERS (%)</th>
<th>No. of CATTLE (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>00-10</td>
<td>752 (21.4)</td>
<td>5 849 (6.3)</td>
</tr>
<tr>
<td>11-20</td>
<td>1 091 (31.1)</td>
<td>17 505 (18.8)</td>
</tr>
<tr>
<td>21-30</td>
<td>674 (19.2)</td>
<td>17 018 (18.2)</td>
</tr>
<tr>
<td>31-40</td>
<td>390 (11.1)</td>
<td>13 591 (14.5)</td>
</tr>
<tr>
<td>41-50</td>
<td>228 (6.5)</td>
<td>10 080 (10.7)</td>
</tr>
<tr>
<td>51-60</td>
<td>125 (3.5)</td>
<td>6 790 (7.3)</td>
</tr>
<tr>
<td>61-70</td>
<td>88 (2.5)</td>
<td>6 394 (6.8)</td>
</tr>
<tr>
<td>71-80</td>
<td>58 (1.6)</td>
<td>4 435 (4.8)</td>
</tr>
<tr>
<td>81-90</td>
<td>36 (1.0)</td>
<td>2 554 (2.7)</td>
</tr>
<tr>
<td>91-100</td>
<td>24 (0.7)</td>
<td>1 890 (2.1)</td>
</tr>
<tr>
<td>101+</td>
<td>44 (1.3)</td>
<td>7 268 (7.8)</td>
</tr>
<tr>
<td>TOTAL</td>
<td>3 510</td>
<td>93 374</td>
</tr>
</tbody>
</table>

Note: Average herd composition (n=32): Bulls - 3.8%; Oxen - 20.3%; Cows - 38.3%; Heifers - 17.5%; Calves - 18.1%.

Recent reports indicate that breeding may be strongly inhibited by the fact that most farmers castrate all their male stock because of the paramount need for oxen for ploughing services (Masdar, 1993), and that most households have no bulls. This information conflicts with the average herd composition cited above and the fact that the regional herd is increasing in size (88 700 cattle in Jan 1992, 98 000 in July 1993; Masdar, 1993).

Herd management warrants considerable investigation.

The issue of livestock sales and marketing in the northern communal lands of Namibia is one open to question. Yaron et al. (1992) side with many others citing the Veterinary Cordon Fence (the Red Line) and the collusion of formal sector businesses (e.g. the
former FNDC and MeatCo) in controlling prices and so limiting marketing incentives in Okavango. There is, however, little evidence to support this point of view and, given the findings of Adams et al. (1990) and NEPRU (1991) that Okavango is a nett importer of meat from south of the Red Line, the lack of marketing opportunities is unlikely to be a problem. The market is more likely to be constrained by high expectations of stock values on the part of stock-owners and a reluctance on their side to sell when these expectations are not realised. As cattle value is related to the multiple uses to which they are put this is not surprising. This may be especially true with regard to the commercial markets where prices are dependant on demand, and the fixed pricing and grading structure currently in place. There is additionally and overall reluctance to sell cattle as there are few investment opportunities for communal farmers and cattle represent an investment with a potentially high rate of appreciation (Peat Marwick 1993). In this study the majority of stock-owners interviewed expressed little interest in selling cattle and would only do so to raise money for special needs. Stock owners also intimated that they would rather slaughter cattle for bush-butcheries than sell to MeatCo. or others as live sales, as prices realised in bush-butcheries (R 1 700) was much higher than live sales (R 900) (Veterinary Services, 1992). In Owambu nearly twice as many cattle are sold in bush butcheries as there are sold to the formal sector (Cunningham et al. 1992). The easing of restrictions regarding the Veterinary Cordon Fence is unlikely to improve the sale of cattle markedly.

Although there does not seem to be any established system of transhumance in Okavango, there is a degree of mobility in cattle herding which allows for utilisation of the "patchy" grazing resources. This flexible herd management system allows farmers to spread their risk. Studies in Zimbabwe have shown that flexible herd management systems allow higher carrying capacities over time and returns are greater than commercial ranching systems (Z$14.1/ha/yr vs. Z$12.4/ha/yr) (Cousins, 1987). The long term sustainability of livestock production systems in Okavango are being weakened through changing patterns of stock ownership (more cattle owned by fewer people, very often urban residents (IFAD 1992), the establishment of "commercial" farming units and borehole programmes. All of these factors are leading to an increasingly sedentary system of livestock production which weakens the opportunistic and flexible traditional systems.
Holistic Resource Management (or Short Duration Grazing) has been proposed as a possible solution to some of the problems raised by increased sedentarisation of stock. The system has been successfully used on a number of commercial farms in Namibia, where productivity levels have increased significantly. The practice of short duration grazing requires subdivision of range into small units (paddocks/camps) each of which is grazed until overgrazing of key indicator species is recognised. Livestock are then moved onto the next grazing unit. Although the system is well suited to commercial enterprises, lessons from Zimbabwe indicate that its usefulness in communal lands may be limited (Behnke & Scoones, 1992). Problems include: the high degree of technical proficiency required of a manager (recognition of key species, division of range into management units) which is seldom satisfied as cattle are herded by young boys; the division of communal land into fixed units which reflect the patchiness of key resources; and, the ceding of grazing rights by many to a single "manager" who then determines when and how many cattle are taken off an area. Additionally, there is no recognition in the system that individual owners have different objectives regarding livestock ownership. Although these factors mitigate against its use, Holistic Resource Management has as its base, sound scientific principles which may provide the basis of a management system more suited to the constraints of communal land tenure and agricultural systems.

2.3.2 Crop production

Crop production in Okavango is broadly divided by Yaron et al. (1992) into commercial operations (principally irrigated) owned by the Namibian Development Corporation (NDC; formerly the First National Development Corporation) and dryland subsistence cropping which is the domain of the small scale communal farmer. NDC's projects were developed through the late 1970's and early 1980's and were designed to be an "example" of agricultural development opportunities for local small scale farmers. This approach is questionable, the emphasis having been placed on capital intensive irrigation schemes which are of little relevance or interest to the subsistence farmers of the region. Community level development initiatives should ignore NDC scale projects and need to focus on dryland cropping practices.
Three grain crops are important in the local subsistence economy: pearl millet (*mahangu*), sorghum and maize. Yaron *et al.* (1992) give a detailed breakdown of factors important in limiting production of millet (at 74% of annual production, the most important crop). Problems listed include: a lack of agricultural equipment (including oxen for ploughing services), lack of land; lack of credit; lack of rain; and, a lack of expertise, markets and transport. While these factors are undoubtedly important little mention is made of the limits on crop production imposed by the biophysical environment.

The highly variable nature of the rainfall (see Section 2.1) is the primary determinant of agricultural production and farmers use a number of risk aversion strategies to compensate for the variability. Probably the most important of these is the cultivation of a number of varieties of millet with different growth rates, heights, seed head characteristics, etc. This practice is firmly established in the agricultural system and Yaron *et al.*'s (1992) comment that Okashana-I introduction into the region would be viewed with scepticism by farmers is surprising. During the course of the current study Okashana-I was found to be widely accepted and sought after - it is in fact now known as "Canamco" - with farmers recognising its growth characteristics as important in increased food security ("If it only rains a little, we still get some food"). The important point here being that although traditional agricultural practices are well established, farmers are amenable to new products/approaches, as long as these are not too far removed from the traditional experience (i.e. the farmer can evaluate risks based on his own expertise).

Poor soils are also a major factor in the low production per household (314 kg per household per year). Yaron *et al.* (1992) analyzed production in households along the river and in areas to the south and found no significant difference between the two, and from this it was assumed that the soils along the river have been degraded through overutilisation over time. This is an oversimplification. Good quality, high production potential soils are limited along the river and the only extensive areas of these have been taken over for NDC schemes. The majority of soils, along the river and in the areas to the south of the river, have poor production potentials (AOC Technical Services, 1976; van Rooyen, 1977; Page, 1980)(see Section 2.1.5 above for reference on soils) and it is therefore not surprising that household production does not differ significantly between these two areas. There are limited areas of good production potential soils within
Okavango and on some of these yields can be as high as 1 300kg/ha. However, if regional production is to be increased and household food security improved the approach required is one focused on intensification production per unit under cultivation through soil fertilisation.

Poor soil fertility is seen by most farmers as a problem but few practice any sort of soil fertilisation. Spreading of manure on fields is common practice in Owambo where access to land is limited and there are limited opportunities to expand operations or move into new areas. In Okavango the only farmers found to practice any soil fertilisation were those in the west who had direct contact with people from Owambo. In the east only one farmer practised soil fertilisation and he had learned this in Owambo during service in the military. There is an urgent need to promote soil fertilisation and strengthening practices. This can be done through: expanding intercropping practices, including the use of non-food soil nitrification species (clovers); promoting mulching rather than burning of old stalks; promoting the use of green-fertilisers; promoting the use of livestock manure and possibly liquid manures. The use of chemical fertilisers should not be discounted but there are considerable problems related to this and their use should be approached with caution.

The generally poor soil conditions have led to a demand for large plots of land to meet subsistence needs and as the population has increased, so has the area of land of marginal cropping quality under cultivation. Two practices here are of particular environmental concern: "slash and burn" cultivation; and, the clearing of riverine fringing vegetation. The use of "slash and burn" cultivation practices is expanding as settlement of the Kalahari sand areas increases. The poor quality of the soils in these areas dictate that there is a two to three year cropping cycle on any piece of land. In many areas crop rotation and fallowing has given way to "slash and burn" practices, where virtually all trees and shrubs are cleared from fields. This has led to a marked decline of trees important for fuel, food and construction and as large areas are required under cultivation (combined with a rapid turn-over time) people have to travel long distances to collect firewood, construction materials and wildplant foods.
High population densities along the river have led to a high demand for land. Clearing for cultivation has resulted in the loss of considerable tracts of riparian forests, riverine woodland and vegetation important in stabilising the river banks. Erosion of upslope sites, dune slumping and topsoil loss are all a feature of cultivated lands along the river. Most of the material lost is deposited in the river or on the floodplains, resulting in increased sediment loads (poorer quality water), siltation of floodplain areas (loss of fish breeding sites, loss of grazing areas for livestock) and development of a channelised river course which floods its banks less and less. Due to the large scale clearing of woody vegetation, the demand for trees for construction materials in riverside communities is high and because of the loss of riparian forests, certain communities have to import construction materials from outside sources. For example, the Kangongo community had to cut trees in the Mukwe-Andara area for the construction of the community development centre. The high demand in certain areas has led to the loss of communal tenure on trees important as food species. Examples were found where important food trees (e.g. Guibortia coleosperma - Ushivi) were cut for fuelwood and construction materials against traditional proscription. The reason given was that it was too far to go to get alternative materials and that the tree belonged to no-one. The lack of important basketry palms in the Mbukushu area (outside the Mahango Game Reserve) is also ascribed to the breakdown of traditional control of this resource which prohibited cutting of palm hearts (this kills the tree).

2.3.3 Vegetable farming

Vegetable production has been proposed by a number of authorities as a viable economic undertaking in Okavango, and some go so far as to state that there is potential for the region “to be the breadbasket of Namibia” (Louw, 1977). Based on a perfunctory examination of production potential within an area of 600 mm of average annual rainfall, it seems that this may be the case. Rainfall, however, is highly variable in both space and time and the soils of the region are nutrient poor sands of low production capacity - both of these factors thus preclude rainfed vegetable production, with the exception of a handful of bean, pumpkin and melon crops.
Intercropping with beans, pumpkins, melons and traditional leaf crops ("spinach") is a well established practice in Okavango. This practice should be encouraged and strengthened through provision of new high production varieties. A number of traditional vegetable crops offer cash crop potential, for example *mutete* (*Hibiscus sabdarafa* producing flower bud hips) and the traditional spinaches. These crops are used by the majority of people interviewed, are easy to grow, can be dried (easy storage) and are easily transported. Most traditional vegetable crops require little maintenance, are disease resistant and are water efficient. An investigation into the potentials for commercial cropping of these traditional vegetables should be undertaken.

Groundnuts and roundnuts are two similar crops which are low maintenance and would possibly find wide acceptance as intercropping species. These crops are a good source of protein and are easily stored. The groundnut breeding programme sponsored by ICRISAT in Malawi provides a variety of cultivars for trial purposes in Okavango.

The potential for irrigated production of vegetables and the cash benefits to be derived from this enterprise, has often been overemphasised. Although there are very high potential benefits from irrigated vegetable production, proponents have underplayed the costs involved and practical problems involved. These include high labour inputs, pest control, harvesting, storage, market acceptance and transport. Most people interviewed during the current study expressed interest in producing vegetables (mostly for cash) but few were aware of the complex and intensive inputs required to make irrigated production a profitable undertaking.

The problematic nature of irrigation production of vegetables is well summarised by Yaron *et al.* (1992), who state that "irrigated vegetable production is clearly a risky business for the small scale farmer (p.77)" and go further to emphasise the poor market situation, "the only buyers were local people…. but demand was severely constrained by the lack of cash in the local economy". There is however, considerable potential for small scale low-technology production systems which service local village level demand and which can expand into more substantial commercial production units.
It is the opinion of the Consultant that development agencies should re-evaluate the role that vegetable production can play in the communities of focus villages. Up to now the emphasis has been on the cash incentives, rather than the potential dietary and food security benefits. People undertaking vegetable production should be made aware that markets are primarily local and that disposable income is small. There is also a need to make producers aware of the relatively narrow margin between production costs and a realistic market price. The issues of household food security and dietary supplementation should be addressed before cash incentives are advanced. Small scale food garden schemes based on Permaculture principles have achieved considerable success in Zimbabwe and South Africa, and have provided an excellent training ground for individuals interested in expanding into commercial production (Auerbach, 1991).

2.3.4 Fish farming

Although fish are known to contribute significantly to the local diet, no fish farming enterprises are established anywhere in Okavango. There have been a number of attempts to develop fish farming, but these have all failed. The reasons for failure are not clear from the interviews held during the course of this study. However, the distinct impression is that fish farming is viewed as a "quick and easy" option, which is not the case in Okavango where there are a number of technical and logistical problems which are costly to overcome.

There is a tendency for fish farming proponents to oversimplify the complexity of the enterprise and fish farming should be approached with caution. Problems include: the lack of clay to line constructed ponds to retain water; the lack of breeding centres and hence problems of access to fingerlings; the poor understanding of the breeding biology of local fish species; the low nutrient content of the water; the high cost of production and breeding pond construction; the high cost of pumping water into ponds (the use of river diversion ponds such as the ponds at Kangongo are of questionable durability and there are problems with nutrient retention in a through flow system); the high cost of nutrient inputs, especially in the start-up phase; marketing and logistics of transport; storage of harvested fish; the high cost of harvesting nets. A breeding and provenance programme
based on local fish species would have to be undertaken before fingerlings suited to local conditions would become widely available. The introduction of exotic species (notably *Oreochromis mossambicus*) should not be considered because of the threat that this poses to the artisanal fisheries along the river course and into Botswana. Introduced species elsewhere in Africa are known to have upset the population dynamics of indigenous fish species with the result that traditional fishing techniques become less effective.

Like vegetable farming there are distinct possibilities for this type of enterprise to supplement the subsistence economy of the region. Environmental risks are low and fish are already firmly established in the diet of the local people. Successful establishment of fish farms is constrained by the high levels of certain inputs and limitations peculiar to Okavango (e.g. lack of clay, nutrient poor water). Fish farming may best be approached through establishment of a pilot project to develop a programme best suited to local conditions.
3. THE CANAMCO/OXFAM-CANADA PROJECTS

3.1 THE CANAMCO/OXFAM-CANADA PROGRAMME

The following assessment of the CANAMCO/Oxfam-Canada programme is based on the
three documents provided by CANAMCO/Oxfam-Canada staff (listed as Griggs 1991;
COC1 1991; COC2 1992 in references), interviews and discussions and field surveys
carried out during the period of the consultancy.

According to programme documents (Griggs 1991; COC1 1991; COC2 1992) the primary
project goal is to increase the productivity of the agricultural and cottage industry sectors
of the rural poor in Okavango through technical and material assistance in these sectors
and assistance in three key support services: community mobilisation; health; and, non-
formal education. Due to budget cuts and programme revision the assistance to the health
and non-formal education sectors has been dropped from the programme. This
assessment, therefore, is limited to the assistance provided to the agricultural and cottage
industry sectors through CANAMCO/Oxfam-Canada's community development initiatives
and emergency programmes.

The rationale for the programme is outlined in document COC1 (1991) and it is clearly
stated that the programme has chosen a multi-sectoral and multi-dimensional approach in
response to the expressed needs of the local community. According to programme
documents, the programme is designed to avoid creating dependency, so activities will be
non-recurring or will develop Namibian institutions to carry on activities independently.

The project goal as outlined in document COC1 (1991) is:

To increase the agricultural production of small farmers in the Kavango
region, and to promote the marketing of agricultural produce and thereby the
generation of income for small farmers.
The discussion below is based on this stated goal and the project objectives outlined in the documents. The assessment of the projects below is laid out in the sectoral divisions given in the project documents provided and the Terms of Reference (Appendix 1). As most of CANAMCO/Oxfam-Canada’s projects are not well advanced, most of the recommendations are centred around the perceived training and capacity building needs of the communities such that the product of interventions is sustainable and equitable development in Okavango. There is a need to develop a level of awareness on which communities can build structures of decision making such that the goal of community control of communal resources can be achieved. The majority of CANAMCO/Oxfam-Canada employees and CDC members interviewed in this study expressed an interest in undergoing some degree of skills development in the fields of agriculture and environmental evaluation. It would be true to say that most employees lack essential skills in both these fields and that if the programme is to be successful, training should be made a priority.

The ORAP (Zimbabwe) curriculum was not available for review during the period of consultancy so is not included in the discussions below.

3.2 AGRICULTURAL DEVELOPMENT

Stated project objectives (relevant to this sector) designed to achieve the project goal are:

- To increase the productivity of small farmers per unit area of land;

- To enable the exploitation of larger land areas both for arable and livestock production, and thus to alleviate the over-crowding and concomitant environmental degradation near the Cxavango River by enabling resettlement away from the river;

- To stimulate the development of processes involved in the marketing of agricultural produce.
These objectives will be dealt with under the agricultural practices outlined below (sections 3.2.1 to 3.2.4). There are, however, environmental concerns of a general nature which require clarification.

The second objective regarding the exploitation of land areas away from the river to relieve environmental pressures on the river is one which has gained considerable popularity, but is questionable in practice. The areas which are open for settlement are often described as having "underutilised or unused" grazing resources, but have a resource base which is considerably poorer than that along the river. Soils are generally nutrient poor sands, with low crop production potentials (there are small patches of soils with higher production potentials) and large areas are required to produce the subsistence requirements of an average household. Additionally, dry season grazing for livestock is poorer than grazing along the river. This resource base is clearly perceived to be poorer by people settled along the river and there is a general reluctance to move if there is a requirement to give up land holdings within the riverine strip.

The point here is that although settlement of "new" areas away from the river gives certain opportunities particularly regarding the livestock industry, movement of people away from the river is likely to be on a small scale and probably slow. This scale of movement is unlikely to "alleviate the overcrowding and concomitant environmental degradation near the Okavango River".

The environmental problems associated with high human and livestock densities along the river are not going to be resolved by attempting to shift the population away from the river, but by developing adaptive strategies of resource use along the river based on a strong ethic of communal tenure. The CANAMCO/Oxfam-Canada programme has as its base the principal of community mobilisation, and it is at this level that the programme can make it's most significant impact through assisting the development of communal resource management strategies.

**Recommendation:** CANAMCO/Oxfam-Canada should not use the "resettlement to relieve demand" argument as a primary objective in any of their projects. If
CANAMCO/Oxfam-Canada is to continue to be involved with borehole development projects or resettlement schemes, interventions should be focused on ensuring resource security (food, water) and integration into a service infrastructure (shops, health, education, roads). (See Kirkwood (1993) for further recommendations on this point). CANAMCO/Oxfam-Canada resources may well be better used in addressing environmental and socio-economic issues on the river, than supporting resettlement programmes.

3.2.1 Livestock farming

CANAMCO/Oxfam-Canada is not involved with any projects directly related to livestock farming. However, based on experience elsewhere, the emergency borehole programme will have the effect of increasing cattle numbers, in that water supply to these areas is now secured. Environmental concerns in this regard are principally focused on overgrazing around boreholes. This is almost sure to happen, but through the community mobilisation programmes being developed people can be made aware of the risks that environmental degradation poses for sustainable livestock management. Oxfam-Canada have made contractual stipulations with the Department of Water Affairs that livestock numbers are limited to 1 LSU/20ha on boreholes funded by them (J. Graham, in litt.). These limitations will be difficult to enforce, but the added precaution of providing handpumps to most sites limits water supply and so limits cattle numbers. There is a need for community mobilisers and possibly Community Development Committee members (CDC) to undergo some training with reference to livestock farming and sustainable range management.

Recommendation: It is recommended that the CANAMCO/Oxfam-Canada programme management develop a profile of training requirements relevant to livestock farming practices. This can be then taken further by approaching relevant government agencies and possibly NGO’s to give training on a formal or informal basis. The training should be focused on the facilitators of the programme (i.e. community mobilisers and CDC members). Where time constraints allow, senior management officials should attend these courses. Courses should include modules on: grazing resources and their management;
the use and misuse of fire as a management tool; the assessment of carrying capacities and the importance of annual variation of rainfall on these assessments; general herd health, including information on nutrition, husbandry techniques and disease control; markets, and how to develop new co-operative structures for marketing; and, an assessment of traditional systems of livestock management and how these can be improved. The main thrust of the training should be focused on complementing, supplementing and adding to structures already in place. Interventions should not be based on technological packages which would be completely new to the focus communities.

Training in certain components can be done by:

Dept. of Veterinary Services, Rundu - Dr. T. Tolmay, State Veterinarian, is prepared to give a series of training lectures (given to Stock Inspectors) to the mobilisers and other interested parties.

Department of Agriculture, (Pasture Sciences Division) - run short training workshops for farmers on commercial farms, which can be easily be adapted to conditions in communal lands.

Directorate of Forestry, Rundu - are willing to run short training course on fire usage, forest resources and to a lesser extent on rangeland management.

There is also a training component in the Northern Communal Lands Livestock Improvement project currently nearing completion by IFAD (contracted to the Department of Agriculture).

Recommendation: Community mobilisers should start to collect information on attitudes, needs, and expectations regarding cattle ownership and livestock management along the lines of the programme already established by the Department of Veterinary Services in Kaokoland (Kunene) and East Caprivi (Linyanti). This data is used for evaluating marketing demands, how to improve access to markets and to structure marketing campaigns to best satisfy expectations of communal farmers.
3.2.2 Dryland crop farming

The improvement of dryland crop production is an important component of the CANAMCO/Oxfam-Canada programme and several interventions have been made in this field. As outlined in Chapter 2 above, the improvement of crop production in Okavango is a difficult task given the biophysical constraints on production, with rainfall variability and poor quality soils of prime importance. Access to agricultural equipment and the problems related to land availability are also important constraints on improved production. CANAMCO/Oxfam-Canada has provided loans for use as ploughing subsidies, provided tools at cost or subsidised prices and has distributed seeds of at least two varieties of millet, sorghum, maize, beans and pumpkins as part of the emergency programme.

These interventions have had a positive effect on crop production. However, other initiatives supported by the programme are less likely to achieve long term sustainable increases in production. The expansion of cultivated lands into the area to the south of the river will see short term gains but these will not translate into sustainable increases in most areas largely as a result of the rapid depletion of soil nutrients in these areas after clearing for cultivation. There are areas where soils are more productive, but if productivity is to be increased regionally, there is a need to develop a integrated system of cultivation where soils are fertilised, crops rotated, intercropping practices enhanced and forest resources conserved. Again the emphasis here should not be on providing a technological package with little relevance to the communal farmer. The focus should be on building on the experience and expertise already in place and to introduce improvements which are likely to be accepted.

Environmental concerns within this agricultural sector are based on: the "slash and burn" practice which has become increasingly common as people move away from the river, where the traditional practice is a form of falling; the high demand for land along the river and the concomitant degradation of riverine habitats so important for the subsistence economy in the area; and, the destruction of traditional food trees and other plants which provide resources such as construction materials, fuelwood and medicine. The nett result
of all of these concerns is a rapid expansion of cultivated lands at the expense of traditional communal resources which have always been an important buffer against natural catastrophes such as drought.

There is an urgent need for facilitators to: gain an understanding of the interrelated nature of the biophysical limits on crop production; to understand the value of traditional farming methods designed to minimise risk; and, to understand the value of traditional wild plant foods. An understanding of these facets of the subsistence economy of the region could provide the foundation of a programme of improved crop productivity designed firstly to improve household food security and secondarily to produce excess for resale.

Recommendation: Facilitators should be given a good grounding in the principles of agronomy, with specific emphasis on the problems of dryland crop production. This training should include components on: soils, soil classification and crop suitability; crops suitable for dryland crop production and their different characteristics; planting techniques; pests, pest control and the problems associated with this in communal lands; harvesting and storage techniques; methodologies to investigate traditional farming systems to elucidate risk aversion strategies; and, strategies designed to improve productivity in environments with highly variable inputs.

Recommendation: Facilitators should investigate traditional farming systems to assess: current crop production strategies; farmer attitudes, needs and expectations; use of traditional wild plant foods; traditional varieties of crops in use; labour practices; and, access to ploughs and ploughing services. This information would be important in the design of future interventions, as these data would provide a basis on which to develop these interventions (i.e. build new projects on the expertise and experience already in the community).

Recommendation: Facilitators need to undergo specific training in aspects of soils science, specifically: soil classification; soil suitability for different crop types; taking samples; and, field appraisal. This would allow people to make assessments of soil suitability in the field, which would reduce the chances of bad decisions being made
regarding placement and size of cultivated lands. An assessment of traditional systems of soil classification should be undertaken, to see if the traditional system can be adapted for use in extension programmes.

**Recommendation:** An assessment of the dependence of households on traditional wild plant foods needs to be undertaken and extension programme developed from this. Wild plants have a number of valuable properties. They provide important dietary supplements in the form of vitamins and protein, as well as cheap construction materials and fuel wood. The values of these plants needs to be emphasised and their conservation promoted. Other important considerations in this regard are: wild plants serve as breeding sites for crop-pest predators and leaving trees in cultivated fields will almost definitely reduce pest problems; and, leaving food plants in cultivated fields allows for a rapid regeneration of natural vegetation during fallowing, which allows for a quicker recovery of depleted soils.

**Recommendation:** Soil fertilisation techniques and intercropping practices need to be investigated, and a practical extension programme developed from this. The only way in which sustainable increases in crop production are going to be achieved is through fertilisation of cultivated lands. There is a need to explore the possibilities of: providing intercropping species for soil fertilisation and food production (e.g. roundnuts); the use of green mulch and non-food nitrifying plants (e.g clovers); composting on small fields; the use of livestock manures; and, the use of liquid manures. With regard to intercropping species, consideration should be given to expanding the choice currently available and subsidising costs, but, this should be accompanied by a strong extension message and not just be given as a hand-out. All technologies introduced to increase agricultural production should also attempt to decrease the inequalities between rich and poor farmers. This can be done by introducing technologies that require inputs that poor farmers can afford. For example, introducing new intercropping plants would be better than introducing chemical fertilizers which are more expensive. However, the impressive gains in production achieved in Malawi through a programme of subsidised chemical fertiliser distribution could have parallels in Okavango. Environmental risks in Okavango would be centered around contamination of ground water and the river. These can be minimised
by limiting quantities of fertiliser, improved farming techniques (e.g. terracing to reduce surface run-off) and the development of an extension and training programme for participants emphasising aspects of storage, handling, application and the concomitant risks involved. The MAWARD currently has a chemical fertiliser programme in Okavango but less than 300 bags per year are sold (pers. comm, P. Horn, Director of Agriculture, Rundu).

**Recommendation:** A subsidised programme of chemical fertiliser distribution should be considered, but not until a full assessment of the risks involved, is undertaken. This would need to include soil survey work to assess application rates, soil run-off characteristics and farmer training requirements. Distribution of chemical fertilisers should be linked to a strong extension programme promoting the use of farm yard manure. Current estimates are that a single large stock unit will produce 2 tonnes of manure in a kraal per year (Masdar 1993). Livestock held by an average household will produce enough manure for applications of 6 tonne/ha, which in combination with 20 units of phosphate will provide the best opportunity for intensification of mahangu production (Masdar 1993). This would be best applied in the areas bordering the river where most cattle are kraaled at night.

Due to the high cost of chemical fertilisers there is a distinct risk of a client dependency relationship developing between CANAMCO/Oxfam-Canada and focus communities.

**Recommendation:** A full survey of the provenances and varieties of traditional millets should be undertaken to investigate varietal characteristics. Several varieties are grown in Okavango, all with different growth and seed production characteristics. High production, quick growing varieties such as Okashana-1 may already exist in the region, but need a wider distribution. CANAMCO/Oxfam-Canada can play a role in this through cooperation with the Namibian Plant Genetic Resources Programme (NPGR), currently housed at the National Botanical Centre in Windhoek. The NPGR can organise training in collecting techniques, provenance evaluation and breeding systems. This is not a technically difficult course. More detailed and intensive training is available through the SADC Regional Gene Bank, housed in Lusaka. A 3 month study grant is provided to
study seed collection, storage, provenance evaluation and extension programmes in Norway and Sweden.

**Recommendation:** An extension programme needs to accompany any seed distribution programme supported by CANAMCO/Oxfam-Canada. As part of the emergency programme several varieties of millet seed were distributed throughout Okavango. Interviews held with farmers during the field survey suggest that there was often mixing of traditional and emergency distributed seed. These were sown together, rather than cultivated separately. This is a sure way to loose the beneficial varietal characteristics quickly. This was not the case with all farmers, but an extension programme needs to be developed which focuses on the importance of cultivation in separate plots, separating the harvest and the storage of different varieties.

**Recommendation:** The CANAMCO/Oxfam-Canada programme should investigate traditional ploughing systems, such that an assessment can be made of how these systems can be made more efficient (time/area cultivated) and made more accessible to farmers who have no ploughs/oxygen themselves. The programme should not consider supporting the government ploughing service as it stands at present. There is a threat of client dependence on an non-sustainable service. The tractor ploughing service is: unreliable and inflexible (traditional ploughing takes place before, during and after rains, whereas the government service is a once a season service); promotes poor land use practices, as more land is ploughed than can be seeded with the nett result soil is degraded through erosion, desiccation and death of soil microfauna.

**Recommendation:** Storage techniques currently in use should be investigated such that an assessment of traditional systems of storage can be made to elucidate ways in which these may be improved, supplemented or replaced. Post-harvest losses of grain is reported to be high in some areas and there is a need to improve storage facilities. Improvements can be very cheap. For example, in Zimbabwe traditional basket storage has been replaced by open platform stores. Extremes of temperature in the winter (post-harvest) kill stored grain pests, whereas traditional basket storage (similar to practices in Okavango) tend to be constant temperature environments in which pests flourish. Consideration should be
given to distributing certain low cost products such as Actellic (ICI products) which while being toxic to stored grain pests is harmless to people.

**Recommendation:** The CANAMCO/Oxfam-Canada programme should investigate the development of a "Master Farmer" support project in Okavango. The easiest way in which to get new innovations accepted within communities is to lead by example. A "Master Farmer" programme could well provide the best avenue to do this. Through encouraging and supporting on-farm trials and pilot projects, such as the fertiliser trials currently being undertaken by Department of Agriculture and ICRISAT, new practices and strategies can be introduced into the subsistence economy of the region.

3.2.3 Vegetable farming

CANAMCO/Oxfam-Canada is supporting the development of commercial vegetable gardens through their programme of assistance to communities in focus villages. There are a number of such developments under way at present. As with any development project of this nature some of the production units are operating successfully while others are not. Many of the problems (inappropriate size plots - some were planned to be up to 50 ha in extent; sites with low irrigation potential soil; unrealistic expectations and poor understanding of complexity of the enterprise by participants) with these units has largely been a consequence of the relative inexperience of the community mobilisers in the early phases of development. As pointed out in Kirkwood (1993) the environmental implications of inadequate or poor extension work are potentially significant. As outlined both in Yaron *et al.*'s (1992) report and Section 2.3.3 above, vegetable farming is a risky business and requires high capital outlays, high labour inputs, high levels of technical knowledge and is characterised by a low return per unit sold. There is, without doubt, a demand for vegetables and a good production potential exists in Okavango, but the enterprise needs to be approached with caution if it is to be sustainable in the long term. There is a need to develop and awareness of the potential negative environmental impacts of vegetable production at both the facilitator (community mobiliser) and participant levels.
Issues of principal concern with regard to vegetable production are:

- those related to poor extension, which can be largely addressed through training
  of facilitators and participants;
- those related to technical inputs, such as clearing of sites, fertiliser use and
  application of biocides.

Recommendation: Facilitators within the programme should undergo training in the basics
of vegetable production, such that they will have a clear idea of the risks involved, the
importance of guaranteed market supply, problems of pest control, storage, transport,
produce quality, etc. Participant training is not the emphasis here - it is facilitators who
act as extension officers within the communities and it is they who need the training.
Some of the problems encountered at vegetable plots were a direct result of the relative
inexperience of the mobilisers. Training can be done by a number of institutions. Certain
training interventions have taken place since the draft report of this study was submitted
and the programmes funding of Mr. P. Lenhardt is a major asset in this regard.

Food Gardens Unlimited, a South African based NGO, does training in low cost, small
scale production units, designed largely to satisfy household demand. The emphasis in
their programme is soil strengthening techniques, low cash inputs, low technology
requirements, low labour inputs and non-chemical techniques of pest control. The
training and the production unit (a small plot about 2m x 3m) are designed to satisfy the
needs of rural communities with little access to resources.

Recommendation: Prospective participants in vegetable farming schemes (whether
commercial or own-use) should be required to undertake a short training course, in any
programme supported by CANAMCO/Oxfam-Canada. Expectations often exceed realistic
levels of production and so the course should emphasise the problems related to this
enterprise, as well as potential benefits. Participants should be encouraged to undertake
vegetable production on a small scale first, to assess the demands on the individual in
relation to labour, cash inputs, production levels and expected cash returns on resale.
This recommendation is made with the view that failure of any enterprise such as
vegetable plots is environmentally costly, especially where initial developments are on a
large scale.

Recommendation: Before supporting projects of this sort (fish farming, vegetable production, poultry units, etc.), CANAMCO/Oxfam-Canada would do well to develop small appropriate scale pilots on which to base an approach for introduction of technologies into focus villages. This would allow a step-by-step interactive approach between CANAMCO/Oxfam-Canada and participants, such that responsibilities, needs and expectations are clearly defined. This would allow an appropriate scale of project to be arrived at simply, efficiently and cost effectively. Pilots may be run as part of the "Master Farmer" programme recommended above.

Recommendation: The use of traditional vegetable crops should be investigated, such that an assessment of their cultivation potential for intensive gardening can be made. Several varieties of "spinach" and other vegetables are grown through Okavango, and they are widely accepted by the local population, store well, are disease resistant and are easily grown (water requirements are considerably less than commercial vegetable crops). They have the potential to contribute considerably to the local subsistence economy and their value should be reinforced through an extension programme.

Recommendation: The total clearance of prospective vegetable production plots of all indigenous trees and shrubs should be discouraged. The value of indigenous trees and shrubs lies in soil nutrition functions (particularly leguminous species such as Acacia), shade (important for nursery sites) and acting as islands of protection for predatory insects within the cultivated areas. Work in the Sahel on the importance of nutrient inputs by Acacia albida has shown that crop and vegetable production is increased significantly if A. albida trees are left within plots and gardens (Booth & Wickens 1988). Work by Cambell (1986) in Zimbabwe has shown that in plots with large trees still standing, crop pest infestations are significantly lower than cleared plot sites as the trees were refuge sites for insect predators. Trees also serve to bind soil, break rainfall impact on soil and can also serve as a source of food.
Recommendation: The use of farm yard manure for plot fertilisation should be actively encouraged. As discussed above, there are sufficient cattle within the vegetable growing region (the riverine strip) to supply an abundance of manure for field application. The collection and distribution of manure can in itself form the basis of a small cash industry as it does in Ovambo. The use of chemical fertilisers should be investigated in some of the larger plots where farm yard manure supply may not satisfy demand. However, in areas where soils are predominantly sands care should be taken to assess the fertiliser application rates and not to exceed these, as excess fertiliser can move through the profile into aquifers. Sands have very poor chemical binding properties and will do little to halt fertiliser movement into the aquifer. In parts of western Zambia problems of nitrate pollution of aquifers under tobacco fields is a particular problem. The same applies to biocide application on sandy soils. The facilitators should be given training in fertiliser application, handling and an extension programme promoting farm yard manure should be developed.

Recommendation: The use of chemical herbicides and insecticides should be used with caution (if at all). Problems with regard to the use of biocides usually arise through poor handling and understanding of the methods of application and operation. Systemic insecticides are of particular concern as they operate for a number of days after application and people are often poisoned after eating vegetables before the poison has been broken down. If biocides are to be used, the programme needs to develop the capacity to conduct intensive training for participants and to monitor the effectiveness of this training at different sites. This responsibility should perhaps be given to a single mobiliser. Bayer Agrochemicals based in Windhoek does field training and there are a considerable number of courses available in both Zimbabwe and South Africa on the handling, application, storage and monitoring of biocide use. The majority of these courses are presented by the large agrochemical companies, some of which provide overseas study grants for advanced courses.

The use of alternative pest control methods should be investigated. Food Gardens Unlimited have a series of low cost recipes for insecticides made from readily available constituents. These range from basic salt and water applications for controlling leaf
pests, soap and water sprays for aphids, to the planting and mulching of marigolds for the control of soil nematodes. The advantage of these types of insecticides is that they require little management, storage or training at the same time as being effective. Chemical biocides on the other hand are dangerous and have to be handled accordingly.

3.2.4 Fish farming

CANAMCO/Oxfam-Canada has had no direct involvement with fish farming, with the exception of providing a loan to Katemo Co-operative for this purpose. Fish farming, like vegetable production, has the potential to contribute significantly to the diet of local people as well as provide some cash income. However, there are considerable technological and financial problems to be dealt with before a unit is likely to become profitable. Some of the problems to consider are: construction costs of ponds; access to breeding stock and fingerlings; feeding; harvesting; post-harvest storage; and, marketing. These problems are discussed in Section 2.3.4 above.

Recommendation: Facilitators within the CANAMCO/Oxfam-Canada programme should receive training in fish farming techniques, management and marketing. Training should include components on: construction materials and requirements of ponds; water aeration; fish biology and breeding systems; feeding; breeding stock and fingerlings; water quality; harvesting; marketing; and, hygiene and pest control.

Training can be done by several institutions in the region. The Aquaculture for Local Community Development (ALCOM) programme in the SADC region provides training courses in-country and has considerable experience in the development of small scale fish farms in the region. They have access to a broad range of expertise which may be important in resolving problems specific to Okavango.

Recommendation: CANAMCO/Oxfam-Canada should initially limit support to small scale pilot projects which can act as a development facility for possible expansion into new areas. This step wise approach provides good training for facilitators and can be developed along the lines of the "Master Farmer" idea discussed above.
There is currently an excellent opportunity for this type of approach at Max Makushe School in the Mbukushu District. A proposal for the construction of a small operation at the school is being developed, the main focus of the programme being to test whether fish farming is viable, to integrate this practice into the life sciences curriculum and possible the business management/accounting curriculum and to act as an extension service in the region.

**Recommendation:** CANAMCO/Oxfam-Canada should actively discourage the use of exotic fish species in fish farms, and should not support any project proposing to use exotic species. Of special concern in this regard is *Oreochromis mossambicus* which is very closely related to indigenous species in the river, which will be outcompeted by *O. mossambicus*. This may have severe negative effects on the artisinal fisheries in Okavango and Botswana.

**Recommendation:** CANAMCO/Oxfam-Canada should promote or assist in developing an extension programme focused on fish and artisinal fisheries in Okavango in consultation with relevant government departments. Fish are a resource of great importance in the subsistence economy of the region, but it is widely held that this resource is being depleted. No control or management of fisheries is currently being undertaken and the demands are not being reduced. An extension programme could serve as a vehicle to enlighten people of the inter-related nature of the factors controlling fisheries production and the "health" of the river, which is the determinant to a large extent of the health of the human populations along its course.

### 3.3 DEVELOPMENT OF FOREST RESOURCES

CANAMCO/Oxfam-Canada is not supporting any projects directly involved with the exploitation or development of forest resources, with the exception of loans to the Mbangura Wood Carvers Co-Operative. Members of the Mbangura Co-operative buy wood from the commercial timber mill in Rundu, as well as cut dry wood in the bush. This has relatively little impact on the forest resources of the region at present.
However, there are areas of intervention where the CANAMCO/Oxfam-Canada programme can have direct inputs and have a positive impact on the management and utilisation of forest resources. Forest resources provide cheap materials, food and fuel for subsistence level communities and the value of these traditional resources needs to be reinforced and entrenched in communities dependant (to a greater or lesser extent) on them. The indiscriminate use of fire, cutting of food trees, "slash and burn" cultivation practices and overgrazing, need to be discouraged and the use and management of these resources, on a sustainable basis, needs to be encouraged.

**Recommendation:** Facilitators within the CANAMCO/Oxfam-Canada programme need to be trained in the principles of forest resource management, problems associated with the indiscriminate use of fire, wood harvesting techniques and the values (uses) of forest resources. This training would provide the basis of inputs for developing an extension programme for the promotion of rational and sustainable use of forest resources. The extension programme would need to include a component specifically addressing the value of traditional wild plant foods and their conservation.

Basic training and support for the extension programme can be provided by the Directorate of Forestry, Rundu, where staff already have an extension programme in place and work closely with schools and NGOs in the region.

More specific training may be available from the Development Brigades Corporation, who have a well structured Forestry Training Programme, running at both Berg Aukas (Grootfontein) and near Mashare Agricultural College.

**Recommendation:** CANAMCO/Oxfam-Canada should investigate ways in which the artisanal wood carving industry in the region can be aided in its development. The current involvement with the Mbangura Wood Carvers Co-Operative needs to be taken beyond loan inputs, to one where skills training is the prime focus of interventions. The emphasis should be on more efficient use of wood products (there is considerable wastage, especially in dry cutting) and the improvement of quality of finished products such that items can enter the high value added end of the market. Traditional skills levels are high,
however, these do not fulfil the needs of the buyers market (principally tourists) which wants fine finish products (blind joints, dowels not nails, clean sand papered finish). Tourism is set to rise in Okavango over the next two years with the opening of the Trans-Caprivi Highway, and products are going to have to be of a high standard to compete with the high quality market in Zimbabwe.

Recommendation: CANAMCO/Oxfam-Canada should investigate ways to encourage alternative forest product usage amongst traditional wood workers. In other parts of Namibia species such as *Terminalia sericea* (common in Okavango) are the basis of furniture industries which do well (e.g. Geelhout Industries in Gobabis). Only a few species are considered for wood working in Okavango, but this spectrum can definitely be expanded.

3.4 EMERGENCY BOREHOLE PROGRAMME

CANAMCO/Oxfam-Canada supported an appeal by the Government of Namibia for assistance with drought relief during the 1991/1992 drought and Oxfam-Canada supplied funding for the drilling of 13 boreholes. Siting of boreholes and drilling was done under the auspices of the Directorate of Water Affairs. In a fax dated 9 June 1992 to the Chairperson of the National Emergency Committee, it is stated that the emergency borehole drilling programme supported by CANAMCO/Oxfam-Canada "is designed to alleviate the grazing stress of large livestock on areas close to the river". This point has been discussed elsewhere in this document. The Consultant is of the opinion that this statement is unsubstantiated and should not be used as a justification for this type of programme. Borehole developments, do however have the potential to significantly expand the agricultural base of Okavango, particularly with regard to livestock.

The CANAMCO/Oxfam-Canada borehole programme will have negative impacts, the most important of which is the general degradation of rangelands and forest resources in the immediate vicinity of the borehole. The boreholes have been sited at villages already established (or areas already utilised) so some degree of degradation has already taken
place. There is very little that can be done to directly ameliorate this type of degradation (Biot, 1993). The CANAMCO/Oxfam-Canada decision to place hand pumps on boreholes where technically feasible, is a very positive intervention which is the only practical way in which stock numbers can be limited at borehole sites. This will hopefully act as an example to other development agencies and government departments. Other negative impacts include: the possible expansion of cultivated lands under "slash and burn"; extensive cutting of wood for palisade fences; overgrazing of interdune rangelands which is often more palatable than that on dunes; and, the marginalisation of settler communities with regard to the service infrastructure. All these impacts can be mitigated to some extent through the community mobilisation and extension programme currently centred on Waterpoint Committees.

The Terms of Reference specifically state that recommendations for a monitoring programme must be developed for the CANAMCO/Oxfam-Canada borehole project. Beyond making the broad recommendation that CANAMCO/Oxfam-Canada should support a national initiative in developing an environmental impact data base and monitoring programme (specifically on borehole developments) for Namibia, the Consultant does not feel that under current conditions there are any recommendations regarding monitoring that can feasibly be implemented. Monitoring is expensive in money and manpower and must, therefore, concentrate on questions for which answers are needed by management to achieve its goals. Monitoring consists of keeping track of components a system specifically to assess their progress in relation to the objectives (set by managers) for the system (Bell 1990). As monitoring is laborious and expensive it should be restricted to those components that it is essential for management to keep track of. However, the problems of which components should be monitored and how these data can be used to influence the management of an area, arise but are seldom addressed. The CANAMCO/Oxfam-Canada borehole programme is faced with two problems: who is going to do the monitoring?; and, how are data collected going to be used to achieve objectives set by management? Current staffing structures and skills levels determine that monitoring of borehole sites cannot be done by CANAMCO/Oxfam-Canada staff. There is a need for senior CANAMCO/Oxfam-Canada staff to formulate the objectives of the programme interventions relevant to the borehole project, and from this monitoring
priorities can be determined. A monitoring strategy should be designed to let decision makers know when to intervene. However long-term monitoring programmes often fail because (i) land uses and management objectives change with time, and (ii) it is very difficult to distinguish irreversible long-term change from reversible short to medium term production declines which result from climatic fluctuations (Biot 1993). Given the problems with monitoring systems outlined above, it is suggested that the emphasis be placed on the human factor in environmental management and resource conservation, and that socio-economic factors be given a high priority in any monitoring programme. With regard to changes in the vegetation and other biophysical parameters, the simplest and most cost-effective monitoring system that could be established would be one of simple photo-point monitoring. Here photographs are taken at assigned locations at fixed time intervals, and comparison of photographs can give a general approximation of changes that have taken place. There is very little requirement for the collection of qualitative data.

The use of remote sensing data (taken to mean satellite imagery) in a monitoring programme in Okavango is of questionable value. Resolution is too poor to make any direct inferences of cause and effect, it is expensive and again the question arises as to how this data will be used.

Early programme documents clearly state that there should not be any major involvement in water supply during the initial two year period. That two year period is now past, and there is a need for the programme directors to formulate policy guidelines in this regard, such that interventions are sustainable and in line with the stated programme goal stated at the beginning of this chapter.

**Recommendation:** The proposed construction of tube-wells in collaboration with CO-Operation for Development should be limited to providing wells to those communities with extant pits, and should not look at opening up new areas until such time as objectives with regard to water supply interventions are formulated.
Recommendation: CANAMCO/Oxfam-Canada should consider restricting interventions in the water-supply sector to borehole rehabilitation and on-site capacity building so water supply is secured for communities. At present the government department charged with servicing boreholes and pump installations is stretched almost beyond capacity. Teaching people to service their own boreholes, pumps and to assume responsibilities in this area, is likely to make water security less of an issue than it is at present. Interventions in other areas are not then disrupted by breakdowns in water supply, and are thus more sustainable.

3.5 EMERGENCY SEED DISTRIBUTION

As part of the emergency support programmes developed during the 1991/1992 drought CANAMCO/Oxfam-Canada undertook a seed distribution programme. A variety of seeds (in a package) were distributed free or at subsidised prices. This intervention definitely had a positive impact in that it markedly increased food supply and security. There is a definite need within Okavango for farmers to increase the number and varieties of crops grown but access to seed is a problem for most. For this reason the seed distribution programme should be continued.

Recommendation: CANAMCO/Oxfam-Canada should continue the seed distribution programme. This programme satisfies a demand for good quality seed, while at the same time increasing household food security and supplementing dietary deficiencies. The programme should undertake an investigation of dietary needs to see where overall community health can be improved through introduction of crops good for dietary supplementation.

Recommendation: Any seed distribution programmes should be accompanied by an extension service providing information on the planting, care, harvesting and storage of the different crops. The importance of separating varieties is particularly important (see section 3.2.2 above).
4. CONCLUSIONS

One of the central tenants of the CANAMCO/Oxfam-Canada programme is to help the poorest of the poor within the Okavango Region. The objective is to deliver benefits to households and communities within Okavango, while at the same time, holding constant or decreasing the inequalities between households and communities.

The programme objectives are being achieved through:
- building organisational capacity through the formation of community development committees (CDC) and water point committees (WPC);
- support to existing co-operatives;
- direct assistance to community groups and households involved with agriculture, vegetable production, sewing and other cottage industries;
- assistance to the drought relief programme, through funding borehole development (no longer continued).

The CANAMCO/Oxfam-Canada programme has attempted, through the establishment of CDC’s and WPC’s to make the decision making process (w.r.t development initiatives) within communities as democratic as possible. At the same time the programme has emphasised the fact that supported projects should contribute to increased community control of local resources with a view to sustainable resource use.

The CANAMCO/Oxfam-Canada programme, as a whole is well formulated and initiatives have had positive impacts across a broad range of socio-economic conditions. Significant contributions have been made to the development of focus communities, as well as outside these communities (e.g. the emergency seed distribution project). It is, however, the Consultants opinion, that implementation and success of projects and the environmental sustainability of projects is being compromised by several factors. These factors were identified through discussion with programme participants as well as programme staff. They are general issues which are likely to be common to development programmes.
similar to the CANAMCO/Oxfam-Canada initiative and should not be construed as criticisms, but rather as areas within the programme to which more resources and time could be allocated. These issues are being addressed by the programme, but are included here as they were found to be central to specific project problems identified during the study. Most of these issues are addressed by Kirkwood (1993).

The most important factors are:

- the generally low level of awareness among programme staff and participants of the inter-relatedness of socio-economic condition and the quality of common property resources. The term environment should be interpreted to include the biophysical, social, economic, cultural and political components of the region. There is a tendency to separate socio-economic issues from natural resource issues and to place natural resources in a "nature conservation" type of framework. In communal lands the two are inextricably linked and quality of life is very often dependant on the quality of the natural resource base available to people. The important aspect here is the need to recognise the fact that environmental impacts of interventions often go well beyond the immediate boundaries of the intervention. For example, the secondary (settlement) and cumulative (overgrazing) impacts of borehole developments are generally far greater than the impact of the borehole itself.

- the poor monitoring and reporting structures, the failure to establish a clear record of decision and a poor understanding of the project cycle, particularly by the community mobilisers. Poor monitoring and reporting within the programme can lead to potentially serious environmental impacts in that projects which have negative impacts can continue for a long time. There is also potential for the same mistakes to be made at other sites. A clear record of decision is central to successful project implementation - a record of why decisions were made, what decisions were made, who is responsible for implementation, what resources have been allocated, etc. are all intrinsic to sustainable projects. No records of this kind lead to problems of continuity (especially in relation to changing management
objectives), repetition which may lead to scarce resources being misapplied (reinventing the wheel).

- the poorly trained facilitation staff (community mobilisers), particularly in respect of specific sectoral expertise (e.g. crop production, livestock husbandry). Low levels of sectoral expertise have environmental implications in that decisions made regarding certain interventions may have much wider consequences than are immediately apparent. If facilitators are going to successfully encourage environmental awareness and sustainability within communities, they have to have a clear understanding of the consequences of project interventions and all aspects of the environment in Okavango.

Many of these problems are being addressed by the programme at present, such that the objective of environmentally sustainable projects can be achieved. Central to this must be a commitment to assign resources for a broad spectrum of training for facilitators as well as participants.
REFERENCES


