

**FACTORS INHIBITING DAMBO UTILIZATION IN
ZAMBIA:
A CASE STUDY OF GWEMBE DISTRICT**

BY


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DECLARATION

I, **Kamwanga Carlos .K**, declare that this report has been composed by me and that the work recorded has been done by me, that the sources of all material referred to have been specifically acknowledged, and that the project report has not been accepted in any previous application for academic award.

Signature 

Date 15/12/2003

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ABSTRACT

The study was undertaken to determine factors inhibiting dambo utilization in Zambia, taking the case of Gwembe District. The research involved the collection of data relating to management of dambos, accessibility to credit and agricultural information by the indigenous people of Munyumbwe area and their awareness of the law governing the use of dambos, specifically Chapter 198 of the Laws of Zambia.

The study also involved the comparison of ‘undisturbed’ dambo and a ‘disturbed’ dambo. The study found that Chapter 198 of the Laws of Zambia (Water Act) is not known by farmers in the study area and therefore does not in itself inhibit dambo utilization. It was also observed that farming practices being employed by farmers in the study area significantly contributed to the degradation of the dambo under study.

The study recommends appropriate land-use techniques to reduce the degradation of dambos: the dambo should not be allowed to dry out permanently; cultivation should take place only on the upper dambo zone; grassed strip at least 60m wide running along the bottom of the dambo should be left uncultivated; application of cow manure or compost and the ploughing in of crop residues should be encouraged and heavy machinery for dambo cultivation should be discouraged. The study also recommends adjustments in Government policy over dambo use: review the present designation of dambos as non-arable; and modify the present legislation to incorporate safe levels of cultivation. The paper further recommends areas for future research.

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Dambos are small-scale environmental resources, which are wide spread in Africa's tropical plateau savannas. They are shallow seasonally waterlogged depressions at or near the head of a drainage network (Mackel, 1985). Dambo catchments are thought to act as hydrological reservoirs, storing water in the rainy season and releasing it for evapotranspiration on the dambo surface and for dry season stream flow (Hough, 1986).

Dambo is a Bantu word of Malawian-Zambian origin meaning valley meadowland. In Eastern Africa, similar features are known by the term Mbunga (Swahili), while related West African wetlands include the Fadamas of Nigeria and the Bolis of Sierra Leone. In South Africa, similar wetlands are known as vlei. No systematic attempt has yet been made to map the extent and distribution of dambos or other valley-bottom wetlands at a continental or sub-continental scale. However, it is known that dambos have a core area in central Southern Africa within which they occupy around 10% of the total land surface (Bell *et al*, 1987). This research will establish factors inhibiting dambo utilization in Zambia, taking Gwembe District of the Southern Province as case study.

1.2 BACKGROUND AND RESEARCH PROBLEM

In Zambia, Dambo cultivation has been going on since time immemorial. The colonial government discouraged dambo cultivation for fear that wetland cultivation would cause erosion and drying-up of streams. Raussen (ed) (1997), notes that white settlers banned

dambo gardening. This deprived African farmers of an important aspect of their livelihood, which made the ban unacceptable. Because dambos remain moist during the dry season, they represent a reliable near-surface water supply for human and animal consumption. They are especially important in areas where alternative water sources are remote or prone to drying up.

Dambo utilization is governed by Cap 198 of 1957 (Water Act) of the Laws of Zambia, in which dambo use is categorically prohibited, except for 'primary use'. The Act defines primary use as "the use of public water for domestic purposes and the support of animal life (including the dipping of cattle)". But in view of the persistent drought and the fact that these dambos have been in use on a small-scale level with the prohibiting law in place, it is imperative to assess whether existing and possible future use could significantly deplete the dambo. The study seeks to see whether Cap 198 (Water Act) of the Laws of Zambia inhibits dambo utilization, and also whether small-scale use of dambos significantly contributes to the degradation of dambos.

1.3 AIM OF STUDY

The aim of the study was to determine factors inhibiting dambo utilization in Zambia.

1.4 OBJECTIVES

To achieve this aim the researcher undertook the following objectives: -

- 1.4.1 To determine whether legislation relating to dambos is effective in regulating dambo use.
- 1.4.2 To establish how the indigenous people of Gwembe District manage dambos at local level.
- 1.4.3 To determine the environmental effects resulting from dambo use and awareness of these effects by indigenous people of Gwembe District.

- 1.4.4 To establish whether indigenous people of Gwembe District have access to credit facilities to invest in dambo utilization.
- 1.4.5 To establish whether indigenous people of Gwembe District involved in dambo use have access to agricultural information on dambo utilization.

1.5 HYPOTHESES

The research hypotheses are as follows:

- 1.51 Cap 198 of 1957 (Water Act) of the Laws of Zambia has inhibited dambo utilization in Zambia.
- 1.52 Small-scale use of dambos does not contribute significantly to the degradation of dambo areas.

1.6 RATIONALE

This research was intended to help the rural masses to evaluate whether local use of dambos did contribute significantly to degradation of dambos. This could lead to the formulation of better and appropriate methods of dambo use to avoid degradation, whilst achieving food security- the major reason for dambo utilization by the rural masses.

1.7 SCOPE OF STUDY

The study was limited to Munyumbwe area because of the limited financial resources to cater for more dambos in the district. Most of the data collected was qualitative and lacked enough quantitative information. Furthermore, not all data could be said to be reliable since no credible authority could authenticate it. However, more data could have been generated if the monitoring of the dambos covered the whole year.

1.8 DEFINITION OF TERMS

Dambo: a shallow seasonally waterlogged depression at or near the head of a drainage network.

Soil Erosion: is a process by which soil is degraded through the action of water (run off) or wind.

Intercropping: is the growing of two or more crops at the same time on the same piece of land.

Crop Rotation: is the growing of different crops in succession on the same piece of land including fallows.

Land Degradation: is the physical, biological or chemical diminution of the soil, mainly due to overgrazing, deforestation and inappropriate agricultural techniques.

Soil Fertility: inherent capacity of the soil to provide plant nutrients in sufficient and desired proportions to support crop growth.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter reviews the relevant literature about the use of dambos. It looks at the issues involving land degradation of dambos as seen by different authors. The chapter reviews the Zimbabwean case in the use of dambos and further looks at the law governing the use of dambos in Zambia.

2.2 DAMBO SAFETY

Over the last 40 years, an extensive literature has been produced on agriculture. In this, many papers and reports have appeared on the possible uses of dambos (Vleis) (e.g. Rattray *et al*, 1953; Cormack, 1972; Elwell and Davey, 1972; Theisen, 1975; Whitlow, 1983; Windram, 1983). All of these have recognized that under an appropriate form of management dambos represent important agricultural resources. Many have been hesitant, however to recommend action to promote their use because data on the environmental consequences have been inadequate or ambiguous. Rattray *et al* (1953, P. 480) for example, emphasized that “little reliable data is available on the effect of various methods of utilization of vleis on their moisture conditions”, while Elwell and Davey (1972, P. 156) argued that “We have not yet proven that we can use them safely, without damage to the soil and water resources.”

2.3 ZIMBABWEAN CASE

Bell *et al* (1987) undertook extensive research on the use of dambos in rural development with reference to Zimbabwe. The results reveal that dambos provide an invaluable source of land for cultivation and grazing, as well as water for irrigation, livestock and domestic use to communal areas of Zimbabwe. Raussen (ed) (1997), commenting on the Eastern Province of Zambia, notes that dambos are another very valuable asset for small-scale farmers because they are characterized by residual soil moisture during the dry season and often-high fertility. They play an important role especially for dry season pasture and gardening. Bell *et al* (1987) further reveal that environmental studies carried out so far show that cultivation has minimal effect on dry season stream flow in dambos and points out that cultivating that portion of the dambo that is wettest and which naturally evapotranspires freely during the dry season (under grassland), existing cultivation does not significantly increase water loss. The legislation on dambo cultivation in Zimbabwe, as observed by Bell *et al* (1987), is a major constraint everywhere, upon access to land for gardens. This has resulted in some households voluntarily giving up their gardens for fear of prosecution. Financing for inputs is more of a constraint on dambo cultivation than dry land farming.

2.4 DAMBO FERTILITY

Dambos represent the lower segment of a tropical catenary sequence (Young 1976: Watson 1964). In situ decomposition of grass and sedge vegetation under seasonally oxygen deficient conditions leads to a build up of organic matter and the creation of a hydromorphic, sometimes peaty, upper soil horizon.

Dambo soils are cultivated because they are fertile and moist, conditions that are tied to the high level of organic matter in the soil. If this high level of organic matter is destroyed, particularly in sandy dambo soils, the fertility will be seriously affected. In clay dambo soils, the effect of a reduction in organic matter may not be so serious reports Bell *et al* (1987). When soils are cultivated, a drop in organic matter is to be expected

due to greater weathering and decomposition. Dambo soils, with their level of organic matter on which their fertility may depend, are particularly vulnerable. There is evidence in the past of dambo soils being rendered infertile due to wholesale ploughing-up and drainage by commercial farmers (Whitlow, 1983)

2.5 SOIL EROSION

Soil erosion is one of the most serious forms of land degradation that threatens African Agriculture (Stocking, 1984). In their natural state dambos are well protected by dense vegetation from the effects of both sheet and gully erosion. When this vegetation cover is reduced, the dambo is made more vulnerable to all forms of erosion. Casual observation suggests that overgrazing of dambos is the main factor causing gully erosion. Claims have been made that cultivation leads to sheet erosion and sometimes to gully erosion where shallow wells collapse and initiate gullying (Elwell, 1983).

2.6 DAMBOS IN ZAMBIA

Although only three of the five-wetland systems are present in Zambia (riverine, Lacustrine and palustrine), the country is one of the wettest on the Southern African Region. Dambos fall under the Palustrine system that also includes small lakes or ponds, springs and pans. Dambos are generally distributed on the plateau area, and their variations are attributed to rainfall, topographical setting and substratum. Dambos of the high rainfall belt of Zambia bear plant associations with key species such as *Echinochloa colona*, *E. Pyramidalis*, *Cynodon sp.*, *Digitaria sp.*, *Leersia hexandra*, *Brachiara sp.* and *Acroceras macrum*. Irrespective of where they are located, dambos have had a considerable influence on settlement patterns in Zambia as these habitats are intensely used for cattle grazing, dry season agriculture, water supply for domestic purposes and occasionally for fishing and hunting.

2.7 DAMBO LAW IN ZAMBIA

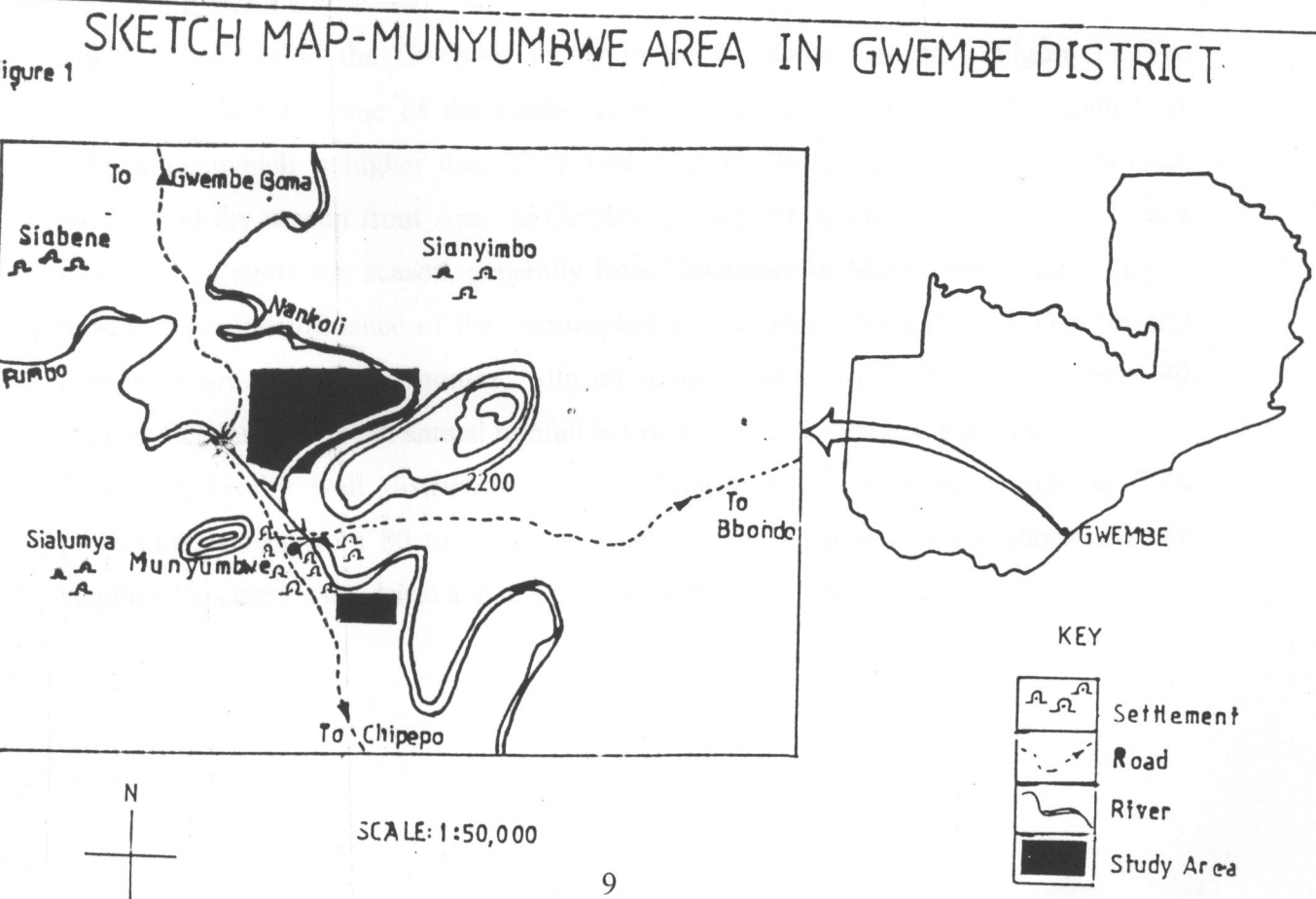
In Zambia Cap 198 of 1957 (Water Act) of the Laws of Zambia governs dambo utilization. The act defines Public stream as “either a water-course; or a drainage depression; or a dambo of natural drainage system, where water flows in ordinary seasons where such water is not private water and whether or not – such water flows visibly on the surfaces; such water-course, drainage depression or dambo is dry during any portion of the year; and the conformation thereof has been changed by artificial means”. The law also defines Primary use as “the use of water for domestic purposes and the support of animal life (including the dipping of cattle).”

CHAPTER 3

LOCATION AND DESCRIPTION OF THE STUDY AREA

3.1 LOCATION

Today's Gwembe District is the central part of the old Gwembe. In the past Gwembe included today's Siavonga and Sinazongwe Districts. Gwembe covers an area of about 12,611 square kilometers out of which only about 4000 hectares is arable land. Munyumbwe is located about 280 Kilometers from Lusaka, the capital city of Zambia. (Figure 1)



3.2 RELIEF AND DRAINAGE

The terrain of Gwembe District is hilly with a slope of about 12 percent. The area is drained by a few streams which almost dry up before October. Major streams are Lufuwa, Jongola, Fumbo and Nankoli. Almost the entire southern part Gwembe District is covered by Lake Kariba. There are several dambos in the area which are the main areas used for vegetable gardens in the dry season.

3.3 SOILS AND VEGETATION

The soils are mostly sandy loam. In other areas sandy soils and heavy clays occur. Shallow and gravel soils are found in rolling and hilly areas. Because of their depth limitations, they are not suitable for cultivation. Most of soils in Gwembe have pH of 6-8, meaning that they are alkaline soils. Two main vegetation types are prominent in the area. These are the *Colophospermum mopane* and *Acacia*.

3.4 CLIMATE

Munyumbwe lies in the Gwembe Valley in the Southern Province, (Figure 1). The Gwembe Valley has one of the hottest climates in Zambia, with a mean annual air temperature which is higher than 22 degrees Celsius. The climate is strongly seasonal, with a long dry season from April to October, influenced by the east to south-east trade winds, and a short wet season, generally from November to March, when the Valley is mostly under the influence of the Intertropical Convergence Zone (ITCZ). October and November are the hottest months, with air temperatures, which frequently exceed 40 degrees Celsius. The mean annual rainfall is low and does not exceed 800mm.

Rain is generally well distributed and the length of the growing season, at 70% probability, varies from 80 to 120 days. Such a growing season is the shortest in the country. This area is the driest and most prone to drought (Muliokela, 1995).

CHAPTER 4

METHODOLOGY

4.1 INTRODUCTION

This chapter outlines the research methodology that was used in the study. The chapter is divided into sub-sections: data and methods of collection, research design and instrumentation, population, sample, and data analysis.

4.2 DATA AND METHODS OF COLLECTION

The data collected was both quantitative and qualitative. The methods of collecting primary data were done through the use of questionnaire, observations, and discussions. The discussions involved the use of Interview Guide (Appendix II) with Farmers, Agriculture Officers, Zambia Police Service, Judiciary and Non –Governmental Organizations operating in Gwembe District at the time of the study. Secondary data was collected from the University of Zambia Library, Department of Agriculture and World Vision International. Field observations were carried out to assess the extent of soil erosion and grazing intensity in the dambos. Under observation were gullies, soils that had been carried and deposited at specific sites within the disturbed dambo. The researcher wanted to know the extent of damage caused by gullies.

4.3 RESEARCH DESIGN AND INSTRUMENTATION

An Intact Group Comparison Design (quasi experimental) was used in the study. A questionnaire and an interview guide were used to inquire about the respondents' views and experiences. The most serious limitation of this research design was the difficult of finding out two similar dambos that were comparable. Secondly, it was not possible to

identify and separate all conditions that contributed to the differences observed to the dambos.

4.4 POPULATION

The study population included all dambos in the district. Officials from the Judiciary, Agriculture, Cooperatives, Zambia Police Service, Forestry and Non-Governmental Organisations operating in Gwembe District and farmers who cultivate in the dambo under study were also part of the population.

4.5 SAMPLE

There are 84 farmers cultivating the disturbed dambo and the researcher decided to pick 40 respondents for the purpose of acquiring data. A scientific study would normally require a representative sample, hence the choosing of 40 respondents. Purposive sampling was used to select dambos. In selecting an undisturbed 'natural' and disturbed dambo, the researcher involved purposive/ judgmental sampling since the researcher was of the view that the selected units were typical of the dambos under investigation and met the following basic conditions: -

- a) The undisturbed 'natural' dambo had not been physically and significantly disturbed by human and livestock activities in the last five years.
- b) The disturbed dambo had been subjected to human and livestock activities like cultivation and grazing for at least five years.
- c) Basically, the undisturbed 'natural' and disturbed dambo had the same gradient and located in the same Agro-Ecological Region but human and livestock activities did produce the difference.

The selection of respondents was done at random using proportionate stratified sampling in which women and men formed the units of strata. A lottery method was used in random sampling using a full list of farmers using the disturbed dambo.

4.6 DATA ANALYSIS

Since a questionnaire and observations were used, data processing was done manually. Organic Matter content was determined by Walkley-Black method. The pH values were done by a pH- Kit, whilst Grain-Size Analysis was used to determine the soil texture. Soil colour determination was done by the use of colour charts.

CHAPTER 5

RESEARCH FINDINGS

5.10 INTRODUCTION

The chapter presents raw data as compiled from the study area and data acquired through the Interview Guide (Appendix II). Qualitative data is also included and conclusions drawn from inferences as narrated by the respondents, government officials and officials representing Non-Governmental Organisations.

Table 5.1 shows that Ministry of Agriculture Officials and Court Officials are aware of Chapter 198 of the Laws of Zambia.

Table 5.1 Awareness of Local People of Chapter 198 of 1957

Category	Aware	Not Aware	Not Sure
Agriculture and Cooperatives	*		
Farmers		*	
Court Officials	*		
Police			*

This is in contrast to the major stakeholders, the farmers, who showed total ignorance of its existence. Police Officers were not even sure of its existence.

Table 5.2 reveals that despite the knowledge of existence of Chapter 198, Officials from the Department of Agriculture view the enforcement of Chapter 198 not as their duty.

Table 5.2 Enforcement of Chapter 198 by Government Agencies

Department	Frequent Actions taken
Agriculture	Land management advise to farmers
Police	NIL
Cooperatives	NIL
Forestry	NIL

They merely give advice on land management. The Zambia Police Service, Department of Cooperatives, and Forestry had taken no action in the area of enforcement of Chapter 198.

Table 5.3 shows that there have been no cases handled by the Courts in Gwembe District involving the use of dambo without permission as contained in the Chapter 198 of the Laws of Zambia in the period from 1993 to 2002

Table 5.3 **Court Cases Handled in Gwembe District**
Relating to Dambos

Year	No. of cases
1993	NIL
1994	NIL
1995	NIL
1996	NIL
1997	NIL
1998	NIL
1999	NIL
2000	NIL
2001	NIL
2002	NIL

The use of fertilizer is common as indicated in Table 5.4. Fourteen respondents indicate that they use cattle manure. Despite the study area being remote, the respondents have access to pesticides, which they use mainly in vegetable production. The pesticides are usually remains from cotton sprays. The dambo is mainly cultivated by the use of ox-ploughs. Water in the dambo is used for irrigation as people have access to domestic water from boreholes. There is no controlled grazing for livestock in the dambo, let alone in the grazing and browsing mountainous areas, though the movements of livestock is restricted in the rainy season.

Table 5.4

Management of Undisturbed Dambo

Activity	No. of Respondents Involved
Use of fertilizer	26
Type of fertilizer: Urea	26
'D' Compound	26
Use of cattle manure	14
Use of anthill soils	0
Use of crop residues	0
Pesticide use	14
Implements used: ox-plough	27
hoes	13
Crop rotation	12
Controlled grazing	0
Water use: irrigation	40
domestic	0
Times for Irrigation: once daily	29
twice daily	11

Table 5.5 shows that the soils in disturbed dambos were dominantly loamy sand. The undisturbed dambo had clay soils

Table 5.5 **Soil Chemical/Physical Data**

		SOIL TEXTURE		ORGANIC MATTER		pH VALUE	
		DAMBO		DAMBO		DAMBO	
Site	Sample	Undisturbed	Disturbed	Undisturbed	Disturbed	Undisturbed	Disturbed
1	1	Clay	Loamy Sand	4.1	1.2	7.2	6.6
	2	Clay	Loamy Sand	3.7	1.1	7.0	6.4
	3	Clay	Loamy Sand	3.4	0.9	6.9	6.3
2	4	Clay	Loamy Sand	4.2	1.3	6.9	6.5
	5	Clay	Loamy Sand	3.9	1.1	6.9	6.6
	6	Clay	Loamy Sand	3.8	1.1	6.8	6.3
3.	7	Clay	Loamy Sand	3.8	1.4	7.0	6.4
	8	Clay	Loamy Sand	3.7	1.3	6.8	6.3
	9	Clay	Loamy Sand	3.5	1.2	6.9	6.6
4.	10	Clay	Loamy Sand	4.0	1.7	7.1	6.4
	11	Clay	Loamy Sand	4.0	1.5	6.9	6.4
	12	Clay	Loamy Sand	3.9	1.2	6.9	6.3
5	13	Clay	Loamy Sand	3.9	1.5	6.8	6.6
	14	Clay	Loamy Sand	3.9	1.3	6.5	6.5
	15	Clay	Loamy Sand	3.5	1.0	7.0	6.3

The data reveals that disturbed dambos have their pH values going towards ‘slightly acid’ (Appendix IV).

Table 5.6 **Soil Colour of Samples Collected**
From Dambos Under Study

Site	Undisturbed	Disturbed
1	Dark Brown	Light
2	Dark Brown	Light
3	Dark Brown	Light
4	Dark Brown	Light
5	Dark Brown	Light

No measurements were done on the water table of the dambos under study. This was due the fact that the soil was too hard to be dug with the tools that were employed by the researcher.

Table 5.7 shows downward trends in crop yields in the study area, with worst affected being sorghum and vegetable production in the period 1998 to 2002. The grazing intensity is indicated in Table 5.8, with livestock units per hectare reducing yearly.

Table 5.7**Trends of Crop Yield Production**

Year	Maize	Vegetables	Cotton	Sorghum	Total
1998	1	2	2	3	8
1999	3	2	1	1	7
2000	1	2	1	1	5
2001	1	1	1	2	5
2002	1	1	1	1	4

Note: 1 – Decrease, 2-Stable, 3-Increase Yearly Maximum Points: 3x4=12 points

Table 5.8**Grazing Intensity in the Undisturbed Dambo Under Study**

Year	Estimated No. of Cattle	No. of LSU	Area of Dambo (ha)	LSU/ha
1998	120	66.0	40	1.65
1999	90	49.50	40	1.24
2000	80	44.00	40	1.10
2001	80	44.00	40	1.10
2002	75	41.25	40	1.03

Note: 1 Livestock Unit (LSU) = 450kg Live weight

Source: Department of Agriculture – Gwembe District

Table 5.9 shows gullies that were observed in the disturbed dambo. The data shows that, depending on the environmental conditions, gullies can rip through the soil leaving big trenches that render that land useless.

Table 5.9 **Gully Erosion in the Disturbed Dambo.**
(Major Gullies observed)

Depth (m)	Width (m)	Length (m)
1.75	2.00	15
2.10	1.85	16
1.50	0.90	20
1.65	0.75	14
1.50	0.45	11

Table 6.0 shows access to agricultural information and credit. It reveals that access to agricultural information and credit by farmers in the study area is mainly concentrated on dry land farming.

Table 6.0 Access to Agricultural Credit facilities and Information

Purpose	Credit		Agricultural information	
	Dambo farming	Dry land farming	Dambo farming	Dry land farming
Crop production	00	24	00	32
Livestock	00	00	00	13
Land management	00	00	13	21
Vegetable Production	00	00	15	00

CHAPTER 6

DISCUSSION /DATA ANALYSIS

6.1 INTRODUCTION

In an attempt to help fill the gaps in research over dambos, the following questions about the environmental hazards and the type and extent of dambo use, addressed by the researcher, are discussed below:

- a) Does Chapter 198 (Water Act) of the Laws of Zambia inhibit dambo utilization?
- b) Does small-scale use of dambos contribute significantly to the degradation of dambos?

6.2 EFFECTIVENESS OF CHAPTER 198 IN REGULATING DAMBO USE

Strict interpretation of the Water Act makes it illegal to cultivate on dambos unless the government has granted an exemption. As a further deterrent, the Forests Act makes it illegal to cultivate within 30 metres of a stream, which would rule out some existing dambo cultivation, especially on narrow, linear dambos.

Despite the presence of Water and Forest Acts, indigenous people of the study area are not aware of these Acts. All forty respondents interviewed emphatically indicated that they were not aware of Cap 198. This was also the case with the three (3) Zambia Police Service Officers; they indicated their ignorance of Chapter 198. To the contrary the five Department of Agriculture officials and two Court officials interviewed indicated knowledge of Chapter 198 (Table 5.1). Research results indicate that despite government officials being aware of chapter 198, they are very reluctant to enforce it; they are also not aware of whose role it is to enforce the Water Act. (Table 5.2)

6.3 MANAGEMENT OF DAMBO AT LOCAL LEVEL

Dambo cultivation is an integral part of the agricultural system, and not simply supplementary to dry land farming in the study area. The existence of numerous and relatively large gardens suggest that what is true about Munyumbwe area may also be true of the entire district as a whole. The research shows that 65 % of the respondents used fertilizer regularly in their dambo fields, the type being mainly Urea and Compound 'D'. However, 35 % of the respondents regularly used cattle manure as organic fertilizer (Table 5.4). The use of inorganic fertilizers to improve soil fertility is positive in the short run. However, they affect the soil by acidifying it. They are also expensive and not easily available in remote areas like Munyumbwe. It can be assumed that acidification of the soil in the disturbed dambo was partly due to fertilizer application.

Plots in the dambo supplied with organic fertilizer (Cattle manure) definitely benefited by improved permeability, structure and water holding capacity. However, the 14 respondents only constituted 35 percent of the sample. This had a minimal positive effect on the entire dambo area. Lack of means to transport the bulky manure was an obstacle to some farmers who had neither wheelbarrow nor ox cart. The use and benefits of crop residues in soil fertility improvement is well understood by the respondents. No crop residuals were being used for soil fertility enhancement since livestock grazes them upon immediately after harvesting of standing crop in April/May each year. Likewise, the use of anthill soils for soil fertility enhancement is not practiced in the study area. The results do also indicate that 14 respondents used insecticides (usually remains from cotton pest sprays). These include Phoskill, Cyrux and Monochrotophos (Table 5.4).

The ox-plough remains the major implement for tilling the land in the dambo. 67.5 % of the respondents frequently used ox-ploughs whilst only 32.5 % used hand held hoes. Prolonged use of ox-ploughs on loamy sands may have negative effects on soil texture, as these soils are often loosened open and tend to dry out quickly. However,

discussions show that given the means, respondents using hoes would quickly turn to ox-plough cultivation. Crop rotation is partly practiced (30 % of the respondents). However, there is completely no controlled grazing in the disturbed dambo. Water from dambo wells is used for irrigation and livestock. The gardens are watered once daily (72.5 % of the respondents) and twice daily (27.5 % of the respondents).

6.4 ENVIRONMENTAL EFFECTS AND AWARENESS

6.41 PAST SITUATION

Environmental issues can be well appreciated when background information is given as revealed by the respondents. The following situation once prevailed in the study area: there were abundant plant species like *Acacia albida* and Mukuyu (*Ficus sycamorus*). *Acacia sp.* enriched soils when they shed off their leaves. Msikili (*Trichilia emetica*) seeds, when crushed, were used for wound treatment. Bondwe (*Amaranthus sp.*), a food plant, has also disappeared. Instead a succession has occurred with the appearance of a reed- like plant that never inhabited the dambo.

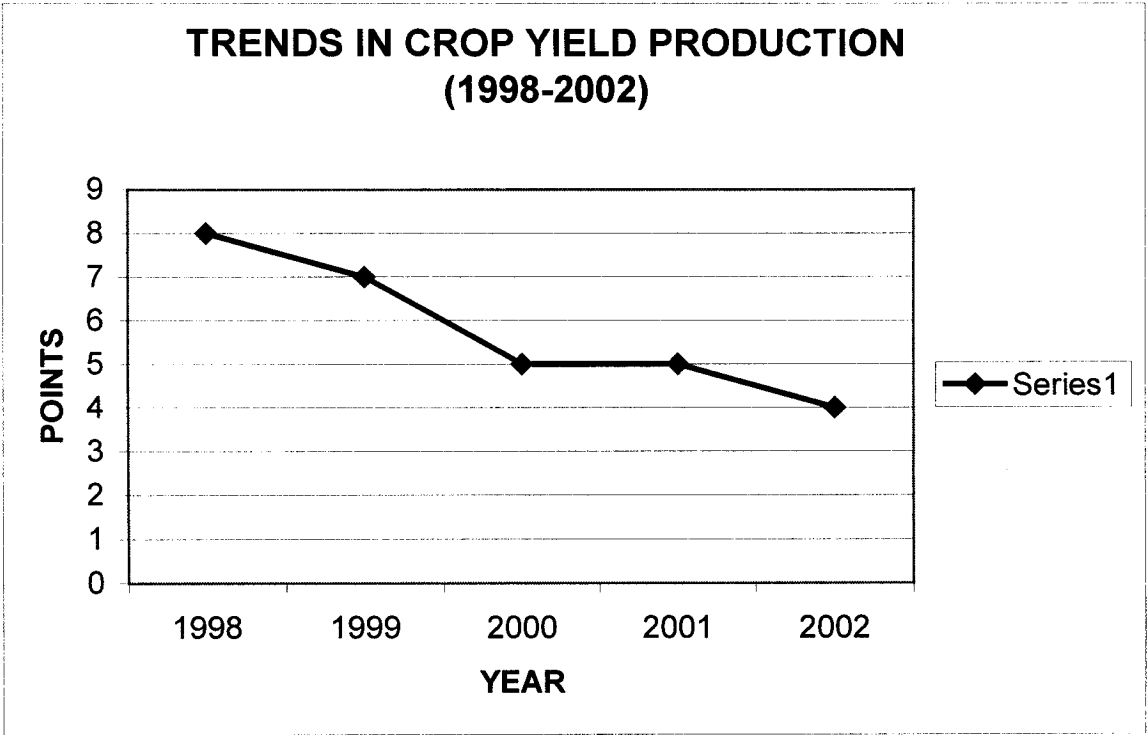
The dambo water flow was relatively slow; dambo water could still be used until the next rainy season. The soils were predominantly loamy, supporting maximum growth of grasses. The fauna of the dambo included long-legged wild birds and several fish species and giant toads that served as food and when boiled the fats were used to treat ear infections. Mushrooms were also in abundance and above all the dambo was mainly used for sorghum production. This situation indicates a change in the biodiversity of the study area.

6.42 Trends in Crop Yield

There was general consensus amongst the respondents that yields had been falling, especially sorghum crop (Figure 2). Just three decades ago, it was narrated, farmers would grow crops without the use of inorganic fertilizers in the dambo. The reductions could not be quantified, but trends indicate a reduction in crop yields even

when rain amounts were at times adequate. This reasoning is reinforced when one compares soil types in disturbed dambo (less fertile loamy sand soils) and undisturbed dambo (fertile clay soils). The researcher assumes that the downward trends in crop yields could be attributed to heavy leaching of minerals in loamy sandy disturbed dambos. This is compounded by the low organic matter content.

Figure 2



6.43 **Grazing Intensity**

By 1998 the disturbed dambo could manage to keep approximately 1.65 livestock Units (LSU). The animals would go through the dry season without losing significantly on weight. By 2002, even with a reduction of cattle through sales and deaths, the disturbed dambo could not support a reduced 1.03 LSU (Table 5.8).

However, major indicators of grazing intensity were the animal body condition in dry season and the physical condition of the vegetation in the dry season. Traditional farmers own the cattle in the study area. Traditional cattle production is characterized by communal grazing which implies that any cow can graze anywhere, except where damage to standing crops must be avoided. Indiscriminate burning of natural pasture has led to shortage of feed, making dambos good alternative. The result is overgrazing and overstocking which have contributed to soil erosion through the

removal of ground cover. It can be deduced that soil erosion has partly been induced by inappropriate tillage and exposure of fragile soils on steep slopes in the study area. This has led to the reduction in soil organic matter as observed in Figure 3. The result has been a decline in soil fertility reflected in the down trends in crop yield (Figure 2)

6.44 Gully Formation/Soil Erosion

In comparison to ‘undisturbed’ dambos, there was clear evidence of soil erosion in the disturbed dambo. The disturbed dambo had developed five medium- sized gullies, (of between 1-5m in depth) with a characteristic V-shaped. The deepest being 2.10m whilst the largest stretched 20m (Table 5.9). It should also be noted that formation of the gullies were partly accelerated by the upland area (catchment) where there was poor ground cover and long uninterrupted slope lengths that provided little impediment to run off. Soil erosion was due partly to heavy grazing common in the study area.

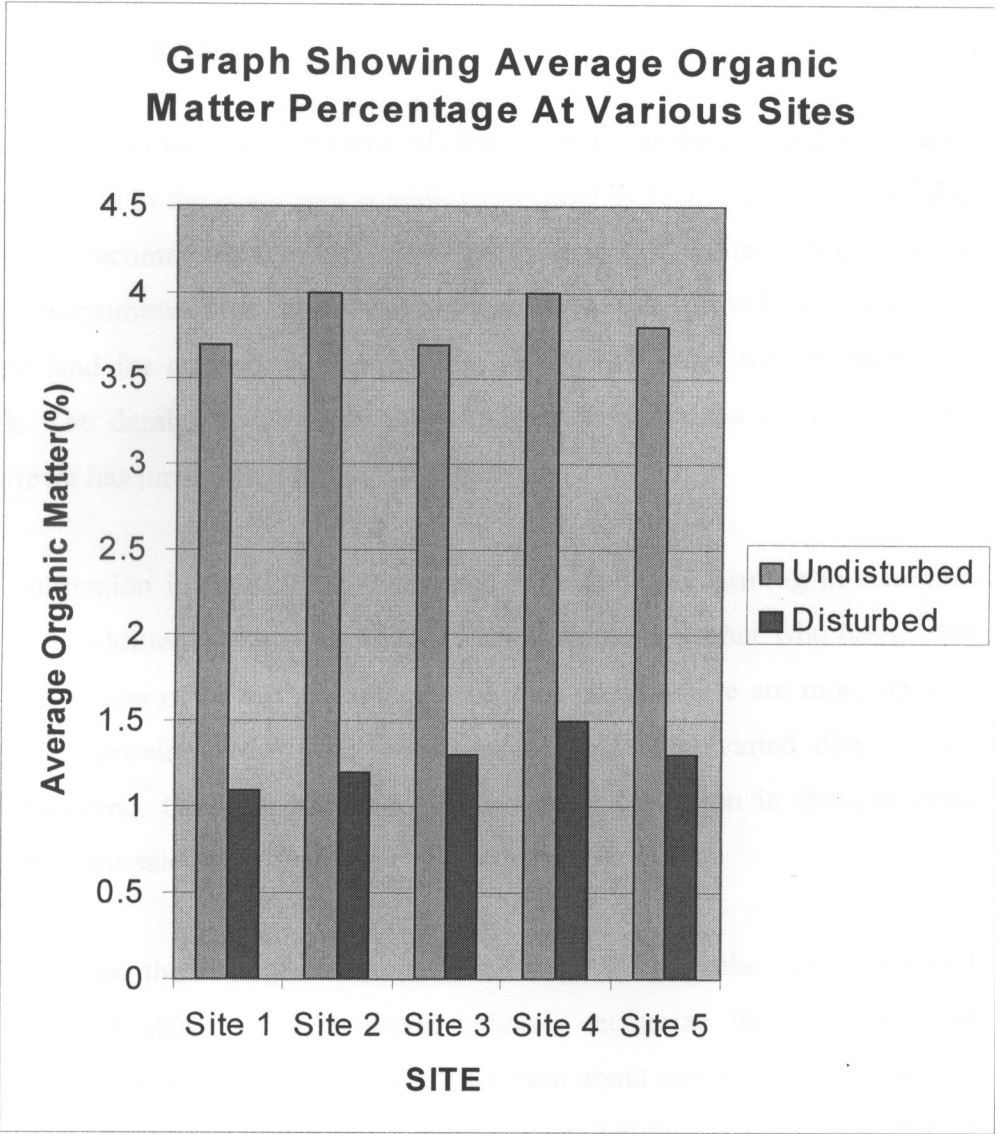
6.45 Soil Water Table

The exercise of collection of water table levels was practically impossible as the water level were beyond the researcher’s digging capacity. This may have been due to less rainfall experienced in the previous rainy season. This exercise was also impossible to carry out on ‘undisturbed’ dambo.

6.46 Organic Matter Content

Results show that there is slightly higher organic matter content in ‘undisturbed’ dambo than in disturbed dambo (Figure 3). The minimal difference observed could partly be due to higher temperatures experienced by the study area in which the available humus is quickly and easily broken down. However, the difference is significant as indicated by the Student- T-Test (Appendix III). It can be deduced that low organic matter in disturbed dambo soils has had an effect on the following: micro-organisms, so important for the development of plants; availability of nutrients important for plant growth; conservation of soil moisture, therefore increasing leaching of nutrients; and soil structure which promotes soil particle adhesion.

Figure 3



CHAPTER 7

CONCLUSIONS AND RECOMMENDATIONS

7.1 CONCLUSIONS

Dambos in Zambia vary in their physical characteristics as well as in their present use. The dambos in the study area is mainly occupied by loamy sand soils and the research and recommendations are based on this type of dambo. In communal areas of Munyumbwe area where dambos are found, they provide an invaluable source of land for cultivation and grazing, as well as water for irrigation and livestock. The dambo under study falls under traditional land on which Chief Munyumbwe has jurisdiction through his headmen.

Dambo cultivation is successfully integrated with dry land farming in Gwembe District. The additional choice available to the communal farmer who has access to a garden is one of its key advantages. With a garden there are more options available for providing the family with an adequate and varied diet and an increased income. Gardens provide a hedge against starvation in drought years and a surplus for sale in good years.

In the study area, the management systems for controlling dambo use are not well established and effective. Agricultural officials recognize the advantages of dambo cultivation. However, there is still concern about environmental effects of dambo use. Micro scale irrigation, as practiced on dambos, is not considered, as of sufficient importance to be included in agricultural or irrigation policy. The effects of the lack of a clear dambo policy include limited agricultural advice and lack of finance for garden cultivation. The research concludes that Chapter 198 of the Laws of Zambia does not inhibit dambo utilization in Zambia; dambo users do not know the Law. Therefore, the existence of Chapter 198 of the Laws of Zambia does not influence respondent's decisions on whether to use dambos or not.

of Zambia does not influence respondent's decisions on whether to use dambos or not.

Small-scale use of dambos, without safeguards, does contribute significantly to the degradation of dambos. The effects on the environment include loss of biodiversity, soil erosion, loss of soil fertility overgrazing and soil acidification.

7.2 RECOMMENDATIONS

7.21 Environmental Recommendations

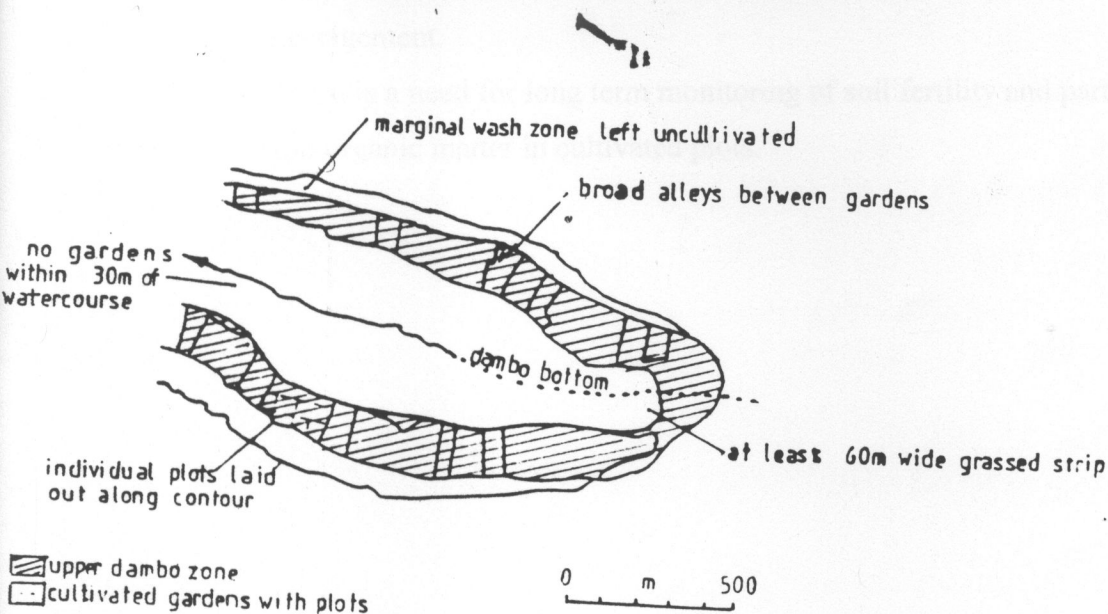
In order to ensure that cultivation of dambos may be carried out in a sustainable way the researcher has the following recommendations. These recommendations apply to loamy sand dambos that can be divided into four internal zones: the dambo margin; the upper or lower permanently wet dambo zone; the lower or seasonally wet dambo zone and the dry dambo bottom (figure 4).

1. The dambo should not be allowed to dry out permanently. Therefore permanent drainage of dambos is not recommended.
2. On the basis of the research, it is proposed that cultivation should take place only on upper dambo zone (Figure 4). This is the zone, which is permanently wet, the water table being close enough to the surface to allow plant growth throughout a "normal" rainfall year.
3. On intensively cultivated dambos it is recommended that grassed strip at least 60m wide running along the bottom of the dambo should be left uncultivated. This is to provide a protected drainage line for runoff from the upper areas of the catchment and to prevent erosion in this most vulnerable part of the dambo. (Figure 4)
4. The application of cow manure or compost and the ploughing in of crop residues should be encouraged so as to maintain the organic content of the soil.

5. There should be intensified environmental campaigns to educate the indigenous people on the use and effects of dambo use.
6. The use of ox plough for cultivation of loamy sand dambos may have undesirable consequences and therefore should be discouraged. It accelerates destruction of soil structure and soil erosion. Therefore, minimum tillage should be encouraged using implements like the Magoye Ripper.

Figure 4

DAMBO LAND USE RECOMMENDATIONS



Source: Balle et al (1987)

7.22 Policy Recommendations

The main goal of any change in policy and/or legislation should be to facilitate successful and safe use of dambos by communal farmers. There are various ways of achieving this goal:

- a. Modify the present legislation to incorporate safe levels of cultivation as agreed upon by the ministries concerned with natural resources, agriculture and water development; and
- b. Review the present designation of dambos as non-arable.

7.23 Research Needs

Further research is undoubtedly needed on many aspects of dambo cultivation.

- a. Research should be done in crops, with particular attention paid to crop rotations that preserve or improve soil fertility and improved pest management.
- b. There is a need for long term monitoring of soil fertility and particularly of soil organic matter in cultivated plots.

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THE UNIVERSITY OF ZAMBIA

SCHOOL OF NATURAL SCIENCES

DEPARTMENT OF GEOGRAPHY

Questionnaire on factors inhibiting Dambo utilization in Zambia: A Case Study of Gwembe District.

Dear Respondent

I am a final year student at the University of Zambia in the Natural Resources Programme. The purpose of the research is to establish factors inhibiting dambo utilization in Zambia. There are no 'right' answers and no 'wrong' answers. It is your own honest opinion the researcher seeks. This information will be used only for academic purposes. It will not be used to identify you in any way. Thanking you in advance.

A) Personal details

(i). What is your sex?

Male ☐ Female ☐

(ii) What is your position in your household?

Husband ☐ Wife ☐ Child ☐ relative ☐

Widow/widower ☐

☐ Any other (specify)

B) Agricultural Activities (crops)

Q1) Did you cultivate the dambo garden during the 2002 dry season?

Yes ☐ No ☐

Q2 What crops did you grow on your dambo garden?

.....

Q3 How many wells do you have in your dambo garden?

.....

Q4 For what purpose is the water from the dambo used?

☐ Household ☐ Irrigation

☐ Any other specify

Q5) How often do you water your garden in the dry season?

☐ Once/day ☐ Twice/day ☐ Every other /day ☐ Any other

(specify)

Q6) Did your well(s) on the dambo garden dry up during the 2002 dry season?

Yes ☐ No ☐

C Agricultural Activities (Livestock)

Q7) Do you keep any livestock?

☐ Yes ☐ No

Q8) If the answer to Q7 is 'Yes' state the type you keep?

☐ Cattle ☐ Goats ☐ Sheep ☐ Chickens
☐ Any other (specify)

Q9) If you own cattle, Goats or sheep, where do they graze from in the:

Dry season?

Rainy Season?

Q10) Do you think there is enough grazing area in your land?

☐ Yes ☐ No

D Local Level Management of Dambos

Q11) Did you use fertilizer on your dambo garden during the 2002 dry season?

☐ Yes ☐ No

Q12) If the answer to Q11 is 'Yes' which fertilizer did you use?

.....

Q13) Did you use cattle manure?

☐ Yes ☐ No

Q14) Did you use soil from the anthills for fertility improvement in your dambo garden?

☐ Yes ☐ No

- Q15) Did you leave crop residue in the garden (dambo) to be ploughed back into the soil?
☐ Yes ☐ No
- Q16) Did you use insecticide(s) for crop protection?
☐ Yes ☐ No
- Q17) If the answer to Q16 is ‘Yes’, state the type of insecticide?
.....
- Q18) How many weeks after the harvest of crops did you cultivate your dambo garden?
.....
- Q19) What implement do you use to cultivate your dambo garden?
.....
- Q20) Do you practice crop rotation in your dambo garden?
☐ Yes ☐ No
- Q21) Does your community practice controlled grazing in the dambo?
☐ Yes ☐ No
- Q22) Do you receive agricultural advice on the dambo farming?
☐ Yes ☐ No
- Q23) Have you any access to loans for dambo farming activities?
☐ Yes ☐ No

Thank you for your co-operation

INTERVIEW GUIDE

(a) INDIGENOUS PEOPLE

On the environment

- Trends in crop yields
- Grazing management
- Sheet erosion/Gully erosion
- Awareness of environmental effects to dambos

(b) CREDIT LENDING INSTITUTIONS IN GWEMBE DISTRICT

- Credit policy relating to:
 1. Dryland farming
 2. Dambo utilisation
- Institutional view on Cap 198 (Water Act) of the Laws of Zambia.

(c) DEPARTMENT OF FIELD SERVICES

- Policy on agricultural information dissemination on:
 1. Dryland agriculture
 2. Dambo utilisation
- Institutional view on Cap 198 (Water Act) of the Laws of Zambia.

. Paired Student t-Test

$$t_{(N-1)} = \frac{\bar{Z}}{S_z/\sqrt{N}} \quad \text{and} \quad S_z = \sqrt{\frac{\sum Z^2 - (\sum Z)^2/N}{N-1}}$$

Where N = no. of pairs.
(N-1) = degree of freedom.
Z = difference between pairs

ir	1	2	3	4	5	6	7	8	9	10	11	12	13	14
sturbed	1.2	0.9	1.1	1.1	1.3	1.1	1.4	1.3	1.2	1.7	1.5	1.2	1.0	1.5
undisturbed	3.4	3.7	4.1	3.9	4.2	3.8	3.7	3.5	3.8	3.9	4.0	4.0	3.9	3.9
	-2.2	-2.8	-3.0	-2.8	-2.9	-2.7	-2.3	-2.2	-2.6	-2.2	-2.5	-2.8	-2.9	-2.4
	4.84	7.84	9.00	7.84	8.4	7.29	5.29	4.84	6.76	4.8	6.25	7.84	8.41	5.76
										4				

Therefore Sz = 0.296
Z = 2.52
T₁₄ = **33.63**

Decision
The calculated value of t with degrees of difference of 14 has a probability of less than 5%.

Conclusion:
There is significant difference in the organic matter content between the disturbed dambo and undisturbed dambo.

Appendix IV INTERPRETATION OF SOIL CHEMICAL ANALYSIS DATA

The following are simplified guidelines for soil fertility evaluation using data from laboratory analysis:

1 pH Ranges

< 4.5	extremely acid
4.6-5.0	strongly acid
5.1-6.0	moderately acid
6.1-6.5	slightly acid
6.6-7.0	near neutral
7.1-7.5	slightly alkaline
7.6-8.5	moderately alkaline
8.6-9.0	strongly alkaline
> 9.1	extremely alkaline

2. Exchangeable cations

	units	low	moderate	high	test
Sodium (Na)	m.e. %	-	0-2.0	>2.0	
Potassium (K)	m.e. %	< 0.2	0.2-1.5	>1.5	
Calcium (Ca)	m.e. %	< 0.2	2.0-10	> 10	
Magnesium (Mg)	m.e. %	< 1.0	1-3	> 3	
Manganese (Mn)	m.e. %	<0.1	0.1-2.0	> 2.0	
Phosphorus	ppm	< 20	20-80	>80	Mehlich
Phosphorus	ppm	< 5	5-20	>20	Olsen

3 Carbon/ organic matter

% carbon	% organic matter	
<1.0	<1.7	low
1.0-2.0	1.7-3.4	Moderate
2.0-4.0	3.4-6.9	Adequate
>4.0	>6.9	high

*** The percentage organic matter is found by multiplying the % carbon by 1.72**

Source: Thomas, D. B (1997)