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Implications of algae bloom on cattle production in the Nkambe Highlands, North West Region of Cameroon.

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Abstract

In the pastoral highlands of Nkambe, the effects of water stress on cattle production has been highlighted by most researchers with little attention given to water pollution by algae bloom. It is for this premise that our paper addresses the actual situation of algae bloom pollution and its effects on cattle production in the study area. Analysing water samples of four major cattle water points in the grazing zone, the results showed a high relative abundance of algae of varied species which affects cattle health especially during water stress periods (Lekeufack, 2014). The laboratory analysis of water samples of six major cattle water points; Njema/Kokoube, Njoke, Binshua, Bontor/Magha however showed that the problem of water quantity is more crucial than the quality problem. Despite the efforts of pastoralists and stakeholders, algae bloom pollution and recurrent water shortages remain a major constraints to cattle production in a region which is consider to supply major urban centres of Cameroon with cattle byproducts (Amino, 2017; John et al, 1980). It is under this backdrop that the actual state of algae bloom pollution of major cattle water points and the future of cattle production in the Nkambe highlands is a research priority.

Key words: Algae bloom, water pollution, food security, cattle, Nkambe.

1 Introduction

In the pastoral highlands of Nkambe, the problem of water availability for cattle both in quantity and quality remain a major constraint to cattle production (Amino, 2017). The main objective of this study is therefore to have a vivid and critical appraisal of the state of algae bloom pollution of cattle water points in the Nkambe highlands, stakes and future prospects in a region where only about ten cattle water points are functional. A majority of the water points has considerably reduced in their discharge, become intermittent or completely dry off as a result of persistent variability in rainfall patterns, prolonged droughts, desertification and inappropriate land use (Tsalefac, 1988). Some of the cattle points have been contaminated through poor domestic waste disposal, cattle fecal contamination favoring the proliferation of algae. Consequently, the demand for water by cattle breeders is much higher and there is clear evidence of population pressure on the available water sources. Poor and inadequate water points mean poor health for cattle and therefore poor reproductive performance and survival rate (Willington Ojong, 2010). The trekking of cattle for a long distance in search of fresh water has affected the weight and quality of the animal. Today, according to MINEPIA services, about 1500 cattle are affected each year of insufficient and contaminated water consumption related complications most especially algae poisoning. It is regrettable that the Kokoube water retention dam constructed in the early 1970s being a Cameroon, World Bank and German Cooperation funded project to boost cattle production was abandoned by the Ministry of livestock and Animal Husbandry. Despite the general seasonal and accidented droughts that affected the volume of water discharge in the Dam, this project intended to serve about 200000 cattle. This was one of the many abandoned pastoral equipments and hydraulic infrastructures envisaged for the agro-ecological zone at the advent of the Structural Adjustment Program and economic crisis in Cameroon in the early 1980s (Tsalefac , 1988)). The small scale grazer's access to pastures, cattle supplements and veterinary services and water points supported by the World Bank meat and zonotic diseases projects, Rural Development Fund (FONADER), Green Revolution programs were suspended making cattle production a very vulnerable activity.

Unfortunately, today the pastoral highlands of Nkambe has witnessed a relatively high prevalence of water vector zonotic diseases amongts cattle herds and a relative drop of cattle carcase weight during the months of Febraury, March and April due to high water stress exacerbated by extreme heat and algae blooms have been a cause for concern (Deffo et al, 2011). This, have had a significant effect on cattle physiology, meat

quality and prices in the main cattle markets (John et al, 1980; Aliou, 2004). Today, pastoralists are confronted with a high cost of animal health care through frequent veterinary attention, vaccination and expenses on drugs during critical periods (Oumar, 1980; Ngeh, 2002). Despite the efforts of pastoralists and stakeholders, algae bloom pollution and recurrent water shortages remain a major dilemma to cattle production in the livestock production zone. (John et al, 1980; Jean-Emet, 2015). It is under this backdrop that, we are preoccupied with the actual state of algae bloom pollution of major cattle water points and the future of cattle production in the Nkambe highlands. To attain our objective, we have to analyse the spatio-temporal contamination of cattle water points by algae bloom in major grazing zones, investigate the reasons why algae bloom is a major constraints to cattle production in an agroecological zone consider as an eldorado for pastoralism? And what is the future of cattle production in the Nkambe Highlands in the context of relative implications of the proliferation of algae on cattle water points, consequently cattle production.

2 Material and Methods

To attain our objective, field observation, pastoralists' and MINEPIA field extension staff experience of the actual situation were primordial.A total of 250 questionnaires were examined to pastoralists to appreciate the state of cattle water points' contamination by algae blooms and the effects on cattle production. Water samples from four major cattle water points (Njema/Kokoube (Zone III), Njoke (Zone I), Binshua (Zone II), Bontor/Magha (Zone II) were collected and analyzed at the Dschang Applied Botany Laboratory to detect the various species of algae found in the study area. Relative Abundance (RA) of each algae species in the water sample was calculated using the formula: Number of Individual of Species in each Water Sample × 100/total Number of individual species. This permitted us to know the state of contamination of each cattle water point by algae bloom for appropriate solution. The water samples collected in four 1.5 Litres plastic bottles during the months of July-August were thoroughly washed and rinsed with distilled water stored in an ice flask was analyzed to identify the human and fecal contamination parameters in the water samples most especially the Total dissolved solids (TDS), Echerichia coli and total Coliforms using the Host-Associated Bacteriodes Quantitative PCR Assays (2018). The concentration of Echerichia coli and total Coliforms in the water were quantified using the Colitest method following the manufacturer protocol. Total dissolved solids (TDS) were measured by evaporating a known volume of water to dryness, then weighing the solid residue remaining (Bikesh et al, 2018). The relative weight of dissolved materials (TDS) was expressed in milligrams of dissolved solids in a litre of water (mg/l).The choice of study site was motivated by her potential in cattle production in Donga Mantung Division in particular and Cameroon in general. This highland pastoral zone found in a humid tropical climate was divided into six major grazing zones considering the capacity of cattle production of each zone and degree of vulnerability to cattle water points contamination by algae blooms (Figure 1).

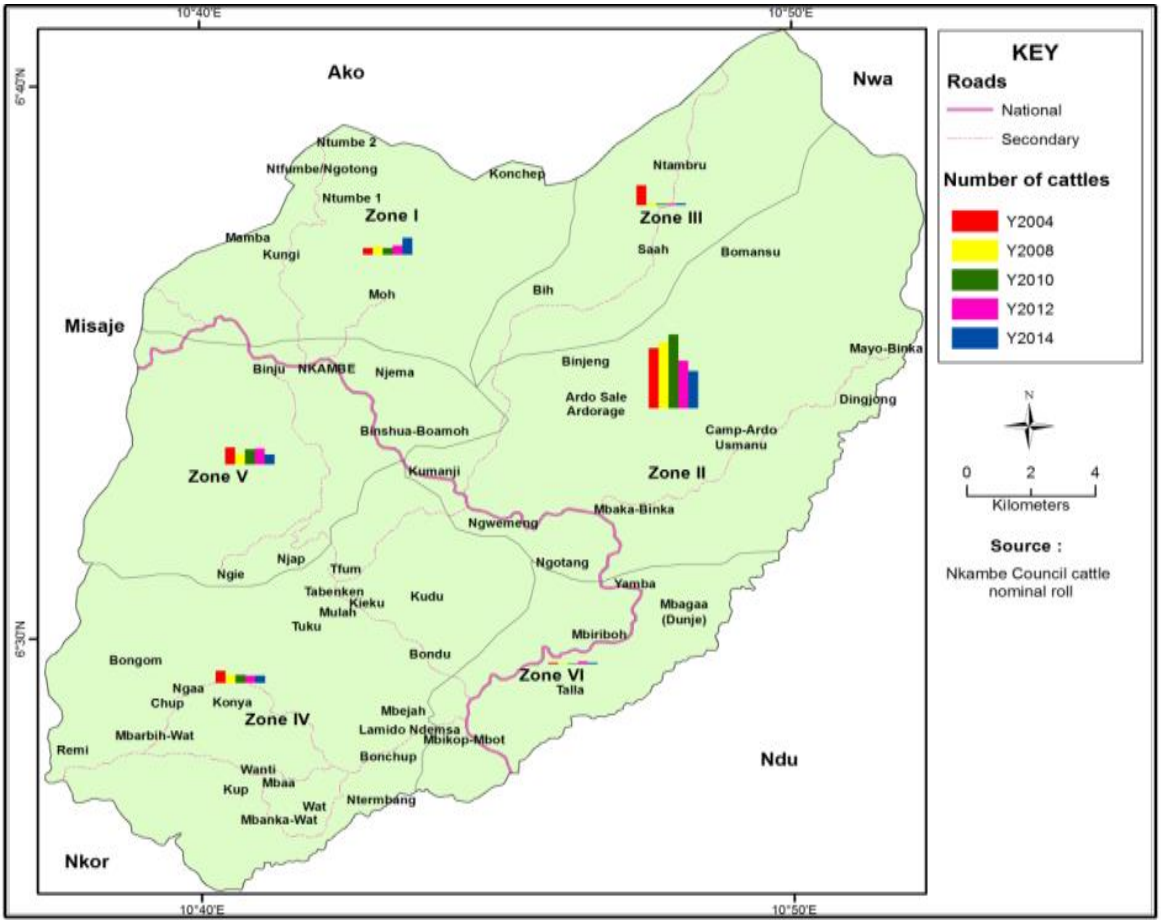


Figure 1: The Nkambe Pastoral Highlands Major Grazing Zones

3 Results and discussion

3.1 Spatio-temporal contaminations of cattle water points by algae bloom in major grazing zones

It is of interest to note that, the physicochemical analysis of water samples from six major water points of Njoke (Zone I), Magha, Bontor (Zone V), Njema, Kokoube (Zone III) and Binshua (Zone II) shows an acceptable concentration of Nitrogen Nitrate, orthophosphate, Sulphate, alkalinity or hydrogen pontential pH Salinity; total soluble salts good for cattle production and relatively high Total Suspended Solids; TSS or TDS was the only risk factor (Table 4). Paradoxically, biological analysis of water samples of the major cattle water points shows a high concentration of both the nontoxic filamentous algae and toxic blue-green algae of varied species (Photo 3 and Table 3). The presence of algae in the cattle water points are indicators of water contamination by inorganic and/or organic matter both in the wet season and dry season grazing periods (Fonteh Fru, 2003; Lekeufack, 2014).This is because the water points' do not have pollution control system.

According to the distribution of algae in major cattle water points, Njoke, Magha, Bontor, Njema and Kokoube have high relative algae abundance indicative of high fecal contamination from both animal and human waste discharge (Table 4). The algae "bloom" is dominated by the toxic blue-green algae with toxins levels highest during or directly after a bloom. This occurs most in the peak of the dry season when cattle water intake is optimum exposing the cattle to blue-green algae poisoning (microcystins, nodularins, saxitoxins, anatoxin-a, anatoxin-a (s), cylindrospermopsin), fecal contamination,fecal coliforms, fecal streptococci, bacilli (Lekeufack, 2014). (Photo 2). The manifestation of blue-green algae poisoning in the Nkambe highlands grazing zones are diarrhea, vomiting, lack of coordination, labored breathing, seizures, convulsions and mortality in very severe cases. This is very common during the months of March, April, and May considered as transhumance transition when cattle on transhumance have been exposed to polluted streams (Pamo, 1995, 2009; Ayodele, 2014).

Photo 2: Cattle Exposure to Blue-Green *Algae* Poisoning (A) as Cattle drinks from *Algae* Blooms (B) infested Njoke Water Point.

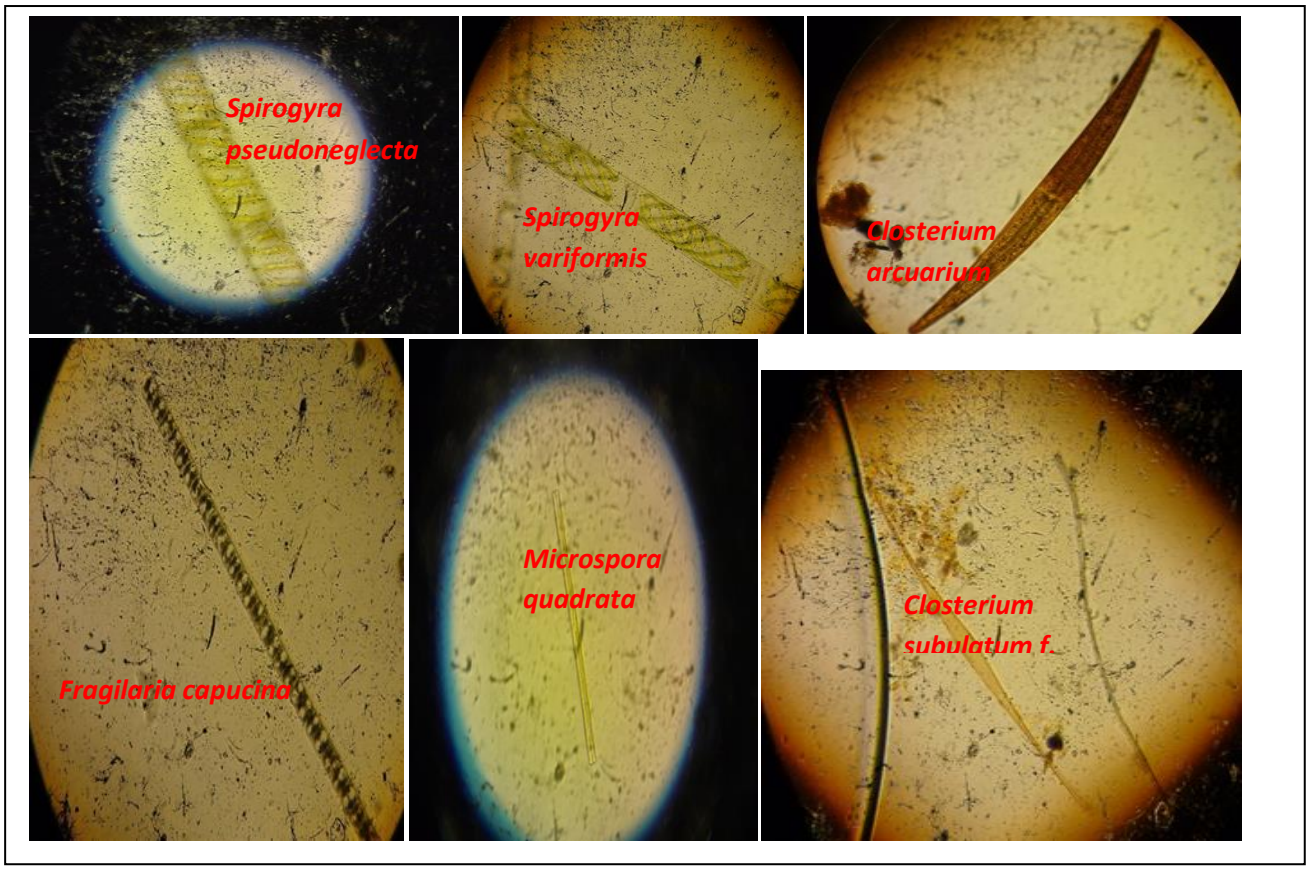


Photo 3: Varied Species of *Algae* Found in Major Cattle Water Points

Table 3: Concentrations of *Algae* Indicators of Water pollution by organic and inorganic Matter by Cattle / Humans in Nkambe Highlands,

	BINSHUA (A) ZONE II			BONTOR/ MAGMA (B) ZONE V			NJEMA / KOKOUBE (C) ZONE III			NJOKE (D) ZONE I		
Algae Species	**Family**	**Relative Abundance %**	***Algae* Species**	**Family**	**Relative Abundance %**	**Algae Species**	**Family**	**Relative Abundance %**	**Algae Species**	**Family**	**Relative Abundance %**
Oscillatoria granulata	Cyanobacteria	25	*Spirogyra irregularis*	Chlorophyceae	76.42	*Microspora quadrata*	Chlorophyceae	47.68	*Spirogyra irregularis*	Chlorophyceae	49.86
Spirogyra irregularis	Chlorophyceae	14.79	*Spirogyra majuscula*	Chlorophyceae	19.68	*Spirogyra varians*	Chlorophyceae	8.28	*Spirogyra variformis*	Chlorophyceae	14.6
Cloterium ralfric var	Chlorophyceae	46.79	*Spirogyra corrugata*	Chlorophyceae	3.64	*Spirogyra irregularis*	Chlorophyceae	43.71	*Spirogyra neglecta*	Chlorophyceae	20.94
Fragtaria capucina	Bacilla rophyceae	13.42	*Frustulia rhomboides*	Bacilla riophyeose	0.26	*Closterium rolfsii var hybridum*	Chlorophyceae	0.33	*Spirogyra corrugata*	Chlorophyceae	14.60

NB: Relative Abundance (RA) is calculated using the formula: Number of Individual of Species in each Water Sample × 100/total Number of individual species.

Source: Laboratory of Applied Bontany, Faculty of Science-University of Dschang; September 2016 Analysis by Julius Tata supervised by DR Martin Lekeulefack

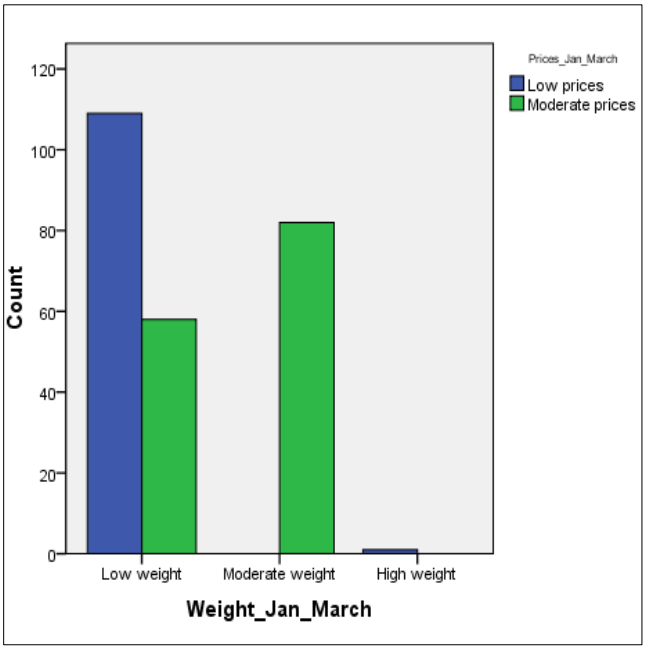
Table 1: Physicochemical Analysis and Concentrations of Fecal Indicators Contaminants in Water used by Cattle / Humans in Nkambe Highlands

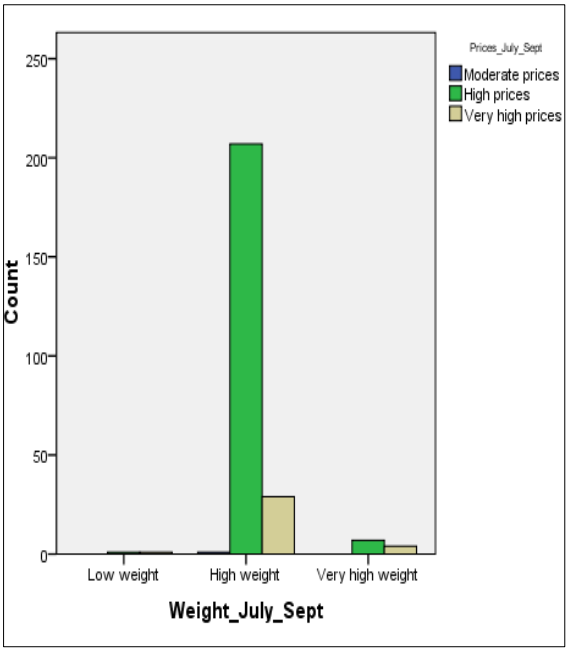
Parameter (S)	Binshua (A) ZONE II		Bontor / Magha (B) ZONE V		Njema /kokoube (C) Zone III		Njoke (D) ZONE I	
	SAFE UPPER LIMIT	Actual situation	SAFE UPPER LIMIT	Actual situation	SAFE UPPER LIMIT	Actual situation	SAFE UPPER LIMIT	Actual situation
Total Dissolved Solids (mg /l)	500mg/l	566mg/l	500mg/l	5790mg/l	500mg/l	5710mg/l	500mg/l	5790mg/l
PH	6.5-8.5	7.00	6.5-8.5	7.20	6.5-8.5	7.00	6.5-8.5	6.97
Salinity (Total Soluble Salts)	3mg/l	6.7mg/l	3mg/l	6.7mg/l	3mg/l	0.1mg/l	3mg/l	1.2mg/l
Sulfate (mg /l)	3mg/l	2.0mg/l	3mg/l	1.0mg/l	3mg/l	2.0mg/l	3mg/l	3mg/l
Nitrate Nitrogen (mg/l)	<100mg/l	0.5mg/l	<100mg/l	0.5mg/l	<100mg/l	0.2mg/l	<100mg/l	0mg/l
Molybdenum Phosphate mg/l	Variable mg/l	0.14 mg/l	Variable mg/l	0.09 mg/l	Variable mg/l	0.06 mg/l	Variable mg/l	0.20 mg/l
Iron mg/ l	Variable mg/l	1.90 mg/l		1.80 mg/l		2.0 mg/l		0.20mg/l
			Variable		Variable		Variable	
Escherichia Coli; CFU/100m/l	0m/l	100m/l	0m/l	200m/l	0m/l	0m/l	0m/l	0m/l
Fecal Coliforms; CFU/100m/l	0m/l	200m/l	0m/l	300m/l	0m/l	100m/l	0m/l	100m/l
Fecal Streptococci; CFU/100m/l	0m/l	200m/l	0m/l	500m/l	0m/l	60m/l	0m/l	200m/l

3.2 *Algae* blooms as major constraints to cattle production in an agroecological zone consider as an eldorado for pastoralism

On the Nkambe highlands, algae bloom pollution of cattle water points exacerbated by climate variability manifested by prolong dry season, dry spells during humid months influence the cattle weight and prices in the course of the pastoral season (Tsalefac , 1988). Statistically, out of 250 pastoralists investigated 167 (66.8%) accepted that cattle really suffered from low carcase weight and prices in January and March, 82 (32.8%) moderate weight/ prices, 1 (0.4%) high weight/prices. Assessing the situation of April and June; 81 (32.4%) low weight/prices, 168 (67.2%) moderate weight/prices, 1 (0.4%) very high weight/prices, July and September; 207 (97.2%) high weight/prices, 7 (2.8%) very high (Figure 2). The severe and prolonged seasonal droughts of 1982, 1983, 1987, 1989, and 2005 manefested by serious water shortages, pasture scarcity, outbreak of foot and mouth diseases. This crisis prompted SODEPA to exceptionally transfer their cattle to Hadada; Kurmaru and Banabumbu transhumance zones reserved most often only to local herders from Nkambe highlands and environs (Willington Ojong, 2010).

According to the movement of Livestock/internal and external file MINEPIA Ref DM/023/ Vol 5, cattle on transhumance to Dumbo SODEPA Ranch in 1982 suffered from severe carcase weight loss and mortality. This situation forced the herders and SODEPA officials to engage in the option sales of affected cattle (Table 3). According to the study carried out by Deffo et al (2011) and confirm from Nkambe MINEPIA service, on the critical period of cattle farming in Cameroon's high Plateau particularly the humid tropical agroecological zones, Adamawa and Nkambe Plateau cattle average monthly performances (weight gain/loss, calving rate) and production costs (feeding and health care costs) are greatly influence by seasonal changes and water quality. The months of December, January, February, March and April always have low cattle weight rates, low calving rates and high feeding costs (Figure 2)However, secondary factors such as recurrent thunder storm, poor grazing techniques, refusal of vaccination by some pastoralists especially the Akous, cattle theft, poisoning and frequent selling of cattle due tohigh family responsibility in a dominant polygamous culture have been equally attributed to recurrent drop in cattle production(Willington Ojong et al, 2010)





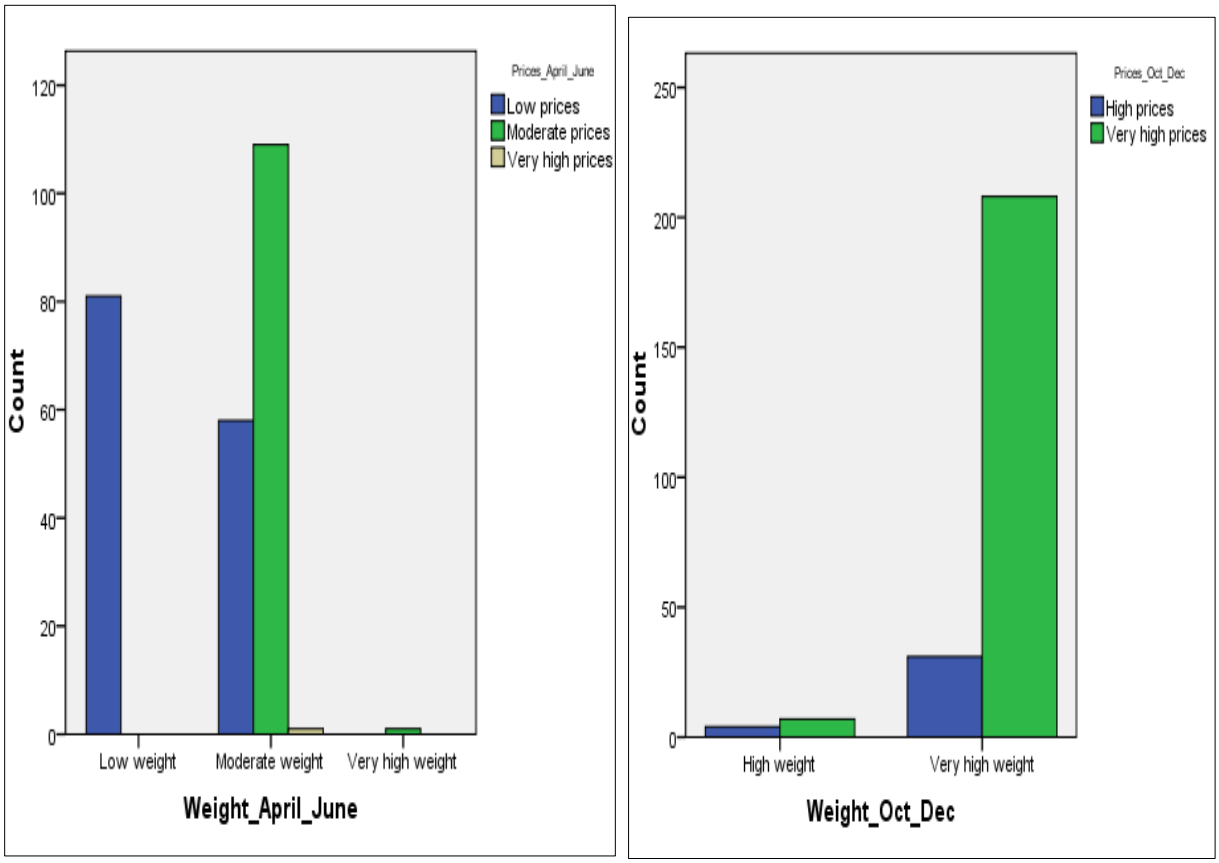


Figure 2*:* Seasonal Evolution of Cattle Carcase Weight and Prices

Table 5: Cattle Option Sales at Dumbo SODEPA Transhumance Zone; March 1982

Categories	**Average Age (YRS)**	**No of Cattle**	**Origin of Cattle(CFA)**	**Price per Cattle (CFA)**	**Total Price(CFA)**
Young Bulls	2-3yrs	72	Donga Mantung	50000	3625000
Heifers	2-3yrs	25	Donga Mantung	55000	1375000
Total		**97**	**Donga Mantung**		**5000000**
Young Bulls	2and half-3yrs	150	Donga Mantung	50000	7500000
Heifers	2and half-3yrs	50	Donga Mantung	55000	2750000
Total		**200**	**Donga Mantung**		**10250000**
Taurillons	2-3yrs	145	Donga Mantung	45000	7250000

Genisses	2-3yrs	50	Donga Mantung	45000	2750000
Total		**195**	**Donga Mantung**		**10000000**
Young Bulls	2-3yrs	112	Donga Mantung	50000	5600000
Total		**112**	**Donga Mantung**		**5600000**

Source: MINEPIA Ref DM/023/ Vol 5

CONCLUSION AND FUTURE PROSPECTS OF CATTLE PRODUCTION IN THE CONTEXT OF *ALGAE* BLOOM POLLUTION

The main objective of this study was to have a vivid and critical appraisal of the state of algae bloom pollution of cattle water points in the Nkambe highlands, stakes and future prospects. To attain our objective, field observation, pastoralists' and MINEPIA field extension staff experience of the actual situation were premodial. It was realized that pastoral hydraulics infrastructures and cattle water points are in a very poor state. In major grazing land where cattle water points do exist, water volumes or discharge in the dry season and /or during recurrent dry spells, prolonged and periodic droughts are not encouraging. Faecal contamination of springs and streams by domestic and animal waste constituted a rich nutritive base for the growth of algae bloom affecting the quality of exposed surface cattle water points. The dependence of pastoralists on natural water sources imposed on them subsistence grazing system dorminated by constant mobility in search for water during water stress periods. The ranching system which is highly profitable and cost effective is impossible due to acute water shortages and poor state of pastoral hydraulics.

A majority of cattle are served with water from uncontrol surface water points of doubtful quality and quantity. The laboratory analysis of water samples of six major cattle water points; Njema/Kokoube, Njoke, Binshua, Bontor/Magha however showed that the problem of water quantity is more crucial than the quality problem. It is however imperative to envisage sustainable protection of cattle water points from faecal contamination consequently algae bloom pollution will be addressed.The State and development partners should invest in pastoral water systems in the study area in other to enhance food security and poverty alleviation enshrined in the Growth and Employment Strategy Paper.The pastoralists are strongly advice to grazed their cattle only at safe water points, population and stray animals should restraint polluting the springs and streams, council regulate the encroachment of peri-urban belts and agricultural farms to grazing zones, major water catchments in other to prevent the contamination of cattle points with fecal and mineral nutrients which enhance the growth of algae blooms most especially the cyanobacteria (blue green algae) that produces toxins harmful to the liver and cattle nervous system. The current decline in animal numbers in the region should therefore be taken as a warning that something is wrong somewhere and if the solution of water shortage and cattle water points pollution by algae bloom are not found, then the economy of the area will witness a major setback. For the livestock sector is a major economic activity of the region employing many people and generating enough income into the economy.

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