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African Journal of Education, Science and Technology

AJEST

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FOREWORD

The first volume of African Journal of Education, Science and Technology is devoted to the publication of the papers from the First International Interdisciplinary Conference which was held at the University of Eldoret from 3rd to 5th September, 2013. The conference was the outcome of collaboration between the University of Eldoret in Kenya and the Anambra State University, Uli, Nigeria. The two institutions signed a Memorandum of Understanding that detailed the envisaged areas and levels of cooperation. This augurs well for the cross fertilization of ideas, joint studies, faculty and student exchanges resulting in mutual gain and growth.

This first volume of AJEST contains papers which were presented at the conference and subjected to peer-review by experts in various fields. Other issues are planned to ensure the inclusion of the vast number of quality papers contributed by scholars, professionals and researchers during the conference. The upsurge of interest and anxiety among researchers, scholars, and professionals for the growth of research in Africa toward policy and practice in education, science and technology are clearly demonstrated in AJEST.

This issue contains twenty six (26) papers selected from a wide array of fields with an attempt to include authors from different nationalities and institutions. The fields covered include: nutrition, agriculture, literature, chemistry, biology, teaching and learning, entrepreneurship, food science, finance, environment, gender, vocational training, among other sciences. They highlight the researches that have been carried out in these fields with results that can be very beneficial to the community at large.

Dr. Mary Felicia Opara (IHM)   Dr. Ahmed Ferej

Editors in Chief

ABOUT THE JOURNAL

African Journal of Education, Science and Technology (AJEST) is a peer-reviewed official journal of the University of Eldoret, Kenya in collaboration with Anambra State University, Uli, Nigeria. AJEST aims to publish and report on a wide range of interdisciplinary papers relating to education, science and technology. The journal seeks to provide forum for scholars, researchers, practitioners and policy makers to disseminate current and emerging thought-provoking essays, discussion and research papers that will be valuable for policy and practice in Africa.

Frequency: One volume of four issues per year.

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Appraisal of Change in Regional and Global Financial Crisis (A Study of Investors' Behaviour during and after the Speculative Bubbles and Crash of the Nigerian Capital Market)

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Abstract

The appraisal of the aggregate market in respect to high price earnings ratio and high asset prices experienced in the equity and asset markets in the end of 1990s and the imminent fall in 2008 ascribed to the speculative bubble crash which is consistent with investors' irrational behaviour, wrong human judgement of the 2008 market decline due to bad credit lending. It is against this background that the study appraises how investors are influenced by these biases and what influenced them to change their investment portfolio during and after the speculative bubble and crash of 1998 to 2009. The use of questionnaires was adopted to get an understanding of what investors' trading pattern was like; it looked at the behavioural bias that influenced their method of stock picking in the past. The performance of the market after the crash was tested using total market capitalization as a proxy. Among the variables, stocks and equity were positive with 1.021 and 0.055 while interest rate and bonds negative at -0.033 and -0.126. Equity was insignificant. This result shows that the fundamental value of a company did not affect market overvaluation. This supports the EMH theory that investors think that they can predict and outperform the market. Conclusively, the common knowledge of the factors underlying the speculative bubble before its imminent burst and the way psychological factors influence decision-making should stand as a guide against a reoccurrence of this phenomenon and improve the efficiency of today's reviving financial market.

Keywords*: Investors, Behaviour, Speculative bubbles, Crashes and Stock Market*

Introduction

The financial crisis of 2007–2009, also known as the Global Financial Crisis and 2008 financial crisis, is considered by many economists, the worst financial crisis since the Great Depression of the 1930s. It resulted in the threat of total collapse of large financial institutions, the bailout of banks by national governments, and downturns in stock markets around the world. In many areas, the housing market also suffered, resulting in evictions, foreclosures and prolonged unemployment. The crisis played a significant role in the failure of key businesses, declines in consumer wealth estimated in trillions of U.S. dollars, and a downturn in economic activity leading to the 2008–2012 global recession and contributing to the European sovereign-debt crisis, Asian crises, Africa and the world over. The active phase of the crisis, which manifested as a liquidity crisis, can be dated from August 9, 2007.

The Nigerian capital market is in no way exempted from the proven imperfections in financial markets throughout the world. Investors sometimes, albeit temporarily, exhibit excessive optimisms and pessimism which culminate in pulling stock prices away from their long term trend levels to extreme points. The theory of efficient market posits that only fundamental factors such as profits and dividends should drive stock prices so that trade plays little or no role in stock price movements. The overvaluation of the Nigerian stock market is a notion supported by meager evidence. But common economic sense tells us that the pace of general economic growth should be in tandem with growth of the capital market. This is premised on the fact that stock market booms are an element of the business cycle, with booms typically arising during cyclical recoveries and other periods of rapid economic growth and ending when GDP growth slows. But so many things still need to be unearthed in the behaviour of the Nigerian stock market in recent times.

The occurrence of bubbles and crashes in experimental markets with inexperienced participants relates to Statma (1999) documentation of observing stock market bubble and crash pattern. The work found that participants who have no previous experience in similar asset market, would exhibit a price bubbles and crashes instead of tracking the fundamental value. When market prices surpass their fundamental values on the high volume, market crashes drop faster in price than their fundamental values often when the terminal stage of the asset is approaching. Resistance to both institutional and environmental changes eradicate price bubbles.

Camerer (2006) posits that when bubble bursts, economic crisis will follow. The Japanese financial crisis of 1990 and Southeast Asia financial crisis of 1997 are examples of financial crisis because of economic bubbles. The impact of this crisis is not limited to the origin country, but expands beyond borders. Stock is one of the main vehicles of bubble economy; according to Shiller (1989; 1990), asset pricing bubble is a major factor that triggers bubble economy.

The Dot-com bubble and crash with Asian Financial crises is a constructive experiment in the study of behaviour of the stock market under extraordinary circumstances, which explains the behaviour of investors in the stock market. Stock markets in the affected countries experience three phases of stock market cycle namely: recent history of general high returns, a spiky fall in market capitalisations after the crisis started and extent of quick but prejudiced recovery. The combination of these three phases establishes the occurrence of a positive bubble followed by a negative price bubble, i.e. the gross overvaluation of share prices before the crisis. Overvaluation of share prices gives rise to overreaction, which results in excessive discounting of share prices (negative bubble).

The Nigerian stock market in recent times, continue to witness persistent bull ride, flanked by escalating gurgles and bubbles. As banks began to give out more loans to potential investors, stock prices began to rise. Despite its miniature stature compared to its counterparts the world over; the Nigerian stock market continue to proved to be one of the most efficient in terms of profitability. The momentum for stock price movement grew very strong and investors were comparing virtually every form of investment to the stock market. Suddenly, in the first quarter of 2008, the bubble burst and the Nigeria Stock market crashed to an all-time bearish ride, with investors losing over a hundred billion naira. As a result, their perception towards investment in shares changed. The study therefore set out to determine whether Nigerian investors' decisions during and after the speculative bubbles and crashes influences their investment portfolio and to evaluate the performance of the stock market after.

Review of Literature

Bubbles and crashes history dates back to the 17th century (Mackay, 1852). When the relations among traders becomes very strong it reaches significant values, a second-order phase transition, and significant behaviour during this phenomenon can be observed, thereby creating a bull and bear market phase. Caginalp (2001) posits that bubble rise is an initial phase characterised by a new initiative or merchandise, which causes changes in expectations about the future. When the system stays at the bull market phase, speculative bubbles occur in the stock market. Speculative bubble describes the situation where temporal high prices are maintained by investors' passion or emotion rather than by reliable evaluation of real value. This results in a feedback effect where rise in price increases investors' passion to increase demand.

A speculative bubble is not sustainable. The idea of speculative bubble is about the irrational side of investors' behaviour. The theory also necessitate that changes in past prices will create faithlessness in judgments, not that they believe that prices will continue to rise. The history of stock market event ranging from the Great crash of 1929, the Tronic boom of the 1960s, the Go-Go years of late 1960, the Nifty Fifty bubble of early 1970, the Black Monday crash of 1992, the bond market crash of 1994, the Dot com bubble of 1990 and the depression of 2008. This period-created opportunity for contrarian arbitrageurs, to force many arbitrageurs out of business, as prices already high went higher before the final market crash. During a bubble however, the propensity to speculate is high, investment bankers can join the chorus arguing for high valuations.

Factors Underlying Speculative Bubble and Crash

Kahneman (2002) describes speculation as *"buying for resale rather than income"* and bubble means, *"predict the bursting"*. According to him, speculative bubbles in the past followed the standard structural pattern, though the information differs from one event to another. According to Lux (2001) a bubble will burst if rational investors can arbitrage without risk. There are many factors that influenced speculative bubble and crash. They include, structural, cultural and psychological factors

Structural Factors: Arrival of New Technology at a Time of Unyielding Earning Growth. It is a known fact that most people in the 1990s never had or used cellular phones and most never heard or used the internet and global web. It was not far before these technologies became a household name making a minded speed at which technology changes. By mid 1990s, earnings rose to the peak; accredited to the birth of a new era that have less or nothing to do with the internet evolution. Introduction of new technologies will always have a great impact on the market (De Bondt & Thaler, 1994; Shiller, 2001).

Cultural Factors: Media. The media is an important part of market dealings because they attract viewers and readers. Activities in the stock market attract the attention of the news media because of the

persistent flow of news in form of daily price changes and company reports. They pike the interest of viewers by attaching news stories to stock price movements, thereby creating a hub of greater attention on their movements. During the period of market crisis, the media can push trading activity to the extremes. The media can set off and strengthen opinions.

Psychological Factors: Expectation and Emotion. Investment decisions most times are affected by contradictory emotions. As emotions increases, it increases with complication and ambiguities surrounding the decision (De bondt & Thaler, 1985). If a participant leaves the market without participating in making money that other investors had shared in, it may degenerate to a sharp feeling of regret. According to Loomes and Sugden (1982), the feeling of regret discovered by experts is the reason why people make changes in their investment decisions. Nofsinger and Baker (2002) explain this as an attachment bias, where investors become emotionally attached to a particular investment. Emotional attachment can cause investors to focus on good news and ignore bad news of an investment. This could hinder the incorporation of information into a share price.

The Speculative Bubbles and Crash of the Nigerian Stock Market

The crash of the Nigerian stock market has been unprecedented in it historic evolution since 1960 to date. Its market capitalization nose-dived from an all time high of N13.5 trillion in the first quarter of 2008 to less than N4.6 trillion towards the year's end. Besides, the All-Share Index (a measure of the magnitude and direction of the general price movement) also plummeted from about 66,000 basis points to less than 22,000 points in the same period (see figure 1). This is as a result of the speculative bubble—an indefensible rise in prices brought on by investors' buying behavior rather than by genuine, fundamental information about value. The stock prices experienced a free-for-all downward movement regime, with supply exceeding demand. Consequently, many of the quoted stocks lacked liquidity as their holders were trapped not able to convert them to cash to meet their domestic and other investment needs. Suddenly, the bubble burst and the market crashed.

Figure 1. Historical Trend in NSE ASI
Source: Meristem Securities Ltd (Member Nigeria Stock Exchange)

From the historical perspective, there is no doubt the Nigerian Capital market soared to extremely high levels in recent years. These results created a sense among the investing public that such high valuations, and even higher ones, will be maintained in the foreseeable future. But figure 1 above looks quite instructive. From a logarithm scale, the index appears quite higher than what it should be. If the history of high market valuations is any guide, the public may be very disappointed with the performance of the stock market in coming years.

Materials and Methods

Description, Justification and Sources of Data

The study used the descriptive and inferential statistics approach to analyze the data. Data were sourced from both the primary and secondary source. Secondary data were obtained from the Central Bank of Nigeria Statistical Bulletin and the Nigeria Stock Exchange Factbook and other cognate population The Ordinary Least Square (OLS) regression was used to analyze the performance of the Nigerian stock market with time series data spanning 1998-2009. Frequency table and Percentages were used to analyze responses from respondents and Chi-square (χ^2) to test for the significance.

Model Specification

The model was developed to evaluate the performance of the Nigerian stock market after the speculative bubbles and crashes (1998-2009). The total market capitalization was used as a proxy for the overall performance of stock market. To achieve this statistical analysis, other dependable variables like interest rate, equity, stocks and bonds were included in the model. The model specified was based on the liquidity preference theory, and mathematically stated as follows;

TMC = F(Interest, Equity, Stocks and Bonds). This could be written in econometric form, thus,

$Y = b_0 + b_1INT + b_2EQT + b_3STK + b_4BND + \mu$

Where;

Y = Total market capitalization

b_0 = Constant

b_1 to b_4 = Slope

INT = Interest rate

EQT = Equity

STK = Stock

BND = Bond

μ = Error term

Data Presentation and Analysis

Hypothesis 1

H_0: The change in Nigerian investors' behaviour during and after the speculative bubbles and crash has no relationship with the Global financial crises.

Respondents Responses and Analysis

Table 1. Percentage Method

Questions	Total	%
Returned	180	90
Not Returned	20	10
Total	200	100

Table 2. Frequency Table: Respondents Views on investors' Behaviour during and After the Bubbles and Crash

Questions	SA	A	D	UD	Average
Scale	4	3	2	1	2.5
1	80	60	10	20	3.10
2	75	80	5	20	3.5
3	85	70	20	5	3.38
4	60	100	10	10	3.1
5	70	90	-	20	3.16
6	90	65	-	25	3.2
7	90	75	10	15	3.38
8	80	60	10	20	3.1
9	75	80	20	5	3.25
10	60	100	10	10	3.1

Source: Researcher Field Survey, 2013

From table 1, it is observed that out of the 200 questionnaires administered, 180 were returned representing 90% of the total while 20 representing 10% were not returned. Analysis was done based on the 180 returned.

From table 2, respondents view on investors' behaviour during and after the speculative bubbles and crash is presented. The questionnaire contained 10 questions, structured on a 4 point linkert scale.
The decision rule was arrived at: $\frac{4+3+2+1}{4}$ = 2.5 (Average/Critical value).

Cr > Ct = Accept H_0, where Cr represents critical value and Ct represents calculated value.

If Cr < Ct = Reject H_0. Ten specific questions were drawn to analyze the change in investors' behaviour during and after the speculative bubble and crash. Five (5) questions addressed the behaviour before the bubbles burst while five (5) addressed the behaviour after the crash. The result for each was greater than the average of 2.5 and significant (see appendix 1). From the results, it was observed that the speculative bubble burst and eventual crash was a chain reaction to the global financial crisis that started in the USA. Generally, before the bubbles burst in Nigeria, the stock market was the most attractive and lucrative place to invest. The continual rush to the market to raise fund abnormally by commercial banks increased investors' confidence with mixed emotions in the market, regulatory inconsistencies and pronouncements created panic selling among investors; the aspirations for wealth and status and sentiments reflecting unrealistic optimism and pessimism greeted investors' behaviours.

The second half of the five questions, addressed investors' behaviour after the crash. From the results, it was observed that since the bubble burst and the eventual crash, the market has not revived with foreign investors pulling out from the market. Investors' behaviours were greeted with regrets and biases; as a result they were compelled to diversify their investments to real estate and government bonds and stocks.

Hypothesis 2
H_0: The Nigerian stock market has not performed significantly well after the speculative bubbles and crashes

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.993	.987	.979	619.4396	.987	128.525	4	7	.000	1.693

a Predictors: (Constant), BON, INT, EQT, STC
b Dependent Variable: TMC

ANOVA

	Model	Sum of Squares	df	Mean Square	F	Sig.
1	Regression	197262823.519	4	49315705.880	128.525	.000
	Residual	2685937.831	7	383705.404		
	Total	199948761.350	11			

a Predictors: (Constant), BON, INT, EQT, STC
b Dependent Variable: TMC

Coefficients

	Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.	Correlations		
		B	Std. Error	Beta			Zero-order	Partial	Part
1	(Constant)	1732.560	1520.973		1.139	.292			
	STC	3.957	.257	1.021	15.422	.000	.985	.986	.676
	INT	-39.747	64.371	-.033	-.617	.556	-.541	-.227	-.027
	EQT	4.123E-02	.037	.055	1.106	.305	.458	.386	.048
	BON	-17.499	7.844	-.126	-2.231	.061	.487	-.645	-.098

a Dependent Variable: TMC

From the results, R^2 of 0.987 implies that the explanatory variables such as stocks, interest rate, equities and bonds influences the total market capitalization by 98.7% that was used as a proxy to measure the performance of the Nigerian stock market after the speculative bubbles and crash. This indicates that it is a good fit, since R^2 is closed to one. The result also shows that F-test at 128.525 was

highly significant at 0.000, since it is less than 0.005 level of significance. Similarly, the Durbin Watson value of 1.693 shows that there is no presence of autocorrelation as it is strongly closer to 2, but the standard error of estimate is quite high at 619.4396.

The standard beta coefficients of explanatory variables to total market capitalization could be expressed in the regression function, thus; $Y = 1732.560 + 1.021STC - 0.033INT + 0.055EQT - 0.126BON$

From the above regression function, it was observed that stock contribute the highest to the performance of the Nigerian stock market at 1.021, follow by equity at 0.055. However, the contributions of Interest rate and Bonds to Nigerian stock market are negative at -0.033 and -0.126 respectively. The study found that there is a positive relationship between stocks, equity and total market capitalization, but equity is insignificant at 0.305 as it is greater than 0.005 level of significance. Similarly, the zero-order correlation shows that stocks are strongly correlated with total market capitalization at 0.985 follow by bond and equity at 0.487 and 0.458. However, there is a negative correlation between interest rate and total market capitalization. In general, the work is supported with the works of Keynes (1936) that sentiment, reflecting unrealistic optimism or pessimism, leads to booms and busts. But the performance of equity and bond, thus does not suggest reality in the Nigerian economy after the bubble burst.

Conclusion and Recommendations

Market Players for sometime relied on the theory of Efficient Market Hypothesis and the rational investors' behaviour when making financial decisions. They believed that rational investors maximise their utility and exhibit perfect self-control over the years. Result shows that despite what research says, the behaviour of market participants at some level are unpredictable during and after the speculative bubbles and crashes of the stock market movement. The results also explain the reasons that led to speculative bubble and crash. The conclusion is that investors are responsible for the market burst; most especially the institutional investors, which are considered the most, informed. The behavioural side underlying these views are numerous.

It is believed that stocks in the market reflect all the available information in the market supported by researchers and academicians (Fama, 1965; Kendall, 1953; Friedman, 2008). However, some still believe that stock markets are not efficient (Brealey & Myers, 2000; Lakonishok, Schleifer & Vishny, 1994; Olsen (1998) and with this fact, it may be concluded that if markets were not efficient, no market would exist at all. In the study, it is discovered that biases such as herd behaviour, overconfidence and representativeness did not cause the stock market volatility that led to the speculative bubbles (IT bubbles).

However, empirical literature on behavioural finance has failed to develop other theories that might explain market anomalies like EMH do and further explain the irrationality of human decision making in the stock market. From the statistical analysis, it proved that herd behaviour, overconfidence and representativeness has no influence on the stock market bubble, and eventual the crash of the market in 2008. The study however, conclude that the behavioural finance has not achieved its study of human irrationality in decision making.

From the study, it is recommended that investors should be re-educated on stock market anomalies and the use of EMH by fama should be introduced into stock market trading. Secondly, the stock market should purge herself of noise traders and the use of certified information should be disseminated in the market. Every major economies stock exchange securities commissions should employ a strict reguations to stocks being placed on IPO and asset that rises above 50% of its intrinsic valued should be pulled out of public offer. For the 2008 crash, financial institutions should be re-assessed and quarterly statement of account should be submitted to the central bank of each country and they should in return look at the companies debt/equity ratio just as Graham value screen suggests. The governemnt should part-own this companies shares by providing enabling environment for trading so as to avoid future occurrence of the 2008 market crash.

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Determinants of Nutritional Rickets among Children Aged below 5 years in Naivasha District Hospital, Kenya

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Abstract

Rickets, a common deficiency disease affecting children below five years of age, is rare in most developing countries but is observed in severely malnourished children. According to literature, Vitamin D, Calcium and Phosphorus deficiencies are the main causes of rickets. The purpose of this study was to investigate the determinants of the development of nutritional rickets among children below 5 years undergoing treatment at the Naivasha District Hospital (NDH). Out of the target population of one hundred and eighty four children (184), seventy four (74) mother-child pairs were purposively selected for this study. The children in this study had been diagnosed with rickets and were undergoing treatment and occupational therapy at NDH. A structured questionnaire was administered to the caretakers of the children. Two (2) key informants from the Municipal council were interviewed and provided information regarding water quality. A pilot test was conducted before data collection. Data was analyzed using the Statistical Package for Social Sciences (SPSS) version 20 (2011). A p value of >0.05 was considered significant. Results showed that poor feeding practices were evident where children were deprived of animal source proteins represented by forty six percent (46%) in infants and forty percent (40%) among those diagnosed post-infancy. Majority (41%) of the children had inadequate daily sunlight exposure of less than 30 min a day. Fifty nine percent (59%) of them were fully clothed during sunlight exposure. Sixty seven percent (67%) of the households used fluoride contaminated borehole water for cooking activities. This finding was significant (p=0.05). Insufficient sunlight exposure due to inappropriate dressing and use of fluoride contaminated water were the main determinants of rickets among these children. It is hoped that results from this study can be used to develop interventions which can alleviate the prevalence of rickets among children in Naivasha.

Keywords: *Rickets, Vitamin D, Calcium, Sunlight*

Introduction

Nutritional rickets is a disease of growing bone that afflicts children and adolescents during times of rapid growth. Vitamin D deficiency and/or nutritional rickets remain prevalent in developing regions of the world and rank among the five most common diseases in children (Lerch, 2007; Wagner, 2008). Vitamin D is essential in promoting absorption of Calcium and Phosphorus which build strong bones and teeth (Schwarz, 2011). Low plasma levels of Vitamin D causes the body to produce parathyroid hormone which causes Calcium and phosphate to be released from the bones leading to their weakness, hence the development of rickets. This consequently weakens the bone structure leading to skeletal deformities such as bowlegs, knock-knees, non-closure of the fontanel, enlarged wrist bone, non-development of teeth even at 6 months and failure to thrive (Wagner, 2008).

The development of rickets is common in areas which have low socio-economic conditions, insufficient breastfeeding, inadequate complementary feeding practices and lack of exposure to sunlight (Thacher, 1999). Researchers have found that insufficient dietary intake of Vitamin D, calcium and phosphorus leads to the development of rickets in sun-rich countries (Pettifor, 2004; Bener et al., 2003). In many developing countries, the staple diet of children who have been weaned is low in Calcium. In Nigeria for example, dairy products are rarely incorporated in children's diet (Bishop, 1999) and fluoride-calcium interaction has been shown to cause rickets (Norman, 2001). Further, uptake of Calcium as Calcium phosphate by bones is hindered by high fluoride content in food and water. The Rift Valley region in Kenya has very high fluoride concentration in water (rivers-2-21ppm; boreholes >7.5ppm), soil (2300ppm) and food sources (>6ppm) (National Institute of Health, 2009). The contents are far above the levels recommended by the World Health Organization and Kenya's Ministry of Water and Irrigation of 1.5 ppm (parts per million) (Rombo, 2009).

Naivasha, one of the constituencies in the Rift Valley, has reported an increase in cases of rickets among children. Hospital records indicate an alarming increase of up to 84 new cases among children aged between 6-12 months, within a 6 month period (Gitonga, 2013). This paper presents findings of a

research study carried out on children aged below 5 years who were diagnosed with rickets and were undergoing treatment and occupational therapy at Naivasha District Hospital (NDH). The purpose of this paper was to find out the determinants of nutritional rickets among the children attending NDH.

Materials and Methods

The descriptive cross-sectional research design was employed in this study. Data was collected from mothers or care givers of children aged below five years undergoing treatment at (NDH) between December 2012 and January 2013.

This research was carried out in Naivasha one of the six constituencies in Nakuru county. It covers an area of 2, 300 Km^2 and experiences seasonal rainfall ranging between 156-1134 mm. This climate supports agricultural activities in particular subsistence farming and floriculture due to the rich volcanic soils. Poverty incidence is high with the urban poor consisting of 41% while the rural poor 45% (Kenya National Bureau of Statistics, 2012). This research was carried out in Naivasha District Hospital which is the main health facility that serves residents of Naivasha and is the only hospital in Kenya which provides the treatment and occupational therapy for children affected by rickets.

According to KNBS (2009) census Naivasha constituency has a population of 224, 141 people. The target population for this study was derived from the hospital records as the estimated number of children who had been diagnosed with rickets and were undergoing treatment and occupational therapy at the NDH in the year 2012. According to these records, 184 new cases of rickets had been recorded this is approximately 15 new cases every month (Muiruri, 2012).

The study sample was drawn from the target population (184) who were mothers and caregivers of children who had been diagnosed with rickets. A total of seventy four (74) children were selected from the target population using the purposive sampling technique. Solvin's formula (2001) was used to calculate this sample size. On a specific clinic day medical personnel assisted the researcher identify the mother or caregiver who had turned up for the child's weekly therapy. Such a mother was found suitable to form the study sample and was interviewed. Thereafter, the next mother or caregiver was identified and if found suitable was selected for the study. On average, the researcher sampled and interviewed about ten mothers every day. This continued until the total number of seventy four (74) mother-child pairs was reached.

The researcher administered a structured questionnaire to the mothers or caretakers of the children attending NDH for weekly occupational therapy and filled in their responses. The questionnaire consisted of the following sections; socio-demographic characteristics of the mothers, child data, infant and child feeding practices, sources of water for cooking and household consumption. A separate section on water quality was filled by Naivasha municipal authority officials with knowledge about water treatment in the area during a scheduled interview. A pilot test was carried out on 5 mothers at the start of data collection to ensure there was no ambiguity in the questions and that the data collected was relevant to the study. Although the questionnaire was written in English the questions were verbally translated to Kiswahili when necessary. Data was coded and converted into numerical codes and analyzed using the Statistical Package for the Social Sciences (SPSS) version 20 (2001). Pearson's chi-square test was used to test relationships between variables. A p value of (>0.05) was considered significant.

Approval to carry out this study was granted by the Naivasha District Hospital Superintendent and the University of Eldoret. Further, consent to participate in the study was sought from the participants. Anonymity of the respondents was maintained by giving them code numbers.

Results

Demographic and Socio-Economic Characteristics of the Respondents

Data was obtained from 74 respondents most (31%) of whom were aged between 23 and 28 years and only 9% had attained the age of 40 years and above. Majority (76%) of the respondents, were married and 11% of them were single. Only 4% of the respondents were widows or widowers. The male headed single household was the most dominant in Naivasha. Seventy percent (70%) of the households were male headed while 24% were female headed.

Of the respondents interviewed, 39% were self-employed whereas 16% formed the lowest segment of the permanently employed. The percentage of respondents who had attained primary and secondary school education was almost equal at 44% and 43% respectively. The rest of the mothers had no formal schooling. This survey also found that 71% of the respondents had less than 5 people per household whereas 29% had between 5 and 10 people per household.

Child Information

More than half (63%) of the children had been diagnosed with rickets at the age of 1-11 months and only 33% were diagnosed at the age of 12-23 months. Seventy percent (70%) of the affected children were female while 30% were of male gender.

Feeding Habits of the Children

Results from this study showed that sixty five percent (65%) of the children were breastfed several times a day whereas the rest were breastfed minimally. Ninety five percent (95%) of the infants were on complementary feeding at the time of the diagnosis while only 5% were not (Figure 1).
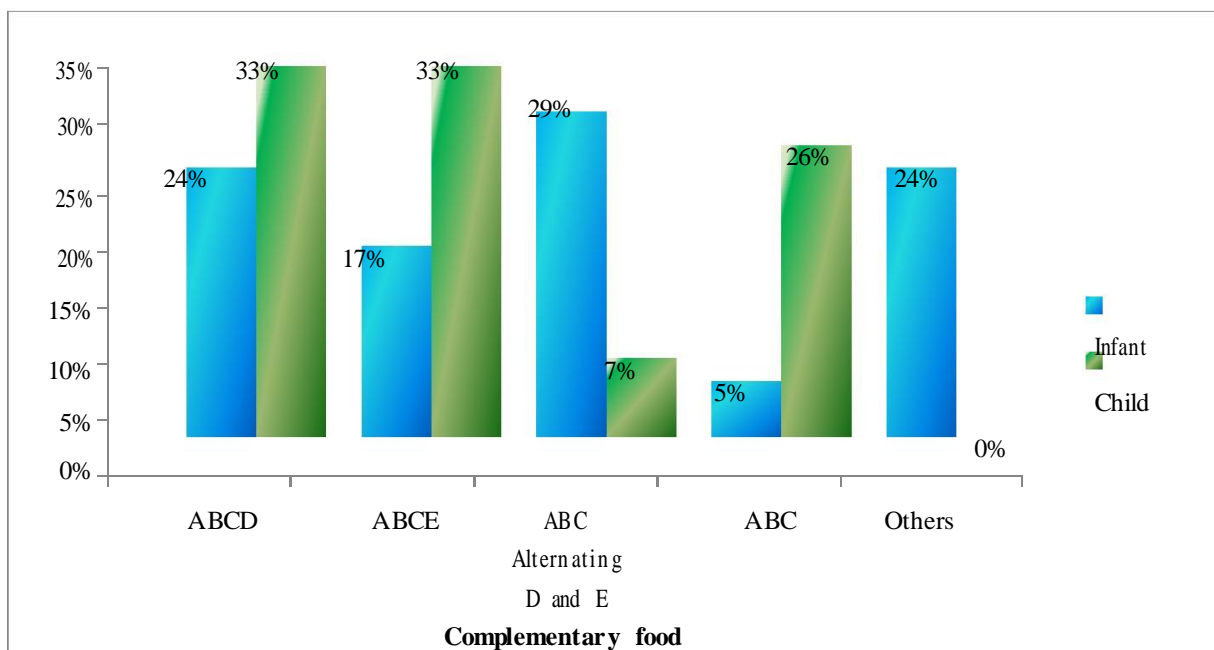
Figure 1. Infant and Child Complementary Food Combination before Diagnosis
A-Cereal based food, B-Vegetables, C-Fruits, D-Plant Proteins and E-Animal Proteins

Infancy: The highest number of respondents (29%) fed their infants on ABC alternating D and E food combination. Seventeen percent (17%) did give food combination ABCE.

Post-Infancy: Figure 1. indicates that more children (33%) were either fed on food ABCD or ABCE. The least (7%) number of the children were fed on food ABC alternating D and E. The complementary food combination of ABCD and ABCE were the highest which indicates that most children who were diagnosed post infancy were fed on balanced diets. A total of 40% (combinations ABCE and ABCD/E) were fed on animal proteins which have Calcium, Phosphorus and Vitamin D nutrients greater than the plant proteins.

Length of Time the Index Child was Breastfed

All the forty three (43) children who were infants at the time of rickets diagnosis were still breastfeeding while 27 children who were diagnosed post infancy had been breast fed before diagnosis. Majority (63%) of mothers breastfed their children for a period of over 8 months in their infancy before they were diagnosed post infancy.

Duration of Daily Sunlight Exposure of Infants and Children

Thirty seven percent (37%) of the children had average sunlight exposure of 26-35 min which conforms with the recommended daily exposure of 30 minutes. However, forty one (41%) percent of the children were under exposed to adequate sunlight thus hindering the synthesis of vitamin D by the skin.

Child's Mode of Clothing during Sunlight Exposure

Fifty nine percent (59%) of the respondents' children were fully clothed when taken out for sunlight exposure which according to the respondents was to prevent the child from catching cold related illnesses. Only 6% of the respondents' children were well clothed for sunlight exposure.

Source of Water for Household Use

The study findings showed that only 14% of the households used harvested rain water which was not contaminated with fluoride. However, sixty seven percent (67%) of households used fluoride contaminated bore hole or well water for cooking activities and another 19% used untreated municipal water for the same. Both these water sources had greater quantities of fluoride compared to the recommended safe levels of 1.5 parts per million. Pearson's chi-square indicated a significant (p>0.713) relationship between water sources and the development of rickets in children. From these results it is evident that fluoride contaminated water was one of the determinants for the development of nutritional rickets among children under the age of 5 years (Figure 2).
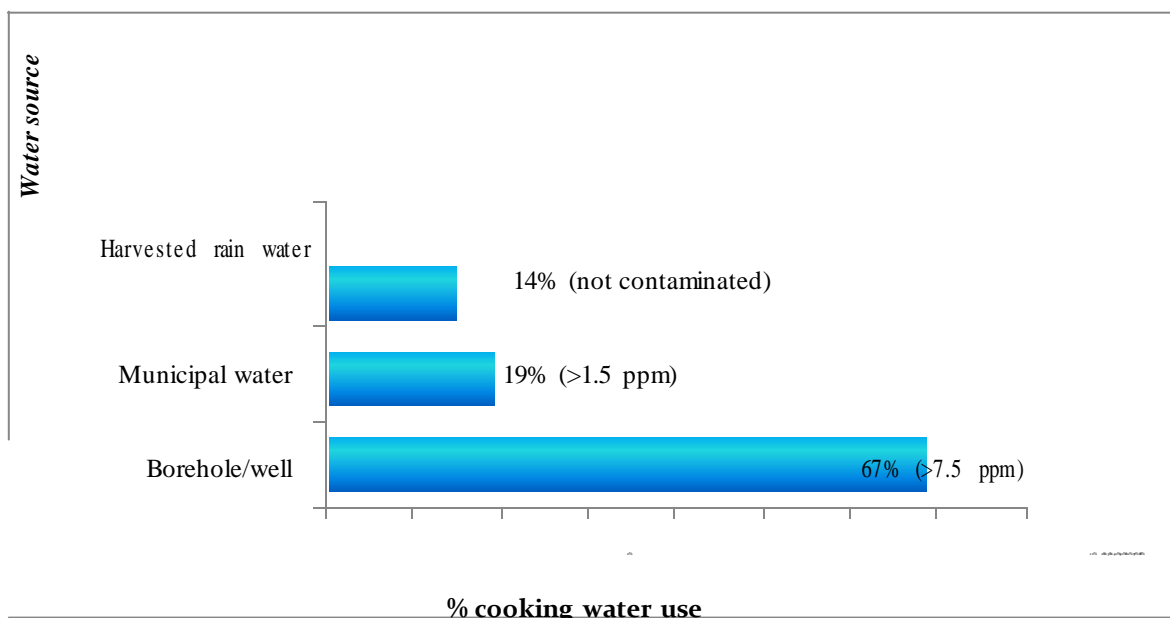
Figure 2. Source of Water for Household Use and Cooking

Discussion

The development of bone related illnesses especially in children that manifests itself as rickets is strongly related to deficiencies of essential micronutrients Calcium, Phosphorus and Vitamin D. The risk factors assessed that contribute to the development of rickets such as poor dietary intake, poor sun exposure and fluorosis are discussed.

Thirty one percent (31%) of the respondents who were mothers and caregivers of the children were aged between 23 and 28 years. This indicates that most of the mothers were relatively young and may be first time mothers thus lack adequate information and experience on raising children in their first years of life. The median age at first birth among women aged 25-49 years in the Rift Valley region is 19.6 years where women with some secondary education begin child bearing three years later (KDHS, 2008).

According to KDHS (2008), 58% of the respondents were married or living with a partner, and only 31% had never been married. Results from this study found out that majority (76%) of the respondents, were married. Seventy percent (70%) of the respondents came from male headed households, which further confirms the norm that males are always the head of most families and not females. Further, it has been assumed that rickets commonly affect children from single mother households or female headed households leading to lack of sufficient care by the caregivers who were left to take care of the children as the single mothers go to work. Results from this study confirmed that the

increase in the prevalence of rickets in Naivasha is attributed to the fact that mothers who work in flower farms and other low wage earning sectors were unable to hire nannies to take care of their children. Instead they took the children to day care centers which are crowded with poor lighting and ventilation leading to an increase in rickets (Kageni 2009; Gitonga, 2013).

Limited income may affect the types of food available to the household. However, findings from the present study are contrary to this since majority (75%) of the mothers were in some form of employment. It is evident that mothers lack adequate time to give full attention to their children in terms of dietary practices and sunlight exposure. Theuri (2012) reported that low socio-economic conditions lead to low education status and empowerment. Consequently, the purchasing power of foods rich in Calcium and Vitamin D that prevent rickets may be affected. Similarly, a study conducted in Turkey found that nutritional rickets was a disease of the underprivileged being strongly correlated to negative social backgrounds (Alsaied et al., 2009).

Mother's education persists as a strong predictor of child's nutritional status (Abuya, 2012; Theuri, 2012). The fact that almost half of the respondents (44%) in the present study had primary education may be an indicator of lack of knowledge on proper dietary habits particularly serving nutritious foods to their children thus, this finding concurs with the Kenyan survey (KDHS, 2008) which indicated that most women in Kenya have not attained high levels of education.

Most research studies carried out in developing countries indicate that malnutrition is common in households with large families. On the contrary, the results from this study showed that the development of rickets in children may not be due to large household sizes where food availability may be affected. This is because 71% of the children affected by rickets came from households with less than 5 persons.

Sixty three percent (63%) of the children were diagnosed with rickets at infancy indicating that infancy period is a crucial period where susceptibility to the development of rickets due to inadequate nutritional practices is high. This is a crucial age for bone development since it is the most rapid period for bone growth (Boyers, 2012). Therefore, dietary practices deficient in Calcium, Phosphorus and Vitamin D and taking or using water highly contaminated with fluoride puts the children at risk.

Female children comprised 70% of the total sample studied. From the results, the female child therefore, seems more susceptible to the development of rickets than male children thus need for more attention to this group. The consequences of untreated rickets to the female child are pelvis deformities which later lead to difficulties in vaginal delivery (medicinenet.com, 2002). This therefore calls for urgent treatment and preventive measures.

Results from this study show that breast milk formed a major part of the infant's diet where 65% of the children were breastfed several times daily. This decreases access to Vitamin D rich sources of food assuming that this was the norm after 6 months of age with minimal sun exposure and complementary feeds deficient in Calcium, Phosphorus and Vitamin D. Breast milk does not contain adequate quantities of Vitamin D thus depriving the infants especially those who were exclusively breastfed of the vitamin (Greenbaum, 2011). Theuri (2012), reported that children who were not breast feeding were 0.3 times more likely to develop rickets than those who were breast feeding. Further, in Kenya, Vitamin D supplementation is not included in the infant and young child feeding requirements and is only given as treatment where deficiency is noted. This underscores the need for supplementation of Vitamin D to the under fives.

Ninety five percent (95%) of children diagnosed with rickets at infancy were on complementary feeding at the time of diagnosis. This finding corresponds with KDHS (2008) which showed that 60% of infants in the country are on complementary feeding by the age 4-5 months and by the age of 6-9 months, 83% are given complementary feeds. This is a huge indicator showing that the choice of food for this kind of feeding may to a great extent have contributed to the development of rickets. Poor choice of food and inadequate weaning practices may be linked to complementary feeding being a contributing factor (Majeed, 2007). The likelihood of developing rickets is higher among children who started complementary feeding before six months of age (p<0.01) (Theuri 2012).

Food combinations greatly reflect the nutritional status of children. The Infant and Young Child Feeding standards recommend infants of 6-8 months receive food from the three food groups other than breast milk twice in a day and at least three times for those 9-23 months of age. For the children who were diagnosed at infancy and were already on complementary feeding, 29% were fed on balanced diets where animal and plant protein sources were being alternated. Only 17% of the children were fed on balanced diets comprising animal source proteins alone. Animal source proteins are richer in nutrients necessary for bone health than plant proteins. The results indicate that insufficient animal source foods may contribute to the development of rickets but cannot be concluded as a predominant risk factor. The

children diagnosed post-infancy had been fed on balanced diets either comprising animal source or plant source proteins. Both food combinations were represented by 33% each. According to the present study, food combinations for this group, especially lack of animal source proteins, therefore, seem to have a minimal link to the development of rickets.

All children who were diagnosed with rickets at infancy were breastfeeding and all children diagnosed post-infancy had been breastfed. From the results of this study, lack of breast feeding was not a cause of rickets thus making breastfeeding a likely cause in the event that it formed a major part of diet and there was inadequate sunlight exposure. This is because of its low quantities of vitamin D. Sixty three percent (63%) of the children were breastfed for a period of over 8 months thus indicating that development of rickets may be due to continuous breast feeding especially exclusive breastfeeding. Girls are breast fed longer than boys in Kenya and women with no education tend to breastfeed slightly longer (21 months) than those who have at least some secondary education (KDHS, 2008). These statistics support why more girls (70%) as seen in this study were affected by rickets. Prolonged breastfeeding beyond 6 months is advised among infants who are being weaned so that breast milk just forms a part of their diets but in situations where it is the main part of the daily diet, it may be a major factor in the development of rickets due to its deficiency in Vitamin D which is needed for Calcium absorption.

The recommended sunlight exposure for infants and children is for a period of approximately 30 minutes every day. Only 37% of the children had sunlight exposure in line with the approximated duration. This indicates that inadequate sunlight exposure which is the best source of Vitamin D by the skin may be one of the major factors leading to the development of rickets. All respondents were of African race thus had darker skin pigmentation which requires longer sun exposure as compared to races of fairer skin pigmentation (Royal Children's Hospital, 2009). In order to ensure maximum absorption of Ultra Violet B rays which assists Vitamin D synthesis, children require adequate duration of sunlight exposure coupled with appropriate clothing where the face, arms, legs and back are exposed. In this study, only 6% of the children were half clothed during sunlight exposure and 59 % fully clothed thus inadequate exposure. This may be attributed to poor maternal education which affects the extent of sunlight exposure in terms of fully wrapping children with clothes (Majeed, 2007). This therefore, indicates that lack of proper clothing that exposes the relevant parts during sunlight exposure is among the predominant causes for the development of rickets.

Majority (80%) of the respondents used water from boreholes for both household activities and for cooking. Borehole water in the area has been confirmed to be highly contaminated with fluoride levels of at least 7.5ppm and up to 50ppm (Rombo, 2009). This puts the respondents and their families at great risk for the development of bone related diseases since the safe levels of fluoride contamination are below 1.5ppm. The municipal officials confirmed that municipal water is not treated for fluoride contamination thus has high fluoride content greater than the recommended 1.5 ppm. However, they were not aware of the level of contamination of the water supplied. This water source cannot be treated for contamination at household level thus leads to ingestion of contaminated food by 19% of households who use it. This is particularly crucial to children who still have fragile growing bone. Harvested rain water was used by only 14% of the respondents for cooking which is possibly free from contamination but may be contaminated in the process of collection especially if rain water hits roof tops containing local dust and soil that are also thought to have high fluoride levels. Dust contains 2300ppm of fluoride contamination while the soil surrounding Lake Elementaita contains 1000ppm (Kenya Bureau of Standards, 2010). These percentages, thus, indicate that prolonged use of fluoride contaminated water for cooking as a predominant factor in the development of rickets

Conclusion
The following conclusions can be drawn from the study findings:
1. Water sources used by all households were contaminated with high levels of fluoride making it the most predominant factor leading to the development of rickets in Naivasha. Continued use could bring about fluorosis which inhibits the absorption of calcium as calcium phosphate by bones.
2. Inadequate sunlight exposure through decreased time under the sun while fully clothed was found to be a predominant risk factor as it hindered production of Vitamin D under the skin.
3. Length of breast feeding and poor combination of complementary foods was also another risk factor for the development of nutritional rickets.
4. Presence of cheap day care centers which have very poor hygiene standards have contributed to the development of rickets in Naivasha.

Recommendations

From the results of this study the following recommendations can be made:

1. The government should put systems in place for adequate treatment of fluoride in all water sources in Naivasha Constituency.
2. The Naivasha District Hospital should increase the number of nutritionists so as to promote health and nutrition of mothers, infants and young children.
3. The Ministry of Health should include Vitamin D supplementation for pregnant mothers and children.
4. Medical personnel should offer nutrition education programs specifically on the prevention of rickets to sensitize mothers on the need to incorporate Calcium, Phosphorus and Vitamin D rich foods.
5. There is an urgent need for a multi-sectoral approach to the issue of day care centers so as to set standards that safeguard the welfare of children in Naivasha.

Acknowledgement

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Molecular Structure Profiles of Major Chemical Components of *Vernonia amygdalina* and *Tephrosia vogelii* Leaf Extracts

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Abstract

Plants contain various chemical components some of which play vital roles in the bodies of plants and animals. It is essential that the chemical composition of these plants be well elucidated in order to come up with their mode of action. The objective of this study was to determine the major chemical constituent of Vernonia amygdalina and Tephrosia vogelii leaf extracts and elucidate the molecular structure profiles of the chemical components. Mature leaves were collected from Kenya Agriculture Research institute (KARI) Naivasha. Collection was done during two peak seasons, dry season February and wet season April. Chemical analysis involved determination of chemical extractive content of the plant leaves; the crude extract of the plants was obtained by Soxhlet extraction using the different solvents comprising of hexane, ethyl acetate, methanol, toluene/ethanol (2/1 v/v) mixture and water, followed by characterisation of the plant extracts by Nuclear Magnetic Resonance (^1H ^{13}C NMR), Fourier-Infra red Analysis (FTIR) and Gas Chromatography Mass Spectrometry (GC-MS). Assays for Chemical Constituents and compound identification were based on National Institute of Standards and Technology (NIST) library. The major secondary metabolites detected in all plants were glycosides, whereas, tannins and rotenoids were detected in Tephrosia only. A higher amount of these compounds were observed during the dry season compared to the wet season. This could be attributed to the increase in maturation of leaves during the dry season. Sesquiterpene lactones were on the other hand detected only in Vernonia during both the wet and dry season at the same amounts.

Keywords: *Vernonia amygdalina, Tephrosia vogelii, rotenoids, sesquiterpene lactones, glycosides and tannins*

Introduction

Vernonia amygdalina is a shrub or small tree of 2-5m with petiolate leaf of about 6mm diameter and elliptic shape. The leaves are green with a characteristic oduor and taste (Beentje, 1994). No seeds are produced and the tree has therefore to be distributed through cuttings (Bentje, 1994). It grows under a range of ecological zones in Africa and produces large mass of forage and is drought tolerant, (Bonsi *et al.,* 1995). It is a popular African vegetable (Abosi *et al* 2003); the leaves are used for human consumption where the bitterness can be abated by boiling or by soaking in several changes of clean water. All parts of the plant are pharmacologically useful (Adaramoye *et al.,* 2008). Both aqueous and alcoholic extract of the stem, bark, root and leaves are reported to be extensively used as a purgative, antimalarial and in the treatment of eczema (Afloyan *et al.,* 2006). It is easily recognized and used for self medication by parasitized chimpanzees (Huffman, 1996). Pharmacological studies have also shown that the leaf extract has both hypoglycaemic and hypolipidaemic properties in experimental animals and could be used in managing diabetes mellitus (Akah, 1992). The common and documented medicinal uses of *Vernonia amygdalina* include the treatment of schistosomiasis, amoebic dysentery and gastrointestinal problems (Huffman *et al.,* 1996). In Nigerian herb homes, extracts of the plant are used as tonic, in the control of ticks and treatment of coughs, feverish condition, constipation and hypertension (Adaramoye *et al.,* 2008).

Tephrosia vogelii is a soft, woody branching herb or small tree with dense foliage, 0.5- 4m tall with velutinous to sericeous indumentum, Stems and branches tomentose with long and short white or rusty-brown hairs. Leaves arranged spirally, imparipinnate; stipules 10-22x 3-3.5 mm early caduceus;

rachis 5-25 cm long including petiolule; leaflets in 5-14 pairs, narrowly elliptical to elliptical-oblanceolate, up to 7x2 cm, base acute to obtuse apex rounded to emarginated, venation most distinct on lower surface, silky tomentose. Inflorescence a terminal or axillary pseudo-raceme, 8-26 cm long, rusty tomentose; basal bracts leaf like, penduncle stout, as long as pseudo-raceme; flower 18-26 mm long, fragrant when fresh, white-purple or blue; pedicel up to 23 mm long. Bracteoles sometimes present on calyx. Pod linear, slightly turgid, 5.5-14x 0.8-1.5 cm. Brown-green, wooly to sericeous, 6-18 seeded. Seed are ellipsoid to reniform, 5-7 x3-5 mm, and dark to black. (Beentje, 1994).

Tephrosia vogelii is found in widely varying habitats, including savannah-like vegetation, grassland, forest margins and shrub land, waste land and fallow fields. *vogelii* has been cultivated for insecticide, fish and arrow poison obtainable from the leaves. The poison stupefies fish, which are then easily caught (Dale, 1961). Dry, crushed leaves are used as insecticides against lice, fleas, and ticks, and as a mollusticide. Used as an abortifacient, emetic, bactericide, purgative and cure for skin disease, schistosomiasis, ringworm and parasitic infections. Leaf decoctions are used in treatment of scabies and yaws; a weak infusion of leaves is taken as an anthelmintic. Root decoctions are used to treat constipation (Dzenda *et al.,* 2007).

Materials and Method

Mature *Tephrosia vogelii* and *Vernonia amygdalina* leaves were collected from Kenya Agriculture Research Institute (KARI) Naivasha. KARI Naivasha is in Naivasha district of Rift Valley province. It lies between Latitude 0 degree 45' South and longitude 36 degree East. It receives a mean annual rainfall 750mm. The long rains occur in March- June and the short rains in October-November). Collection was done during two peak seasons, dry season February 2008 and wet season April 2008.

To obtain the crude extract Soxhlet extraction was carried out at University of Eldoret Chemistry laboratories. Phytochemical analysis of the extracts was carried out at Kenya Agricultural Institute (KARI) Naivasha branch and Lermab in Nancy University France.

Pesticide-free mature leaves from each plant were collected from branches which had produced the final raceme Between 6 and 10 compound leaves below the terminal florescence were picked separately and transported while fresh to University of Eldoret Chemistry laboratories. In the laboratory, the leaves were dried to a constant weight in an electric oven and reduced to fine powder in a hammer mill. The fine powder was passed through a 115-mesh sieve and dried further to constant weights before extraction using a soxhlet extractor. Soxhlet extraction was followed by characterisation of the plant extracts by ^{1}H ^{13}C NMR (Nuclear Magnetic Resonance) and FTIR (Fourier-Transformed Infra red Analysis), GC-MS (Gas Chromatography Mass Spectrometry) and Screening for Chemical Constituents.

Soxhlet extraction was done using the different solvents comprising of hexane, ethyl acetate, methanol, toluene/ethanol (2/1 v/v) mixture and water. 10gm of sample powder was extracted with 180ml of the solvent for 15 hours at the rate of 10 to 12 cycles per hour. To quantify the amount of extractives in the leaves, series extraction was carried out using the different solvents starting from the least polar solvent to water on the same batch of powder successively in the order hexane, ethyl acetate methanol, toluene/ethanol (2/1 v/v) mixture, then water. After each extraction, the solvent was evaporated under reduced pressure in a rotavapor and the residue dried over P_2O_5 under vacuum before weighing.

Two methods based either on direct determination of extractives after solvent evaporation (direct methods, DM) or on the difference between dry weight of powder before and after extraction (indirect method, IM) were used to evaluate extractive contents.

The percentage of extractives was determined according to the formula.

$$\% \text{ DM} = \frac{m_e}{m_s} \times 100$$

$$\% \text{ IM} = \frac{(m_s - m_d)}{m_s} \times 100$$

Where m_e is the weighed mass of extracts after solvent evaporation m_s is the dry mass of the powder before extraction, and (m_d) is the dry mass of extracted powder.

Characterisation of V. amygdalina and T .vogelii Extracts
^{1}H ^{13}C NMR and Infra red Analysis

About 1mg of the dry extract was dissolved fully in methanol-d_4, chloroform d_6 or DMSO-d_6 in a special NMR test tube. The tube was then inserted into an automatic operated ^{1}H and ^{13}C NMR testing machine. The spectra so produced were recorded in $CDCL_3$, methanol-d_4, chloroform d_6 or DMSO-d_6 as

required on a Bruker DRX 400 spectrometer. Chemical shifts were expressed in parts per million (ppm) and calculated relative to TMS. For infra red analysis about 1mg of finely ground and dry extract samples were dispersed in a matrix of KBr and pressed to form disks before introducing into an automatic operated Perkin Elmer IR machine. Infra red analysis (FTIR) spectra were recorded as KBr disks on a Perkin Elmer FTIR spectrometer SPECTRUM 2000 between wave number ranges of 4000-5000cm^{-1}.

GC-MS Analysis

Test samples were analyzed for trimethyl derivatives using the following procedure. In a screw-capped vial, a sample of approximately 1 mg of dry leaf powder was dissolved in 0.5 ml of anhydrous acetonitrile (Across Organics) and 0.4 ml of *N,O*-bis-trimethylsilyl (trifluoroacetamide) containing 1% trimethylchlorosilane (BSTFA / 1% TMCS) (Across Organics) was added. The solution was sonicated for about 1 min and heated at 60°C for 60 min. After evaporation of the solvent in stream of dry nitrogen, the residue was diluted in 1 ml of anhydrous acetonitrile. GC-MS analysis was performed on a Clarus® 500 GC gas chromatograph (Perkin Elmer Inc., USA) coupled to a Clarus® 500 MS quadrupole mass spectrometer (Perkin Elmer Inc., USA). Gas chromatography was carried out on a 5 % diphenyl / 95 % dimethyl polysiloxane fused-silica capillary column (Elite-5ms, 60 m x 0.25 mm, 0.25 mm film thickness, Perkin Elmer Inc, USA). The gas chromatograph was equipped with an electronically controlled split / splitless injection port. The injection (injection volume of 1 µl) was performed at 250°C in the split mode (split flow of 20 ml/min). Helium was used as carrier gas, with a constant flow of 1.2 ml/min. The oven temperature program was as follows: 200°C constant for 4 min, 200°C to 330°C at a rate of 5°C/min and then constant for 330°C. Ionization was achieved under the electron impact mode (ionization energy of 70 eV). The source and transfer line temperatures were 250°C and 330°C, respectively. Detection was carried out in scan mode: m/z 35 to m/z 700 a.m.u. The detector was switched off in the initial 10 min (solvent delay).

Phytochemical screening for major constituents was undertaken using standard qualitative methods as described by Sofowora (1993). 2ml of extract was added to 2mls of ferric chloride solution (FeCl$_3$), a deep bluish green solution was formed with presence of phenols. The colour intensity gave an estimate of compounds present.

3g of the powdered sample was boiled in 50ml distilled water for 3minutes on a hot plate. The mixture was filtered and a portion of the filtrate diluted with sterile distilled water in a ratio of 1:4 and 3 drop of 10% ferric chloride solution added. A blue or green colour indicated the presence of tannins.

25ml of dilute sulphuric acid was added to 5ml of extract in a test tube and boiled for 15 minutes, cooled and neutralized with 10% NaOH, and then 5ml of fehling solution A and B was added. A brick red precipitate of reducing sugars indicated presence of glycosides.

Results and Discussion
Quantification of Extractives

Table 1. Percentage Extracts from *Vernonia amygdalina* and *Tephrosia vogelii* Leaves by Soxhlet

Solvent	*Vernonia amygdalina*		*Tephrosia vogelii*	
	Direct method	Indirect method	Direct method	Indirect method
Hexane	0.7	0.9	0.7	0.7
Ethyl Acetate	0.4	0.5	0.4	0.4
Methanol	1.9	2.0	1.6	1.8
Toluene/ethanol	1.5	1.8	1.4	1.8
Water	5.6	5.8	4.4	4.8

The results show that in all cases, indirect measurements (IM) gave higher extracts content than direct measurements (DM). This may have been due to loss of some extractive components during the removal of solvent in the Rotavapor or manipulation of the sample. In both cases, the direct and indirect methods of water extraction yielded higher values.

Table 2. Series Extractions with Different Solvents of Increasing Polarity

Solvent	*Vernonia amygdalina*	*Tephrosia vogelii*
Hexane	0.6	0.4
Ethyl acetate	0.9	0.8
Methanol	2.1	1.9
Toluene/Ethanol	2.5	2.1
Water	3.2	3.0
Total Extractive	**9.3**	**8.2**

The quantity of extractives increases with polarity of the solvent used and these results are in agreement with observations performed on other tropical plant species. Water extraction leads to the highest quantity of extractives in the two plant species ranging between 3.0 and 3.2%. High quantities of extractives as described in the literature on other plant species contribute to fungal and toxicity and in general their utilization for various uses as biocides (Afolayan *et al.,* 2006*)*.

Identification and Characterisation of Vernonia amygdalina and Tephrosia vogelii Extractives
Vernonia amygdalina Leaf Extractives

Methanol and ethyl acetate gave similar results; ^{1}H NMR analysis of *Vernonia amygdalina* crude leave extractives by methanol and ethyl acetate (figure 1) indicated the presence of methylene protons between 0.8ppm and 2.0ppm and typical fatty acids and simple sugars between 3.0 ppm and 4.0 ppm. ^{1}H NMR for methanol and ethyl acetate extract indicated allylic protons between 2.0 and 2.5ppm and broad vinyl protons at 5.4ppm typical of fatty acids.
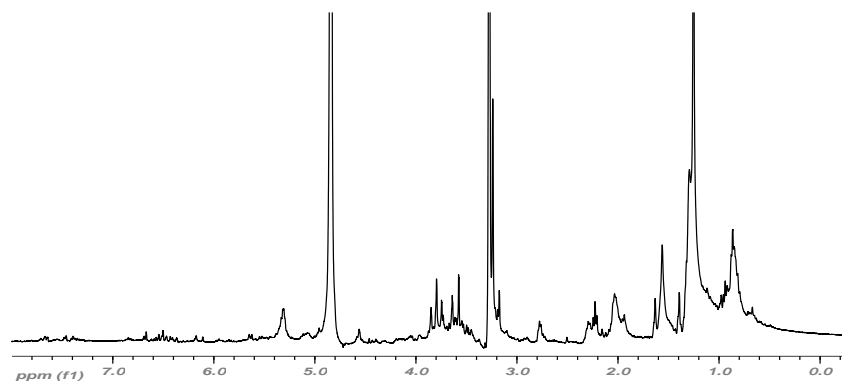
Figure 1. ^{1}HNMR Spectra of Methanol and ethyl acetate *Vernonia amygdalina* Crude Extractives

The FTIR spectrum (Figure 2) indicated a characteristic OH group absorption at 3400cm^{-1} and carbonyl C-H vibrations at 1715 and absorptions at between 2850 and 2920 reported to be present in fatty acids. All spectra indicated characteristic hydroxyl group absorption at 3350 cm^{-1} and aromatic C=C skeletal vibrations at 1620, and 1456 cm^{-1} typical of flavan like compounds.
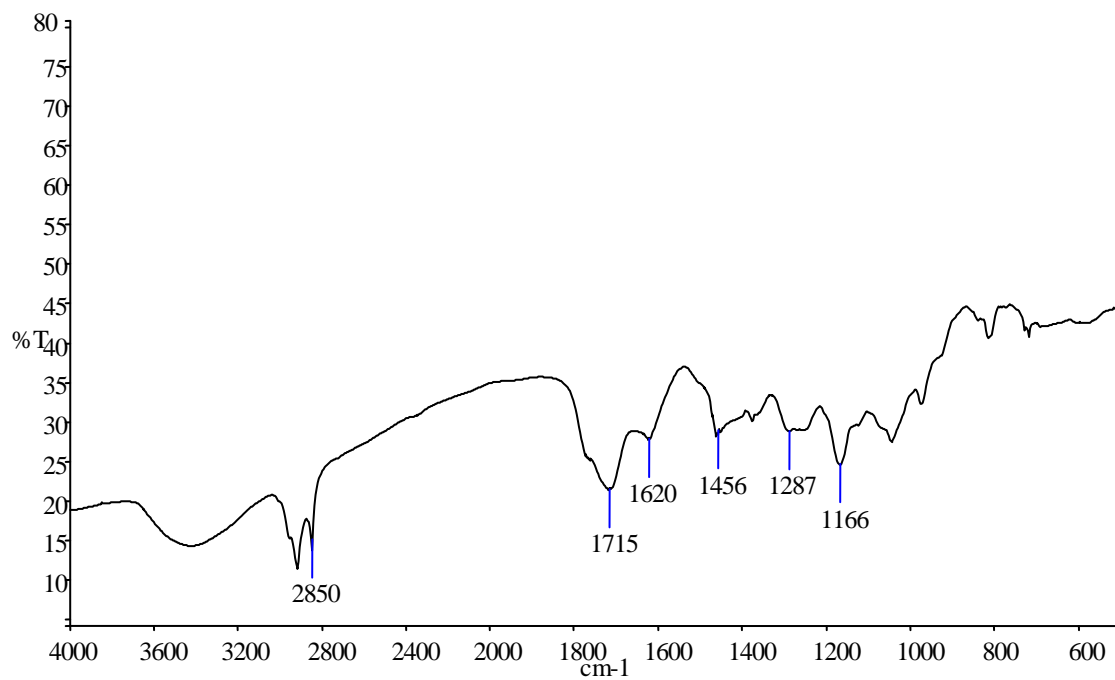
Figure 2. FTIR spectra of methanol and ethyl acetate extractives of *Vernonia amygdalina*

GC-MS analyses of the TMS derivatives of methanol and ethyl acetate extractives from *Vernonia amygdalina* leaves are presented in Figure 3& 4.
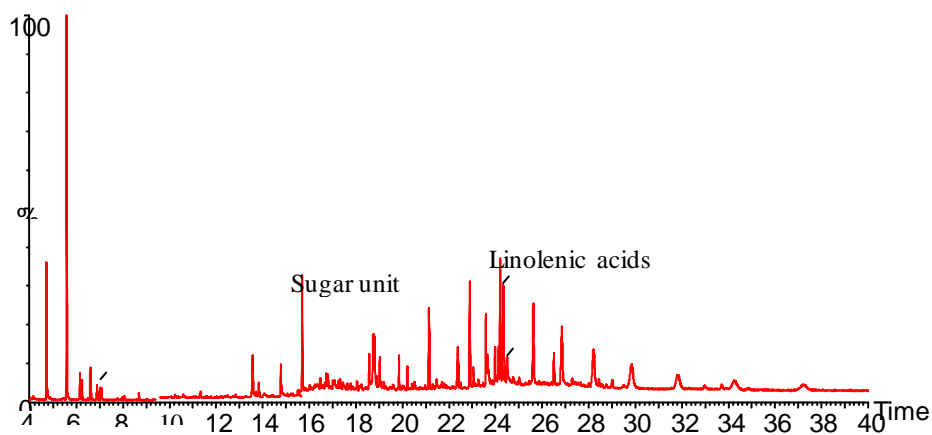
Figure 3. GC- MS chromatograms of methanol extractives of *Vernonia amygdalina*
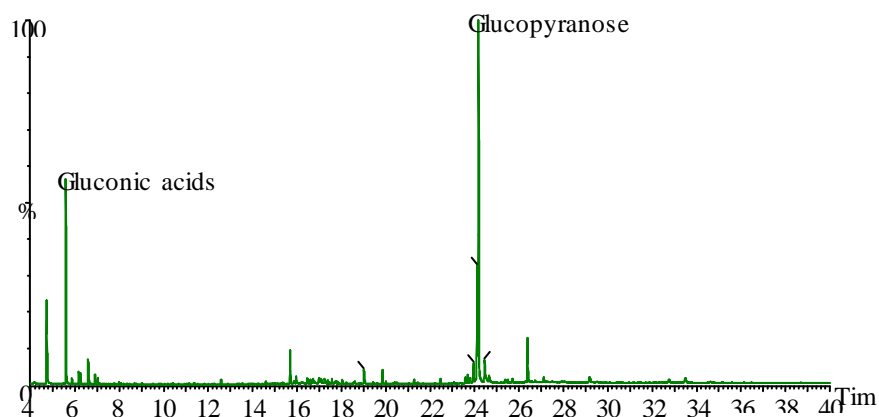
Figure 4. GC- MS chromatograms of ethyl acetate extractives of *Vernoni aamygdalina*

The molecular structures of *Vernonia amygdalina* elucidated from this study are as shown in Figure 5

Glucopyranoside

Galactopyranoside .

Ellagic acid glycosides

Galactomannan sugar unit

Patulitrin sugar unit

Octadecanoic acids

MW = 98
Phosphoric acids
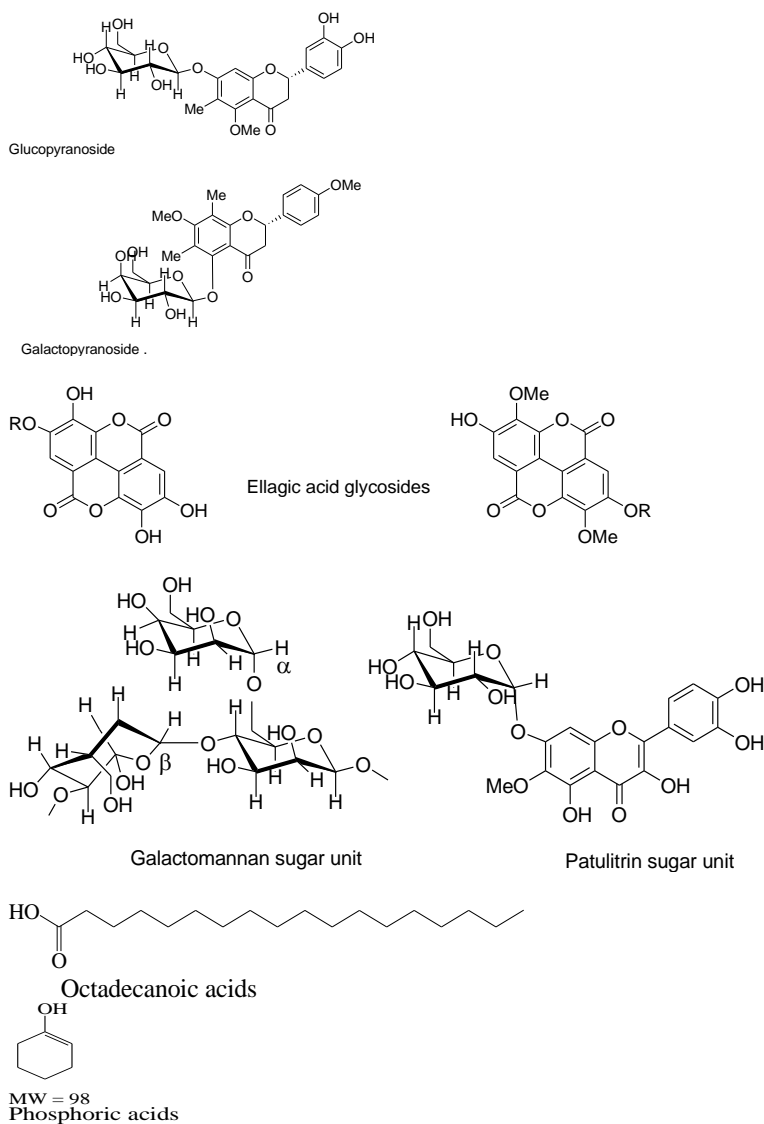
Figure 5. Probable Structures of the Compounds of *Vernonia amygdalina* Leaf Extracts
***Tephrosia vogelii* leaf extractives**

^{1}H NMR analysis of *vogelii* crude leaf extractives by methanol and ethyl acetate (Figure 6) indicated the presence of methylene protons between 0.8ppm and 2.0ppm and typical fatty acids and simple sugars between 3.0 ppm and 4.0 ppm. ^{1}H NMR for methanol and ethyl acetate extract indicated allylic protons between 2.0 and 2.5ppm and broad vinyl protons at 5.4ppm typical of fatty acids.
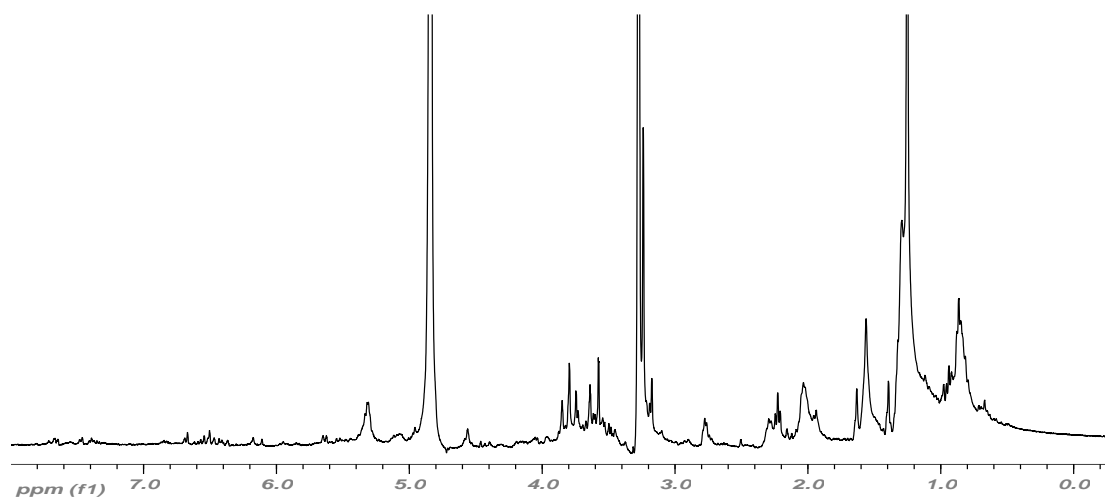
Figure 6. ^{1}HNMR spectra of methanol and ethyl acetate *Tephrosia vogelii* crude extractives

The FTIR spectrum (Figure 7 & 8) indicated a characteristic OH group absorption at 3400cm^{-1} and carbonyl C-H vibrations at 1715 and absorptions at between 2850 and 2920 reported to be present in fatty acids. All spectra indicated characteristic hydroxyl group absorption at 3350 cm^{-1} and aromatic C=C skeletal vibrations at 1602, 1506 and 1456 cm^{-1} typical of flavan compounds.
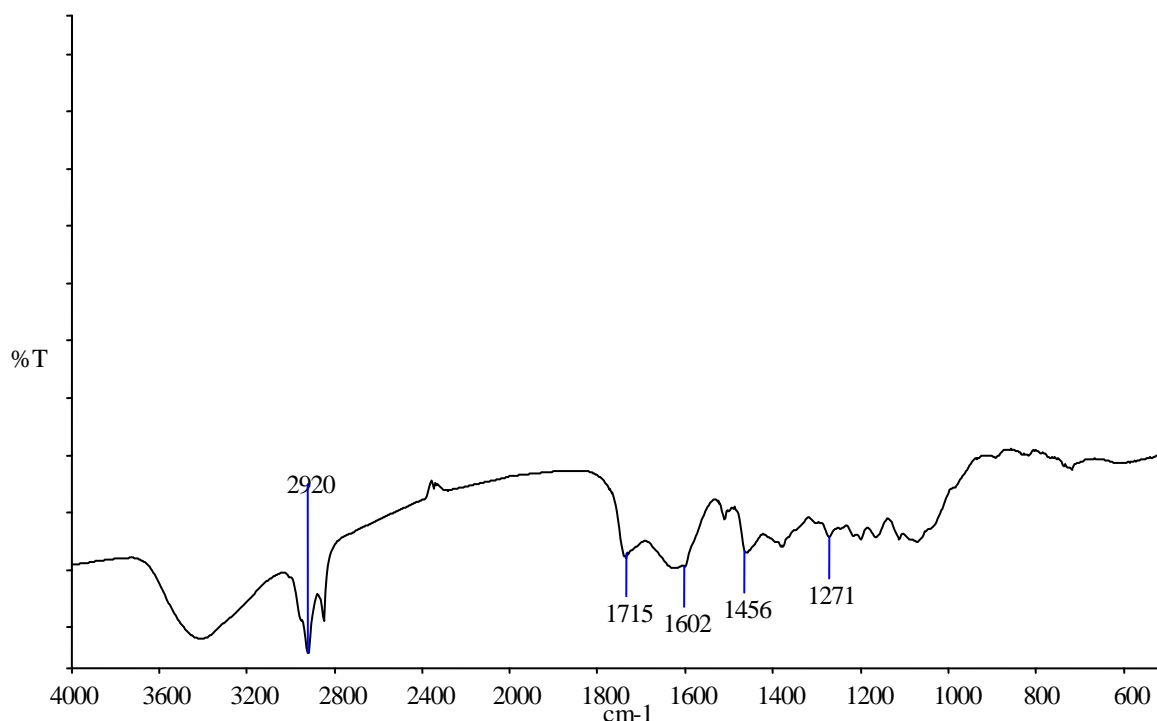
Figure 7. FTIR spectra of methanol extractives of *Tephrosia vogelii*
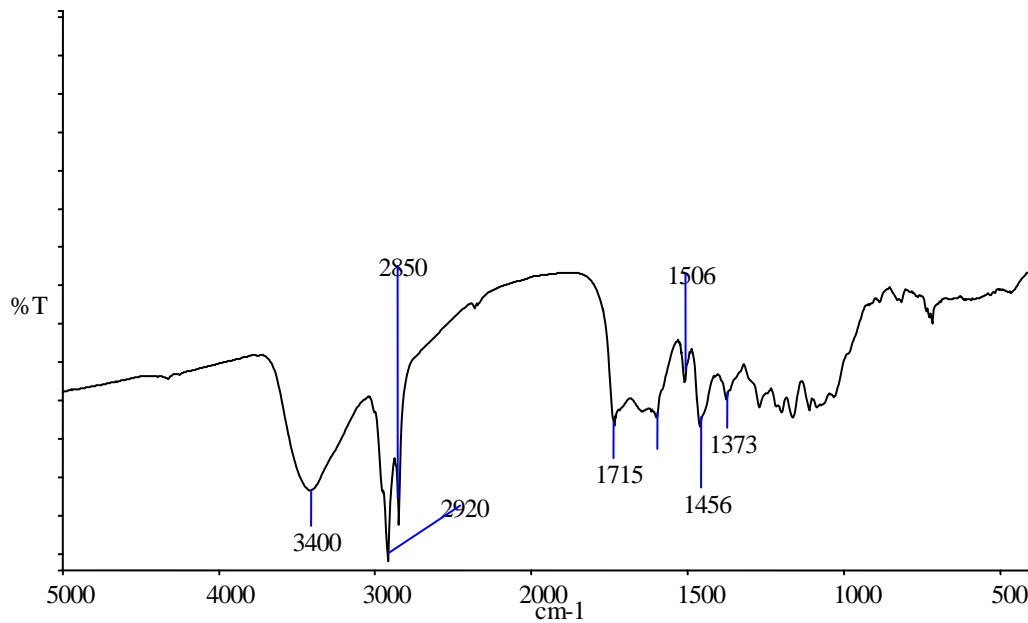
Figure 8. FTIR spectra of ethyl acetate extractives of *Tephrosia vogelii*

GC-MS analyses of the TMS derivatives of different crude extractives from leaves are presented in Figure 9 & 10.
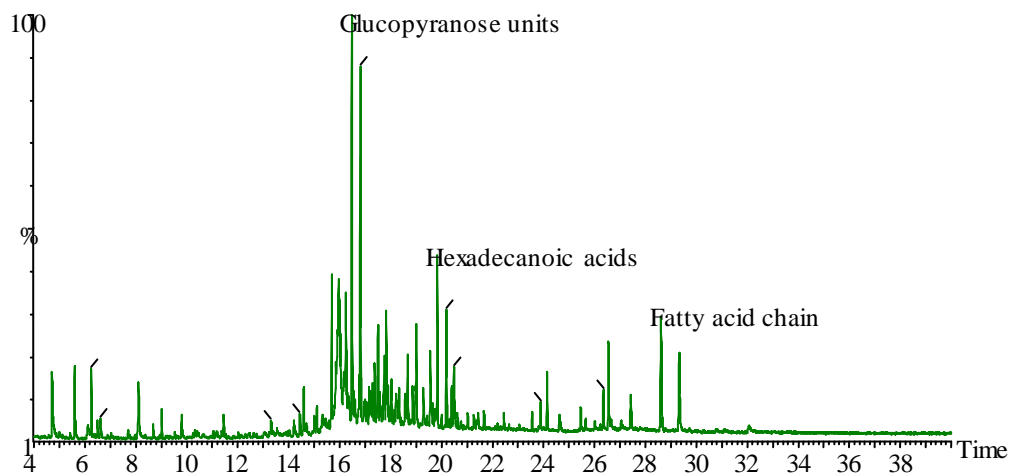
Figure 9. GC- MS chromatograms of different compounds in *Tephrosia vogelii* methanol leave extracts
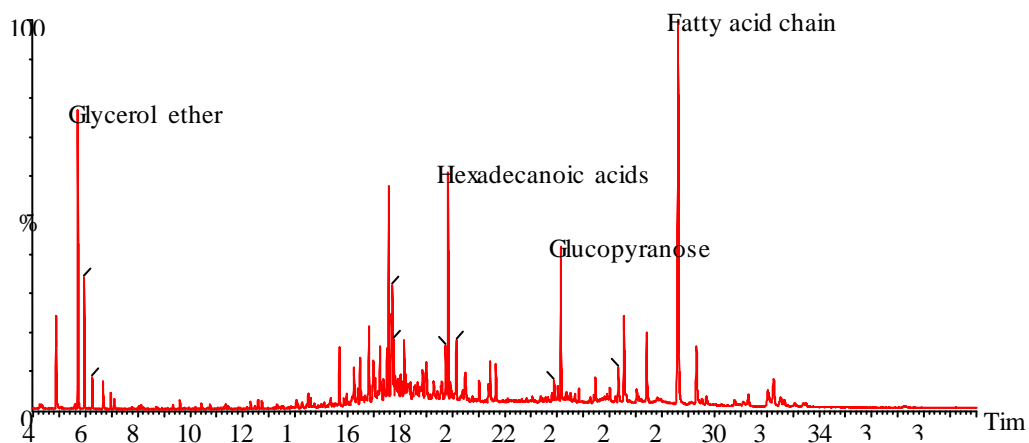
Figure 10: **GC- MS chromatograms of different compounds in *Tephrosia vogelii* ethyl acetate leave extracts**.

The molecular structures of *Vernonia amygdalina* elucidated from this study are as shown in figure 11.

Hexadecanoic acids

Condensed tannins

Hydrolysable tannins

Castelagine
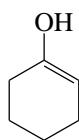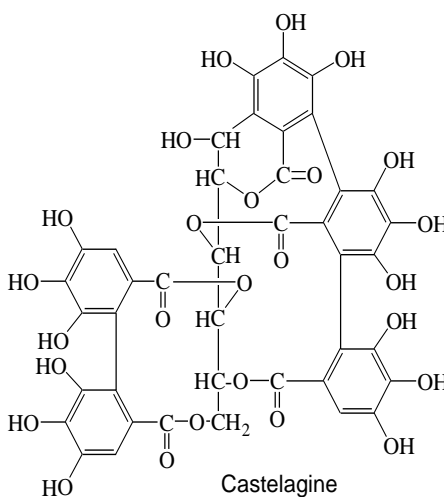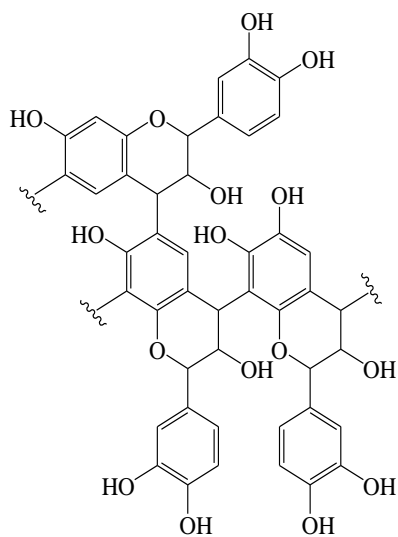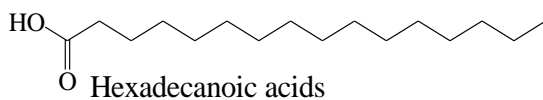
MW = 98
Phosphoric acids
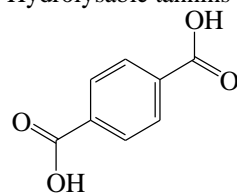
Benzenedicarboxylic acid

Figure 11: Probable Structures of the Compounds of *Tephrosia vogelii* Leaf Extracts

Seasonal Variation of V. amygdalina and T. vogelii Extractives

Variation in yield among test plant species during wet and dry seasons in both aqueous and alcoholic extracts was observed (Table3). The highest yield was for the alcoholic extract of the leaves of *Vernonia* (30.53%) during the dry season and the lowest yield was recorded for the alcoholic extract of the leaves of *T. vogelii* (4.48%) during the wet season.

Table 3. Yield among test plants during different seasons

% Yield W/W	Plant extract (Wet season)		Plant extract (Dry season)	
	Tephrosia	*Vernonia*	*Tephrosia*	*Vernonia*
Water	14.3	11.8	17.6	19.5
Alcoholic	4.48	30.2	16.8	30.53

The major secondary metabolites detected in all plants were glycosides, whereas, polyphenols (tannins) and Flavonoids (rotenoids) were detected in *Tephrosia* only. A higher amount of these compounds were observed during the dry season compared to the wet season. Sesquiterpene lactones were on the other hand detected only in *Vernonia* during both the wet and dry season at the same amount *(*Table 4).

Table 4. Chemical Constituents among test plants during different seasons

Chemical constituents	Plant extract (Wet season)		Plant extract (Dry season)	
	Tephrosia	*Vernonia*	*Tephrosia*	*Vernonia*
Rotenoids	+	-	++	-
Sesquiterpene lactones	-	+	-	+
Glycosides	+	+	++	++
Tannins	+	-	++	-

(+) - Present   (-) –absent

Conclusion

Phytochemical results in the present study indicate that the two plants contain various chemical compounds. The major secondary metabolites detected in both plants were glycosides, whereas, polyphenols (tannins) and Flavonoids (rotenoids) were detected in *Tephrosia* only. A higher amount of these compounds were observed during the dry season compared to the wet season. Sesquiterpene lactones were on the other hand detected only in *Vernonia* during both the wet and dry season at the same amount.

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Effectiveness of Out-patient Therapeutic Program on Nutrition among Under Fives:
A Retrospective Study of Kisumu East District, Kenya

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Abstract

Outpatient Therapeutic Program (OTP) has been implemented with great success. Monitoring and evaluation against program objectives is integral. This study aimed to assess effectiveness of OTP program in Kisumu East District and identify factors influencing its effectiveness. In a retrospective longitudinal study targeting malnourished children 6–59 months registered in OTP, information on type of malnutrition, HIV status, cure rate, defaulter rate, death rate, non-response, average weight gain and Average Length of Stay (ALOS) in the program were abstracted from hospital records of 420 eligible children between January to December 2009; selected by systematic random sampling. Proportions of Marasmus, Kwashiorkor, and HIV were determined. Proportions of outcomes were compared against Sphere standards to assess effectiveness. Associations between type of malnutrition and: HIV status, gender, age and Mid Upper Arm Circumference (MUAC) were determined using regression analysis. From the study findings, prevalence of Marasmus (67.4%) was higher than prevalence of Kwashiorkor (31.2%). Children cured were 54%, 3.3% died, 22.6% defaulted while non-responders were 0.7%. ALOS was 39 days and rate of weight gain 4.8g/kg/day. Regression analysis showed: MUAC and HIV status influenced type of malnutrition, low MUAC increased the chances of dying by 50% (CI 0.302 - 0.944 p=0.031) and each cm increase in MUAC reduced rate of weight gain by 0.8g/kg (CI -1.483 - -0.117 p=0.022). Increase in rate of weight gain increased cure rate by 8% (CI 1.024 - 1.15 p=0.006). The program was effective in achieving low death rates, ALOS and rate of weight gain. High defaulter rate may have obscured true death and cure rates. Factors contributing to high defaulter rates should be investigated and addressed to improve program effectiveness.

Keywords*: MUAC, Outcomes, OTP, Malnutrition*

Introduction

In sub-Saharan Africa, 9.6% of the children are wasted (Friedman *et al.,* 2005). Sadler (2007) notes that Africa is the only region where wasting continues to rise. In Kenya, the prevalence of wasting is 7% and 3.2% in Nyanza (KNBS, 2010). Ministry of Health (MOH) Kenya, recommends a MUAC of < 11.5cm, or Weight for Height Z score (WHZ) <-3SD, no underlying medical conditions and good appetite as the criteria for admission to Out Patient Therapeutic program (OTP) (IMAM Handbook, 2010).

Why and How to Evaluate

Assessments and analyses of programs should be undertaken to understand what works and what does not work, why and how they can be expanded, strengthened and redesigned (Ismail *et al.,* 2003). Sphere handbook (2004), states that programs should be evaluated against internationally accepted locally appropriate minimum standards to measure effectiveness. Effectiveness is monitored through collection, analysis and presentation of quantitative process and outcome indicators on:

- Number of admissions disaggregated by type of presentation (Marasmus, Kwashiorkor, Marasmic-kwashiorkor).
- Number of exits disaggregated by outcome (cured, died, defaulted, non-responder).
- Number of people in the program.
- Average rate of weight gain and average length of stay (ALOS) (Collins *et al.,* 2006b)

Sphere indicators for Therapeutic Feeding Programs are:

- Proportion of exits who have died should be < 10%
- Proportion of exits who have recovered should be > 75%
- Proportion of exits who have defaulted should be < 15%
- Minimum mean rate of weight gain (g kg-1 person-1 day-1) >8g (Collins *et al.,* 2004).

OTP Outcomes

In Dowa Malawi, of the OTP admissions, 85.3% recovered, 12.7% defaulted and 2.0% died in direct admissions; while in indirect admissions 84% recovered, 8.4% defaulted and 7.7% died (Collins *et*

al., 2006a). In Wollo Ethiopia, the outcome was similar between the NGO and MOH implemented programs; In the NGO implemented 80% cured, 6% died, 7% defaulted while in the MOH implemented, 82% cured, 5% died and 5% defaulted (Collins *et al.,* 2006b). In Malawi (outside Blantyre), 94% recovered, 1.8% non-responders, 3.6% defaulted, and 0.9% died (Fanzo *et al.,* 2009). In Kenya, OTP in Arid and Semi Arid Lands (ASAL) saw a total of 111,336 children discharged over the period between 2010 and 2011. The outcomes were, 81% recovered, 1.5% died, and 13% defaulted (UNICEF Kenya, 2012).

SAM in the Context of HIV and Infant and young Child Nutrition

A high proportion (90%) of childhood HIV occurs in children in Africa. This prevalence is associated with 7% of all deaths in children under five (Bunn *et al.,* 2009). In a meta-analysis of African studies on SAM, mortality in HIV-infected children was 30.4%, compared to 8.4 in HIV-negative (Bunn *et al.,* 2009). In Malawi, HIV positive children registered lower rates of weight gain than uninfected children, at 2.8 g/kg/day, and 4.7 g/kg/day respectively. ALOS was longer in HIV-infected (56days) than in uninfected children (42 days) (Bahwere *et al.,* 2008). HIV infection renders achievement of international standards by OTPs challenging (Sadler *et al.,* 2006).

In Malawi, Children with HIV had more Kwashiorkor (57.3%) than Marasmus (42.7%) as Kwashiorkor is the prevalent type of malnutrition in Malawi. Improving SAM survival for all children regardless of HIV status, is a global public health priority, key to achievement of Millennium Development Goal (MDG) number 4- reduction of child mortality (Fergusson *et al.,* 2009; Fergusson and Tomkins, 2009).

Methods

The study was carried out in Kisumu East district. The OTP sites were: Kisumu District Hospital, Pandpieri KUAP, Obunga KUAP, Magadi KUAP, Nyamasaria KMET, OLPS, Lumumba, Rabuor, Nyahera and Simba Upepo. A retrospective longitudinal design was adopted. Information was abstracted from records onto a questionnaire and effectiveness of OTP relative to standard outcomes; and factors associated with the effectiveness of OTP evaluated using either logistic or linear regression as dictated by the independent variable.

Procedure

Kisumu was selected purposively as it had 13 OTP sites operational. Ten sites that had been fully operational from January to December 2009 were included. Proportionate sampling was used to determine the number of participants from each of the facilities. Individuals were then sampled using systematic random sampling. Data was entered and analyzed in the Statistical Package for Social Sciences (SPSS), version 17. Descriptive statistics comprising frequencies and cross tabulations were used to determine proportions of children with Marasmus, Kwashiorkor, and HIV. Proportions of outcomes were compared against Sphere standards to assess effectiveness. Distribution of continuous variables was visually assessed for normality before analysis. Associations between HIV status, age, sex and MUAC were determined using logistic or linear regression for binary and continuous variables respectively. Results were considered significant at an alpha level of 0.05.

Results
Proportions of Admissions

Overall, 67.4% had Marasmus while 31.4% had Kwashiorkor. A higher proportion of malnourished children having Marasmus was observed in all facilities except Simba Upepo where proportions with Marasmus and Kwashiorkor were almost similar. The highest prevalence of Marasmus was observed in Magadi (90.9%) and Lumumba (88.2%). Kwashiorkor was highest in Nyahera Sub-district hospital (54.9%) and less than 50% in other facilities. Data on marasmic Kwashiorkor was not available.

Among children aged six to eleven months, Marasmus was 91% while Kwashiorkor was 9%. Among 12 to 35 months, Marasmus was 59% while Kwashiorkor was 41%, 36 to 59 months Marasmus was 65% and Kwashiorkor 35%. Prevalence of Kwashiorkor was 32% in males and 31% in females while Marasmus was 66% in males and 68% in females. There was no difference in malnutrition presentation between males and females p=*0.931* (95% CI 0.615 − 1.408).

Outcome Indicators of Effectiveness

Cure Rate. Overall Cure rate was 54%. Only Magadi at 75.8% and Lumumba at 82.4% surpassed Sphere standard.

Defaulter Rate. The program registered a high defaulter rate of 22%. Magadi at 6.1% and KDH at 7.8% were the only facilities with low defaulter rates.

Death Rate. All facilities were effective in achieving low death rates. Using <5% death rates which has been achieved by most OTP programs (Heikens *et al.,* 2008, Sadler *et al.,* 2006, Collins *et al.,* 2006a), all facilities were effective except Magadi, Nyahera and Obunga.

Proximate Indicators of Effectiveness

ALOS. All facilities except Lumumba, at 68 days, met Sphere standard. Overall ALOS was 39 days. ALOS among children with Kwashiorkor was 35 days while Marasmus was 42 days, significant based on an unpaired t-test (*p = 0.019*).

Rate of Weight Gain. Sphere recommends rate of weight gain of >8/kg/day for in-patient programs while a lower weight gain of 4g/kg/day is also acceptable for OTP. All facilities exceeded the recommended 4g/kg/day weight gain except Nyahera at 3g/kg/day. The overall average weight gain was 4.8 g/kg/day.

Factors that Influence Effectiveness

MUAC and HIV status were found to influence type of malnutrition. An increase in MUAC by 1cm was associated with a 59% decrease in likelihood of having Marasmus *(p< 0.0001).* The likelihood of having Marasmus for a participant decreased by 68.2% if one was HIV negative (*p = 0.027),* summarized in Table 1.

Table 1. Influence of Age, MUAC, Gender and HIV Status on Malnutrition

	Indicator	OR*	95% CI	*p value*
Marasmus	Age in months	0.982	0.958 - 1.007	0.159
	MUAC	**0.409**	**0.318 - 0.525**	**<0.0001**
	Gender	1.079	0.616 - 1.890	0.79
	HIV Status	**0.318**	**0.115 - 0.877**	**0.027**

None of the factors influenced ALOS. MUAC influences rate of weight gain. An increase in MUAC by 1cm was associated with a decrease in rate of weight gain by 0.8g/kg/day (*p = 0.022*), summarized in Table 2.

Table 2. Influence of Age, MUAC, Gender, HIV Status and Type of Malnutrition on Proximate Indicators

	Indicator	B	95% CI	*p* value
Average Length of stay	Age in Months	-0.071	-0.436 - 0.293	0.700
	Gender	-2.037	-10.292 - 6.218	0.627
	MUAC at admission	-2.534	-6.114 - 1.045	0.164
	HIV Status	2.274	-10.723 - 15.27	0.731
	Type of malnutrition	0.924	-10.145 - 11.992	0.869
Rate of Weight Gain	Age in Months	0.012	-0.059 - 0.083	0.739
	Gender	-0.315	-1.882 - 1.252	0.692
	MUAC at admission	**-0.8**	**-1.483 - -0.117**	**0.022**
	HIV Status	-0.306	-2.749 - 2.137	0.805
	Type of malnutrition	0.855	-1.238 - 2.948	0.421

The outcome factor influenced was death: Only MUAC at admission influenced whether or not a child died. Every 1cm increase in MUAC at admission resulted in 50% decrease in the likelihood of a child dying (*p= 0.031),* summarized in Table 3.

Table 3: Influence of Age, MUAC, Gender and HIV Status on Outcome

	Indicator	OR	95% CI	*p* value
Cured	Gender	1.049	0.666 - 1.651	0.837
	Age in months	0.994	0.974 - 1.015	0.593
	MUAC	1.062	0.902 - 1.25	0.470
	HIV Status	1.218	0.603 - 2.459	0.582
Died	Gender	0.698	0.189 - 2.58	0.590
	Age in months	0.986	0.919 - 1.057	0.687
	MUAC	**0.534**	**0.302 - 0.944**	**0.031**
	HIV Status	0.929	0.106 - 8.114	0.947
Defaulter	Gender	1.061	0.619 - 1.820	0.83-
	Age in months	0.992	0.967 - 1.017	0.522
	MUAC	1.160	0.962 - 1.400	0.120
	HIV Status	0.988	0.423 - 2.306	0.977

Rate of weight gain influenced cure rate. A unit increase in rate of weight gain resulted in 8% increase in likelihood of being cured (*p=0.006*).

Table 4: Influence of Proximate Factors on Outcome

Outcome	Indicator	OR*	95% CI	*p* value
Cured	ALOS	1.002	0.992 - 1.012	0.748
	Rate of Weight Gain	1.085	1.024 - 1.15	0.006
Died	ALOS	0.979	0.883 - 1.084	0.681
	Rate of Weight Gain	0.926	0.762 - 1.126	0.443
Defaulter	ALOS	0.979	0.952 - 1.006	0.132
	Rate Weight Gain	0.988	0.917 - 1.065	0.749

Discussion

Proportions of males and females included were similar. Mean age of admission was 19.0 ± 12.0 months.

Malnutrition Admissions by Presentation

Overall, more children had Marasmus than Kwashiorkor. This was observed in all facilities except Simba Upepo where proportions with Marasmus and Kwashiorkor were similar. No data was available on marasmic Kwashiorkor. The high Marasmus prevalence corresponds to the Child Health and Nutrition Information System (CHANIS) report of 2009 where the prevalence of Marasmus and Kwashiorkor were 85% and 15%, respectively. There was no difference in malnutrition presentation among gender.

When aggregated by age, Marasmus was most prevalent in children 6 to 11 months, while at 12 to 35 months proportions of malnutrition were almost similar. Higher Marasmus cases in children 6 – 11 months could be indicative of access to protein through breastfeeding in earlier months with increasing tendency to Kwashiorkor as the child gets older and is less likely to breastfeed. Breast milk, being a source of protein, could be protective against Kwashiorkor even when overall energy intake is likely to be low, hence higher cases of Marasmus. Children breastfeeding at 6 – 11 months was 93.4% and Kwashiorkor increases at 18 to 23 months because those breastfeeding are 59.3% KDHS (2008-9).

Latham (1997) observed that Marasmus was more common and frequent among one to three years of age, but may occur at any age.

Elsewhere in Malawi among children aged 24-42 months, a higher proportion had Kwashiorkor compared to Marasmus; attributed to the fact that Kwashiorkor is the common form of SAM peaking at 18 to 23 months (Bahwere *et al.,* 2008). Hamidu *et al.,* (2003) stipulates that prevalence varies across geographical regions based on the diet.

Outcome Indicators of Effectiveness
Cure rates. Proportion cured for the program was 54%, below Sphere standard (Sphere, 2004). Most facilities (except Magadi and Lumumba) recorded cure rates below Sphere with KDH performing lowest at 25%. The observed differences in cure rates among health facilities could be due to a number of factors; location some operated as outreaches and high defaulters.

Programs in Bangladesh, Oromia Ethiopia, West Darfur Sudan and UNICEF's study of OTP in Kisumu recorded cure rates of 53%, 33.2%, 68% and 73.7% respectively. Reasons for these rates were given as: in Bangladesh, antibiotics were not provided, use of adapted exit protocols and integration into routine services; In Oromia, attrition of trained staff, lack of supplies and poor community mobilization; in West Darfur it was due to high defaulter rate (17%) (Save the Children, 2007; Belachew & Nekatibeb, 2007; UNICEF Kenya, 2012). A high cure rate of 90% in Southern Nations Nationalities People Regional State (SNNPRS) in Ethiopia was attributed to capacity building, community volunteers' involvement, and linkages to other services (Save the children, 2007).

Defaulter Rates. Overall defaulting was high (22.6%) with OLPS, Nyahera, Simba Upepo and Obunga being the main contributors. Only 2 out of 10 facilities met the threshold that is, Magadi at 6.1% and KDH at 7.8%. Programs in Mangochi Malawi, West Darfur Sudan, Oromia Ethiopia and Kisumu Kenya, recorded high defaulter rates of 22%, 17%, 45% and 17.3% respectively. This was attributed to; in Malawi distance to facility, weak outreach in West Darfur, caregivers were active in the fields during harvest time, insecurities hampered access, and if children improved they saw no reason to continue (Save the children, 2007; UNICEF Kenya, 2012).

SNNPRS and Dedza Malawi achieved low defaulter rates of 13% and 14% respectively attributed to; good community mobilization in SNNPRS and in Dedza, to community follow up, bi-monthly OTP schedule, awareness campaign and community gate keepers involvement (Belachew & Nekatibeb, 2007; Save the children, 2007).

High defaulter rate makes it difficult to adequately assess performance of other indicators such as death and cure rates as defaulters could have been cured, died or remained malnourished.

Death Rate. Overall death rate was 3.3%. Although there were no deaths reported in Pandpieri, Simba Upepo and Lumumba, they still recorded high defaulters. Death rates in Rabuor, KDH, Nyamasaria and OLPS were all well below 5%.

Death rate in a UNICEF' study of Kisumu was 5.2% (UNICEF Kenya, 2012). Malawi recorded death rates of 5% and 2% for Mangochi and Dedza respectively (Save the children, 2007). Only in facilities with low defaulter rates can we assume that the death rate observed may truly reflect the performance of a health facility with respect to this effectiveness indicator. Only in Magadi can we confidently take the effectiveness of achieving Sphere threshold as being a reflection of success.

Weight Gain. The overall rate of weight gain was 4.8g/kg/day. Sphere allows for lower rates of weight gain in outpatient programs, of 4g/kg/day as the risk of exposure to infection and opportunity costs for beneficiaries are lower. OTP in SNNPRS registered an average weight gain of 5.5g/kg/day (Save the children, 2007). Other programs had lower rates of weight gain as observed in Nyahera. Mangochi and Dedza programs in Malawi had weight gains of 3g/kg/day attributed to; low MUAC, illness, HIV, sharing of rations, and missing visits (Save the children, 2007).

Average Length of Stay. HIV and AIDS may result in some malnourished individuals failing to recover (Sphere, 2004). The ALOS for this program was 39 days. Lumumba was the only facility where children stayed longer than Sphere recommendation. In SNNPRS, the ALOS was 44 days (Save the children, 2007). In west Darfur, ALOS for Marasmus was 57 days (Save the children, 2007). The difference in Kisumu East ALOS for Marasmus and Kwashiorkor could be attributed to those with Marasmus tending to be HIV positive compared to Kwashiorkor. Bahwere *et al.,* (2008) also found that HIV-positive children recovered more slowly. He attributed it to slower weight gain arising from reduced intake due to

poor appetite; nutrient mal-absorption, increased incidence of infections, and increased nutrient requirements due to HIV.

Factors Affecting Effectiveness of OTP

In the current study, over 75% of the children were tested for HIV. Most of the children were HIV negative. Nyamasaria had the highest HIV prevalence at 21%. Most of the HIV positive children had Marasmus. The cure rate in HIV positive children was similar to the overall cure rate, supported by the findings that in this study HIV status did not influence cure rate. HIV status for 25% of the participants could not be ascertained. Not testing for HIV should not be an option: untreated, 35—59% of HIV-infected children in sub-Saharan Africa die before their second birthday and children who are HIV positive and also malnourished are twice more likely to die than those with SAM alone (Fergusson *et al.,* 2009). HIV status influenced type malnutrition. HIV positive children were more likely to have Marasmus. This is corroborated by several studies reporting that HIV-infected children develop Marasmus rather than Kwashiorkor (Bahwere *et al.,* 2008: Thurstans *et al.,* 2008).

Age, gender, MUAC at admission, HIV status and type of malnutrition did not influence ALOS. However, other studies have found that HIV status influences this variable (Thurstans *et al.,* 2008). Confidence limits for the relationship between MUAC and ALOS in this study, although corresponding to a non-significant result, suggests a possible influence of MUAC that may not have been detected due to a small sample size (CI -6.114 to 1.045).

Higher MUAC at admission is associated with increased likelihood of having Kwashiorkor than Marasmus, and reduced likelihood of a child dying; interpreted as the likelihood of dying is higher in children with Marasmus than Kwashiorkor. MUAC at admission influenced rate of weight gain and death as an outcome. Although MUAC influenced death rate, this was not attributed to its influence on rate of weight gain because rate of weight gain did not influence death rate. This indicates that MUAC influences chances of dying, and rate of weight gain, independently. Rate of weight gain however, influences cure, with increased rate of weight gain associated with increased chances of being cured. Lower MUACs are good indicators of mortality among children (Myatt et *al.,* 2006).

MUAC at admission influences rate of weight gain but is not associated with length of stay in the program. The more weight a child gains, the more chances they had of being cured, but ALOS did not influence any of the outcomes. MUAC at admission directly influences death rate, but is not associated with cure or defaulting rates. Rate of weight gain is influenced by MUAC at admission, but is not associated with either death or defaulting.

Conclusion

The common form of malnutrition in Kisumu is Marasmus, hence general energy deficits is the predominant nutrition problem. Magadi, is the only facility that was effective. The program was effective in achieving low death rates, ALOS and rate of weight gain. High defaulter rates may have masked performance with respect to death and cure rates. Factors that influence effectiveness are: MUAC, rate of weight and HIV status.

From the study findings it is recommended that OTP Programs be linked with the community and have defaulter tracing mechanisms to reduce defaulters and improve effectiveness.

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Bioconversion of Organic Residues into Single Cell Protein (SCP): Turning Debris into Delicacies

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Abstract

The increasing world deficiency of protein is becoming a major problem for mankind. The conventional sources of protein are scarce and costly and since the early fifties, intense efforts have been made to explore new, alternative and unconventional sources of protein. For this reason, fungi, bacteria and algae have been explored as alternative sources of protein broadly known as single cell protein (SCP). SCP has a number of advantages when used as food or feed; the most important of which is the high protein content (30-80 %) in the cells. Furthermore, SCP also contains fats, carbohydrates, nucleic acids, vitamins and minerals all of which are important dietary components in feeds and food. SCP products are also rich in certain essential amino acids such as lysine and methionine which are usually limiting in most plant and animal foods. Thus, SCP is of high nutritional value for human and/or animal consumption and since SCP production can be done on agricultural and other organic wastes, the utilization of these wastes in SCP production serves two functions; reduction of pollution or environmental conservation and the creation of edible protein. The main aim of this work was to review the use of organic wastes in production of edible protein and to provide highlights on the novelty of SCP.

Keywords*: Edible Protein, Organic Wastes, Environmental Conservation, Microbial Biomass*

Introduction

Single-cell protein (SCP) refers to sources of protein extracted from cultures of algae, yeasts, fungi or bacteria grown on agricultural wastes and used as a substitute for protein-rich foods in human and animal feeds (Nasseri *et al.*, 2011). SCP has also been defined as microbial cells grown and harvested for animal feed or human food due to its high protein content (Adedayo *et al.*, 2011). The term SCP does not encompass protein derived from the filamentous fungi which are now termed as mycoprotein (Kavanagh, 2005). Since proteins account for the quantitatively important part of the microbial cells, these microorganisms are natural protein concentrates and also contain varying amounts of amino acids (Nasseri *et al*., 2011). Due to population increase and worldwide protein shortages, use of microbial biomass as food and feed is being considered (Oscar *et al*., 2010; Nasseri *et al*., 2011). Protein from microbial biomass has been considered an alternative to conventional expensive protein sources such as fishmeal and soymeal.

Use of microbial protein as food may appear unacceptable but its consumption is certainly innovative to solve global food problems. For many years, man has consumed microbial products such as alcoholic beverages, cheese and yogurt together with the microbial biomass responsible for their production (Tuse, 1984). Microbes that have been used as sources of SCP include yeasts (*Saccharomyces cerevisiae* and *Candida utilis Torulopsis*), bacteria (*Rhodopseudomonas capsulata* and *Cellulomonas,*) and algae (*Chlorella* and *Spirulina*) (Becker, 2007; Bhalla *et al*., 2007).

Chlorella, Cynobacteria and *Spirulina* are the most commonly cultivated species of algae as SCP (Raja *et al*., 2008). Yeast is suitable for SCP production because of its superior nutritional quality and general public acceptability but are limited by lower protein content (45-65%) when compared with bacteria (up to 80% ;Oscar *et al*., 2010). Bacteria grow rapidly on cheap substrates (Oscar *et al*, 2010) but their use as SCP is limited by their small sizes, high nucleic acid content and the general public thinking that all bacteria are harmful. Algal cells have high protein contents that are comparable to conventional sources of protein (Rasoul -Amini *et al*., 2009).

Use of Organic Residues as Substrate for Production of SCP (Microbial Farming)

Microorganisms can grow on agricultural wastes and industrial effluents and help in decomposing pollutants (Ashok *et al*., 2000; Waites *et al*., 2001). The use of organic residues in production of fungi and other microorganisms as SCP is not only economically viable but also solves the problem of accumulation of organic wastes and protects the environment (Pandey, 2003; Silva *et al*., 2011). Various hydrocarbon, nitrogenous compounds and agricultural wastes are abundant for production

of SCP (Ashok *et al.*, 2000). Agricultural wastes include wheat bran, molasses, soy bean meals, maize straws and cobs, whey, orange peel residue, bagasse, paper mill waste, rice husks, wheat straw residue, sugar beet pulp, and sweet potato wastes among others (Ashok *et al.*, 2000; Barhim, 2004).

Rapid increase in volume and types of waste agricultural biomass as a result of intensive agriculture is becoming an enormous problem as rotten waste agricultural biomass emits methane and open burning by farmers generate carbondioxide and other pollutants. Improper management of agricultural waste can contribute to air pollution and climate change (Ashok *et al.*, 2000). This waste however, is of high value with respect to bioconversion of organic refuse which is a sustainable technology that employs organisms that feed on organic matter to convert organic waste into feedstock for livestock and food for man (Ashok *et al.*, 2000). This novel approach to waste management meets organic waste management needs and environmental sustainability in many parts of the world. Production of SCP as animal feed is because the creation of acceptable food from novel sources usually requires animal conversion as a last step in most cases because microbial conversion alone produces biomass that is not acceptable as a food to most consumers in most cases (Nasseri *et al.*, 2011). Cultivation of SCP on organic residues is microbial conversion mediated by man that is oriented at waste management in order to sustain the environment with the production of a useful product in the end (Rolz, 1975).

Choice of Microorganisms for SCP Production

The microorganism of choice should have high growth rate for productivity and good yields. The most important consideration to make is safety and acceptability of the microorganism. Microorganisms involved in SCP production must be safe and acceptable for use in food meaning they should be nonpathogenic and should not produce toxins (Shinohara *et al.*, 2000). There should be ease of recovery of cells from the growth medium and the nutritional composition of the product should be known. Bacteria have faster growth rates than fungi and grow at higher temperatures, thereby reducing fermenter cooling requirements. Bacteria are able to double within 0.5-2 hours, yeast in 1-3hours and algae within 2-6 hours (Shinohara *et al.*, 2000). In contrast to fungi, which are easily recovered by filtration, bacteria and yeast require the use of sedimentation techniques and centrifugation. Bacteria produce more protein than yeast (50-83% and 30-70% protein content respectively) (Table 1). Organisms should be stable genetically so that the strain with optimal biochemical and physiological characteristics can be maintained through many hundreds of generations (Becker, 2004).

Production Process of SCP

Single Cell Protein develops when microbes ferment waste materials (Vrati, 1983). SCP production technologies were developed to solve the problem of worldwide protein shortage and evolved as bioconversion processes which turned low value products (often wastes) into products with added nutritional and market value (Ugalde & Castrillo, 2007).

The production of SCP is a fermentation process that is done by selected strains of microorganisms which are multiplied on suitable raw materials (Anderson *et al.*, 2005). The cultivation process includes growth of the cell mass followed by separation processes. It begins with microbial screening in which suitable strains are obtained from samples of soil, water, and air and subsequently optimized by selection. The fermentation process requires sterile growth medium in a fermenter, cell separation, collection of cell free supernatant, product purification and effluent treatment (Ferrianti *et al.*, 1983). Prolonging a microbial culture by continuous addition of fresh medium with the simultaneous harvesting of product has been implemented successfully in industrial fermentations destined for biomass production (Cooney, 1986). Fermenters are equipped with aerators to supply oxygen, stirrers, thermostats and pH detectors (Ferrianti *et al.*, 1983; Sinclair & Cantero, 1990).

Many methods are available for concentrating the solutions like filtration, precipitation, centrifugation and the use of semi-permeable membranes (Oura, 1983). After harvesting, the biomass is treated for RNA reduction and dried in steam drums or spray driers to increase their shelf life. Some of the methods for reduction of nucleic acid content in microbial biomass are alkane hydrolysis, chemical extraction, and activation of endogenous nucleases (Sinclair & Cantero, 1990). SCP needs to be dried to 10% moisture or they can be condensed and denatured or acidified to prevent spoilage (Kim & Chung, 2001).

Another production technology involves Solid State Fermentation (SSF) which is the growth of microorganisms on insoluble substrate. The advantage in SSF process is absence of elaborate media preparation and the efficient utilization of substrate to produce commercially viable products (Becker, 2007).

Nutritional Value of SCP

Table 1. Comparison of Nutrient Composition in Algae, Yeasts and Bacteria

Component	% composition of dry weight		
	Algae	Yeast	Bacteria
True Protein	40-60	30-70	50-83
Protein + NAs	45-65	35-50	60-80
Lysine	4.6-7.0	6.5-7.8	4.3-5.8
Methionine	1.4-2.6	1.5-1.8	2.2-3.0
Fats/Lipids	5-10	5-13	8-10
Carbohydrate	9	NA	NA
Nucleic acids	4-6	9.70	15-16
Amino acids	NA	54	65
Fiber	3	NA	NA

Source: Anupama, 2000.
NA-Not Applicable; NAs- Nucleic acids

The production of SCP assumes special significance on account of their nutritional value (Yu *et al.,* 2002). They have high protein content, lipids, vitamins and amino acids (Adedayo *et al*., 2011) (Table 2). The type of microorganism and medium composition governs the protein and lipid contents of microorganisms (Adedayo *et al*., 2011). The protein obtained from microorganisms is not only cheap but also provides a balanced nutrition for humans and animals (Rajoka *et al.,* 2006).

Table 2. Comparison of Nutrient Content of some Conventional Food Sources and Microalgae (in % of Dry Weight)

Product	Proteins	CHO	Lipids
Saccharomyces cerevisiae	39	38	1
Meat	43	1	34
Milk	26	38	28
Rice	8	77	2
Soy beans	37	30	20
Anabaena cylindrical	43-56	25-30	4-7
Chlamydomonas reinhardtii	48	17	21
Chlorella vulgaris	51-58	12-17	14-22
Porphyridium cruentum	28-39	40-57	9-14
Scenedesmus obliquus	50-56	10-17	12-14
Spirulina maxima	60-71	13-16	6-7
Synechococcus spp.	63	15	11

Source: Anupama, 2000.
CHO- carbohydrates

The mean crude protein in dry matter of algae and yeasts on conventional substrates lies between 40-70 % and 50-80 % for bacteria (Table 1). Bacterial protein content is the highest (50-80 % of total cell contents) (Anupama, 2000; Kurbanoglu, 2011) while microalgae have the highest lipid content. Bacterial products have the highest content of methionine (2.2-3.0%) but generally low lysine (4.3-5.8%) while algal cells have the highest lysine content (4.6-7.0%) (Anupama, 2000; Kurbanoglu, 2011). SCP from yeast has up to about 30-70% protein (Table 1) and has high protein – carbohydrate ratio (38:39) (Table 2). It is rich in lysine (6.5-7.8% but poor in methionine (1.5-1.8%) (Table 1) (Anupama, 2000). It also has good balance of amino acids (54%) and is rich in B –complex vitamins and more suitable as poultry feed (Anupama, 2000; Adedayo *et al*., 2011). Some yeasts have probiotic properties when used in aquaculture,

such as *Saccharomyces cerevisiae* (Oliva-Teles & Goncalves, 2001) and *Debaryomyces hansenii* (Tovar *et al.*, 2002) and can boost larval survival of fish (Campa-Cordova *et al.*, 2002, Burgents *et al.*, 2004). However, many of these yeast supplements are deficient in sulfated amino acids like methionine (Oliva-Teles & Goncalves, 2001) which restricts their extensive use as the sole protein source.

Algae can provide many vitamins including: A, B1, B2, B6, niacin and C, and are rich in iodine, potassium, iron, magnesium and calcium (Simoons, 1991). Commercially cultivated microalgae such as Cyanobacteria are marketed as nutritional supplements for example *Spirulina* and *Chlorella* (Morton, 2000). Lipids in microalgae are especially important because of the high concentration of omega-3 fatty acids which are essential polyunsaturated fatty acids and must be obtained from dietary sources (Morton, 2000). The conventional sources of this essential fatty acid include fish, soy beans and eggs which may present allergic reactions in some users or may be out of reach to many (Morton, 2000).

Advantages of SCP

Large-scale production of microbial biomass has many advantages over the traditional methods for producing proteins for food or feed. Microorganisms have a high rate of multiplication (algae: 2-6 hours, yeast: 1-3 hours, bacteria: 0.5-2 hours) thus mass production and high productivity is amenable (Adedayo *et al.*, 2011). They can be easily genetically modified for improved protein composition. There is high efficiency of substrate conversion and algae grown in ponds produce 20 tons (dry weight) of protein per acre/year which is 10-15 times higher than in soybeans and 20-50 times higher than in corn (Ashok *et al.*, 2011). They can utilize a broad spectrum of raw materials as carbon sources, which include those from waste products and thus they help in the removal of pollutants from the environment (Adedayo *et al.*, 2011; Ashok *et al.*, 2011). Besides the nutritional values of SCP, it also has the benefits of the possibility of its production through-out the year since it is independent of seasonal and climatic conditions (Ndihi, 2010). Since microbial biomass production occurs in continuous cultures (Ndihi, 2010; Adedayo *et al.*, 2011), land requirements are low and are ecologically beneficial (Adedayo *et al.*, 2011). SCP for example requires no arable land and can be grown even in deserts (Adedayo *et al.*, 2011). Algal cultures can be done in places that are normally unused and so there is no competition for agricultural land (Adedayo *et al.*, 2011).

Limitations of SCP

Despite the novel features of SCP, there are several factors that contribute to its limited use globally. High nucleic acid content (6-10%) is the most important factors limiting nutritional value of SCP for animal or human consumption (Adedayo *et al.*, 2011). The concentration of nucleic acid in SCP is higher than in other conventional protein and is characteristic of all fast growing organisms (Adedayo *et al.*, 2011). Consumption of food with high nucleic acid concentration leads to production of uric acid in the blood causing health disorders such as gout and kidney stones (Nasseri *et al.*, 2011). Microbial biomass may also have unacceptable color and flavors (Adedayo *et al.*, 2011).

Sometimes the microbial biomass when eaten may lead to indigestion or allergic reactions in humans (Adedayo *et al.*, 2011). Skin and gastrointestinal reactions resulting into nausea and vomiting have been reported from consumption of foreign protein (Adedayo *et al.*, 2011). SCP from algae may not be suitable for human consumption because they are rich in chlorophyll and have cellulosic cell walls (about 10% of dry matter) that is not digestible for humans and other non-ruminants (Rasoul-Amini *et al.*, 2009). Some contaminants during production process of algal SCP can produce mycotoxins and other cells have low growth rates and low protein content (45-65%) and lower methionine content than in bacteria. Algal SCP also concentrates heavy metals (Becker, 2007; Richmond, 2004). However, some processes have been employed to treat algal biomass to disrupt the cell wall before consumption and these include boiling, high temperature drying, sun drying, and chemical autolysis (Becker, 2004). Bacterial cells have small sizes and low density which makes harvesting from fermented media difficult and costly. Bacterial cells also have high nucleic acid content and require additional processing to reduce the nucleic acid content (Adedayo *et al.*, 2011). The greatest limitation of bacteria as SCP is the general public view that all bacteria are harmful and cause disease. There is lack of familiarity and acceptability for bacteria as food hence the need for public education to dispel this misconception and make the public accept bacterial protein (Nasseri *et al.*, 2011). All these detrimental factors affect the acceptability of SCP as global food.

Future Prospects of SCP Production

Research on SCP is stimulated by concern over eventual food crisis that will occur if the world's population is not controlled (Adedayo *et al.*, 2011). The use of microbes for production of proteins gives

many advantages over the conventional sources. Microbes have shorter generation time, utilize many substrates, and have no requirements for arable land or any particular season to grow so have the possibility of continuous production in any part of the world.

However, many people are still reluctant about microbial food and much education is needed before the full advantage of the novel nutritional value of such cheap and readily available food source can be used. Maximum utilization of agro-industrial wastes will inevitably result in better environmental management and improve the quality of life from added income.

The future of SCP is heavily dependent on reducing production costs, improving downstream processing and the producer organisms by means of recombinant DNA technologies. SCP is gaining research interest among scientists in universities and industries and now SCP is being used in some parts of the world for animal and human consumption (Nasseri *et al*., 2011). The use of SCP as food ingredient is still in its early stages of development and attempts to improve the acceptability of SCP products should be intensified. Further research and development will ensure usage of microbial biomass as SCP or as diet supplements.

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Challenges Facing Teacher Trainees on Teaching Practice: The Case of Maasai Mara University Students, Narok County, Kenya

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Abstract

Teacher education and training forms one of the fundamental pillars that will see Kenya achieve Vision 2030 and the Millennium Development Goals (MDGs). Indeed, one of the main contemporary issue in teacher education and training in Kenya is on how teachers are prepared in order to effectively perform the demands of the teaching profession and resolve the various challenges they face in their roles as professional teachers. Teacher training institutions, including universities achieve their objectives of training effective and competent teachers by exposing them to a wide range of courses focused on the profession including subject areas and professional courses. Of more significance is the field experience or rather internship (attachment) that these teacher trainees undergo during the training; commonly referred to as teaching practice. Teaching practice exposes the teacher trainees to the realms of actual teaching as it takes place in various educational institution and school settings that these very teacher trainees are being prepared to assume after graduating from colleges and universities. However, as new and beginning teachers, experiences on teaching practice may be quite challenging to these prospective teachers. Thus, the purpose of this study was to investigate the challenges facing teacher trainees on field attachment, focusing mainly on curriculum resources, professional and academic issues, mentoring and supervision and socio-economic and health issues. The main findings indicated inadequate curriculum resources in the schools of attachment and lack of some social amenities, particularly accommodation, water supply and road network. Recommendations were made with the need to increase funding for curriculum material to schools by the Government, Donors, NGOs and the Community concerned.

Keywords*: Challenges, Teacher Trainees, Teaching Practice*

Introduction

Research has shown that high student achievement is most strongly linked to high quality training of teachers (Bishop, 1985; Hanushek & Rivkin, 2006). Indeed, current global technological and socio-economic advancement as well as political developments have made quality education a policy priority for governments and humankind all over the world. As Adentwi (2002) posits, the belief in the potency of education to enhance a people's life style, prosperity and happiness compel governments and citizens to invest heavily in formal education. Kenya, as a developing country, is no exception in this direction. The teacher, the vehicle on which education thrives, is therefore indispensable. Teacher Education is critical in nation building because it produces the right caliber of teachers to deliver quality education for national development. Hence, the quality of teachers' education in schools and the quality of Teacher Education and training are inseparable (Adentwi, 2002).

Bishop (1985), long said that of all the educational problems that beset African countries, none is as persistent or as compelling as the one relating to the training of competent teachers. This old comment still remains true about teacher training in Africa generally and in Kenya, in particular today. If we are to have quality education, we need sufficient teachers who are well trained and motivated professionals. Professionalism is one of the most important characteristics that should identify teachers. Thus, the professionally qualified teacher is one of the most influential school-based factors in improving student learning (Hanushek & Rivkin, 2006). Given this influence, it is essential for the Ministry of Education in Kenya to ensure that teachers are recruited, trained, and retained in a manner that gives all students access to the most effective teachers possible. To improve teacher quality, policymakers need to address the preparation of teacher candidates. However, the research base in this area is quite weak, offering no particular formula for an effective teacher training program.

Drawing from the report on the findings of the first Annual Learning Assessment undertaken by an organization called Uwezo in Kenya in 2010, there are five key elements to consider in the development or evaluation of teacher preparation programs as given by Perry (2011): program purpose; requirements for subject-matter knowledge; requirements for professional knowledge; clinical and field experiences; and faculty qualifications. Of interest to the current study was the focus of teacher trainees'

field experiences which dawns to them the realities of the teaching profession. Indeed, teaching practice is important in teacher education as it generally aims at providing opportunities for student teachers to develop and evaluate their competences in the major areas of teaching (Harris & Sass, 2007). Similarly, Allen (2006) argued that teaching practice provides opportunities for the teacher trainees to develop and evaluate their teaching competencies.

Nevertheless, in their professional attachment, teacher trainees are bound to face a number of challenges including lack of curriculum materials, inadequate supervision, and mentors' neglect, and other socio-economic problems (Ankuma, 2007) that may interfere with their professional development and even negatively affect their attitudes towards the teaching profession. Subsequently this will reduce the quality of the graduate teachers who in essence ought to spearhead quality education in schools. Thus, based on this scenario, the present study sought to investigate the actual challenges and problems faced by teacher trainees in field attachment using a sample of students in field attachment from Maasai Mara University in Narok County during the period of May to August 2013.

The researcher sought to identify and describe possible problems that confront teacher trainees in their professional development during teaching practice, thus, jeopardizing their training quality as competent future teachers. Specifically, the study focused on problems associated with the availability of curriculum materials, professional and academic performances, mentorship and supervisory practices and socio-economic and health concerns during field attachment.

The study sought to find answers to the following questions:

(i)   What problems confront teacher trainees with respect to the availability of curriculum materials?
(ii)   What professional and academic challenges do teacher trainees encounter?
(iii)   What are the perceptions of teacher trainees on the mentorship and supervisory roles of assigned school mentors and university teaching practice supervisors?
(iv)   What are the socio-economic and health concerns of the teacher trainees?

Materials and Methods

The study adopted a case study design that utilized a self administered questionnaire which examined distinctive problems facing student teachers from Maasai Mara University on teaching practice and how they were coping with the varying circumstances in their field attachment in the Narok region of Kenya. The sample consisted of 24 students (11 boys and 13 girls) who were randomly visited in their schools of attachment. They were given a self administered questionnaire that asked them about availability of curricular materials, professional and academic challenges, level of supervision and mentorship and on the socio-economic issues they faced in the field. Both closed and open items formats were included in this self developed questionnaire. The closed ended items were put on a 4-likert scale format of strongly agree, agree, disagree and strongly disagree, which were later collapsed in to agree and disagree during data analysis. The data from closed ended items was analyzed using descriptive statistics based on frequencies and percentages, displayed in form of charts. In addition, the data from open ended items were discussed qualitatively. The results of the analysis are discussed below.

Results and Discussions

The results of analysis are discussed under demographic characteristics and analysis of research questions as shown below.

Demographic Characteristics of the Sample

The results of the analysis on sex and age characteristics of the sample, and the place of attachment are shown in figures 1 and 2 below;
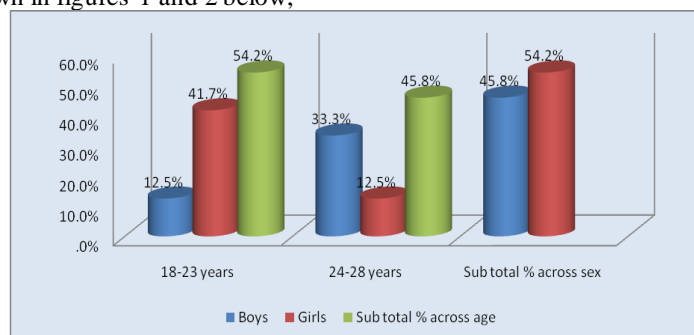
Figure 1. Distribution of Respondents by Sex and Age

Figure 1 above shows that girls were the majority (54.2%) in the sample and boys were represented by 45.8%. The ages of the respondents varied from 18 to 28 years, with the age category of 18 to 23 years being the highest (54.2%), and that of 24 to 28 years being represented by 45.8% of respondents in the total sample. Majority of girls (41.7%) were in the age bracket of 18 to 23 years, while majority of boys (33.3%) were in the age category of 24 to 28 years.
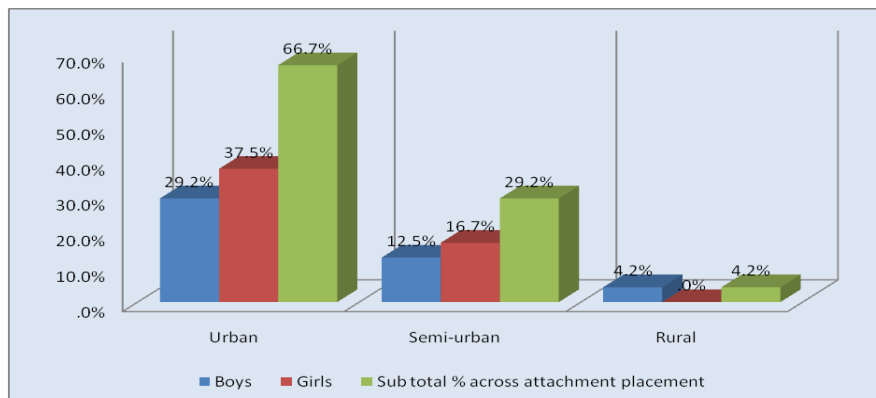
Figure 2. Place of Attachment

From figure 2, majority of respondents (66.7%) were attached in the urban schools of Narok region, followed by semi-urban schools (29.2%) and the remaining 4.2% of the respondents were attached in the rural areas schools of the larger Narok region. In this distribution, majority of girls were attached in the urban (37.5%) and semi-urban (16.7%) schools as compared to boys. The distribution of respondents across various places of attachment within Narok region sheds more light on the nature of challenges student teachers face across these places.

Availability of Curricular Materials
The first research question focused on the problems that the teacher trainees face when it comes to whether or not the instructional materials/facilities/equipments are available, and whether the teaching-learning environment is appropriateness for learning in the schools where they are conducting their field attachment. Figures 3a,b and 4 below provide the analysis of findings and basis of discussions in this respect.
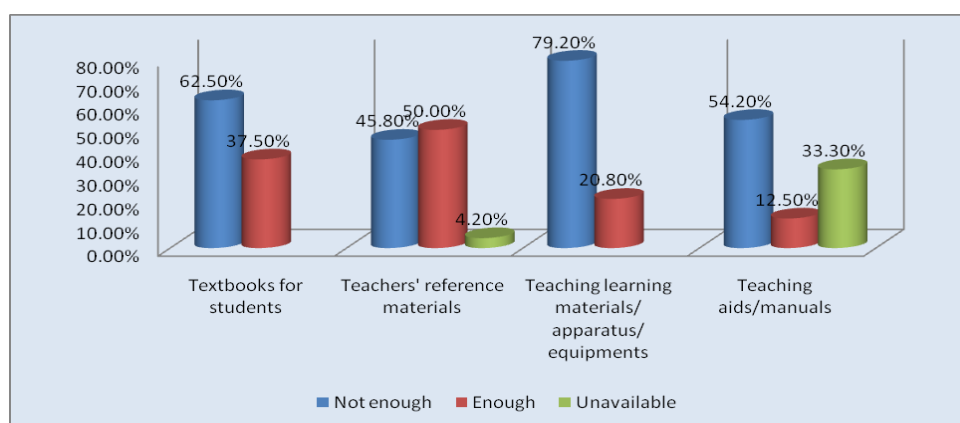
Figure 3a. Curricular Materials

Figure 3a shows that the most important curricular materials were not available in the schools of attachment for the majority of the respondents: these included, textbooks for learners (62.5%), teaching-learning materials/apparatus/equipments (79.2%) and teaching aids/manuals (54.2%). Only teachers' reference materials were enough for the teacher trainees as indicated by 50.0% of the respondents. This could be so, because many of them go to the field prepared with reference materials for their specific subject areas. From the foregoing analysis, it is clear that few schools in Narok region have the requisite supply of resource and curriculum materials. The problem of curricular materials in many schools in

Kenya as a whole is a historical one since Kenya became independent. The cost sharing move of the 1990s tried to alleviate it; however, it was again worsened with the declaration of Free Primary Education in 2002 when the then Narc government came into power. Thus, if quality teachers are to be produced, then a lot has to be done by the stakeholders in education on supply of curricular materials to schools.

In order to manage the challenges faced by the teacher trainees by unavailability of curricular materials, they were asked whether they purchase some of these materials. The findings showed that an overwhelming majority of the trainees (79.2%) use their own meager resources to supplement curricular materials as shown by figure 3b below. This is a desperate move by the trainees to satisfy their need for curricular materials, given that they do not earn salaries during this attachment period and the only source of income is their attachment allowance and family support.
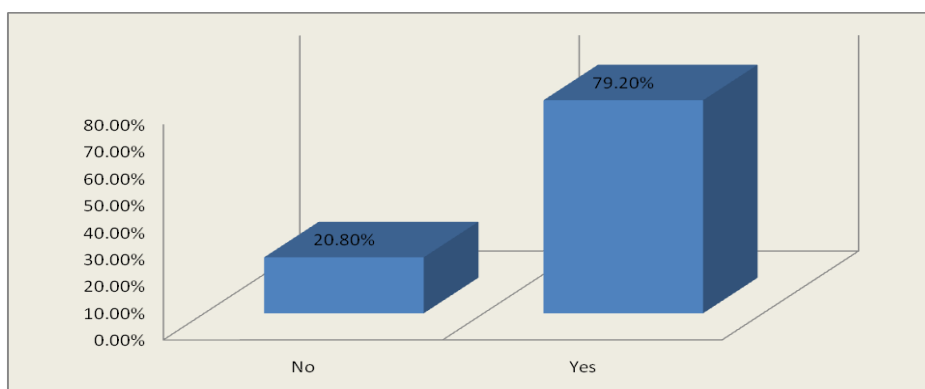
Figure 3b. Self Purchase of Curriculum Materials
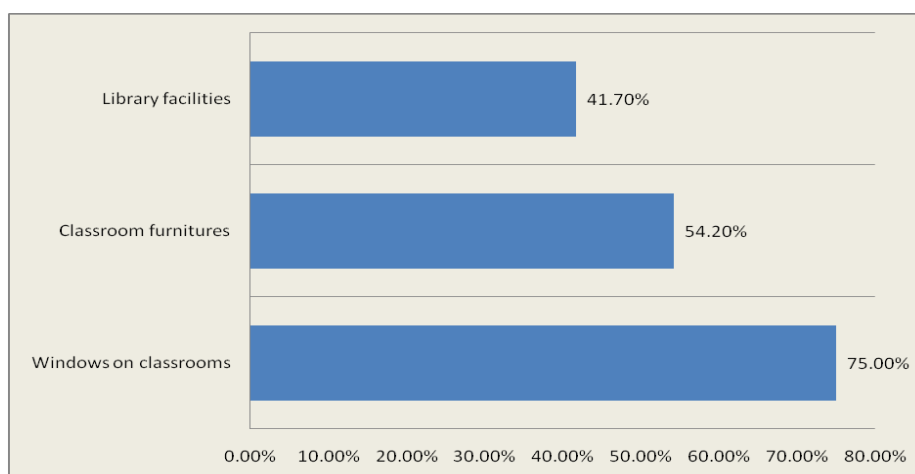
Figure 4. Appropriateness of Learning Environment

The results of analysis presented in figure 4 shows that library facilities and classroom furniture pose problems to trainees in their field attachment; because only 41.7% and 54.2%, respectively, indicated the appropriateness of these learning environment and facilities in their schools of attachment. Indeed it is not uncommon to university supervisors during teaching practice supervision to find learners sharing or squeezing themselves on one desk or seat in class in his/her trainees class. However, some improvements can be appreciated in the classroom buildings which have windows as indicated by 75% of the respondents, which is appropriate and conducive environment for teaching-learning processes.

Professional and Academic Requirements

Research question two focussed on professional and academic issues and requirements faced by the teacher trainees and the analysis of their responses is presented in figure 5 below.
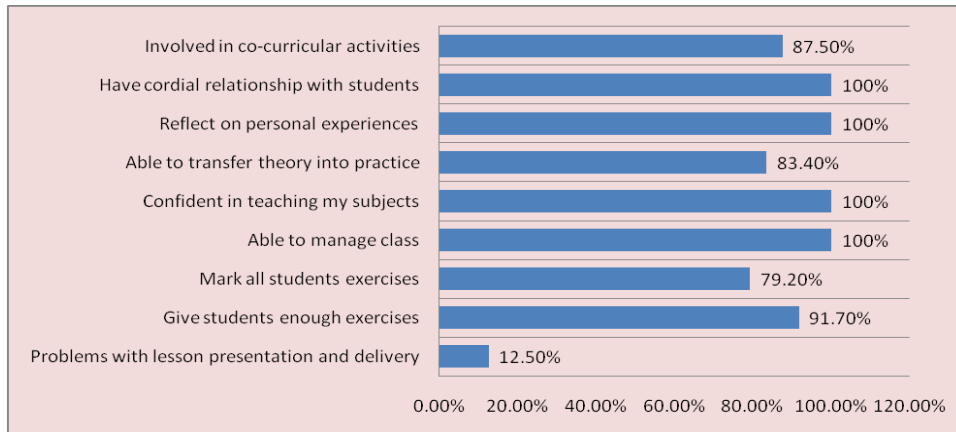
Figure 5. Professional and Academic Issues

The overall picture given in figure 5 shows that the teacher trainees tended to fair on well with the professional and academic requirements amidst challenges posed by lack of adequate curricular materials and inappropriate learning environment (as shown above in figures 3a and 4). Significant achievements were seen in the areas of relationship with students, positive personal experiences, teaching confidence and class management, all of which were achieved by 100% of the respondents. Perhaps these achievements are connected to good professional mentorship and supervisory services and support given to the teacher trainees by support teachers and university supervisors, respectively.

Mentorship and Supervisory Services
Respondents were asked about the nature of support and services they gained from their subject teachers and university supervisors and the results of analysis are shown in figures 6 and 7 below.
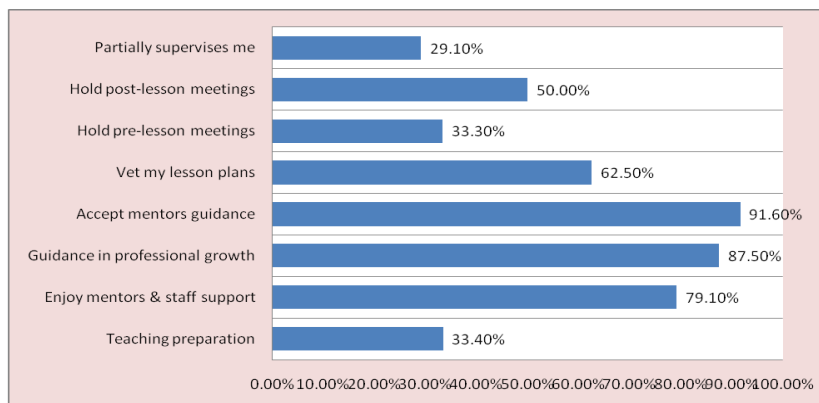
Figure 6. Mentorship Services

Figure 6 above shows that teacher trainees benefited a lot from their subject mentors in the areas of mentors guidance (91.6%), professional growth (87.5%), mentors-other staff support (79.1%), mentors vetting of their lesson plans (62.5%) and holding post lesson meetings (50%). These forms of support are crucial to teacher trainees as they enhance professional and academic growth and development on the part of the trainees. The respondents however indicated that some subjects lacked subject mentors, these were mathematics and chemistry.
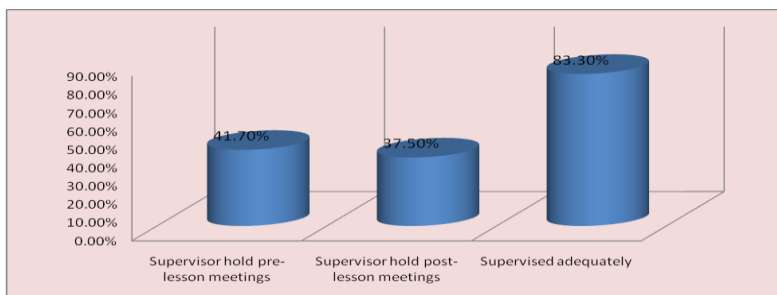
Figure 7. Supervisory Services

The findings in figure 7 show that majority of teacher trainees (83.3%) were supervised adequately by their university supervisors. Nevertheless, compared with subject teachers, the university supervisors did not hold more pre and post lesson meetings with the teacher trainees.

Social, Economic and Health Concerns

The respondents were asked to state the challenges they faced in terms of social, economic and health issues and the results of analysis are presented in figures 8, 9, 10 and 11 below.
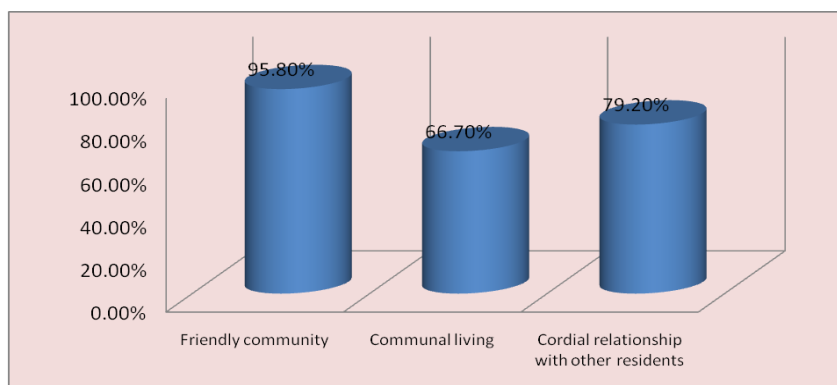
Figure 8. Social Issues

Figure 8 shows that the social interactions of the trainees was adequate and did not pose a big issue of concern during their field attachment as majority (95.8%) lived in friendly community set up.
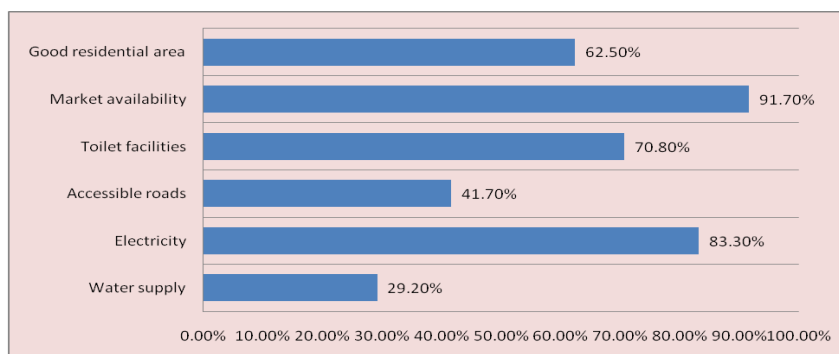
Figure 9: Social Amenities

Figure 9 shows that many of the necessary social amenities were achieved by the trainees given that majority of then hailed from urban schools in Narok area (as shown in figure 2 above). However, some problems were associated with roads accessibility (41.7%) and water supply (29.2%).
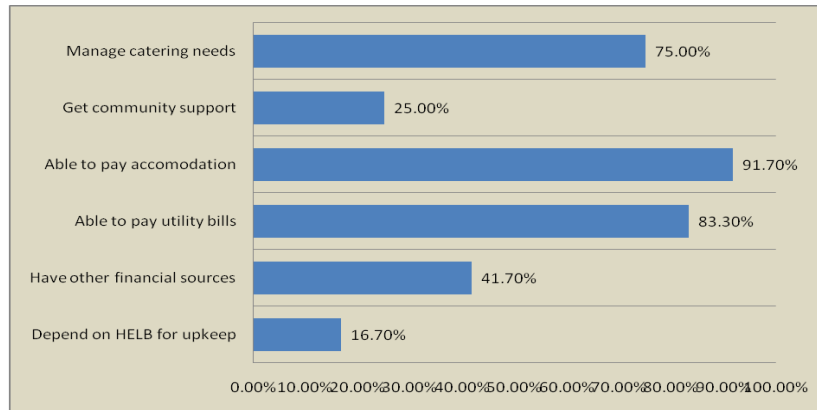
Figure 10. Economical issues

Figure 10 above shows that majority of trainees were able to manage their catering needs (75%), able to pay for their accommodation (91.7%) and able to pay their utility bills (83.3%). This was amidst meagre sources of income and support from Higher Education Loans Board – HELB (16.7%), community (25%) and family sources (41.7%). Thus, funding for trainees is an issue that need to be considered in improving the quality of teacher training.
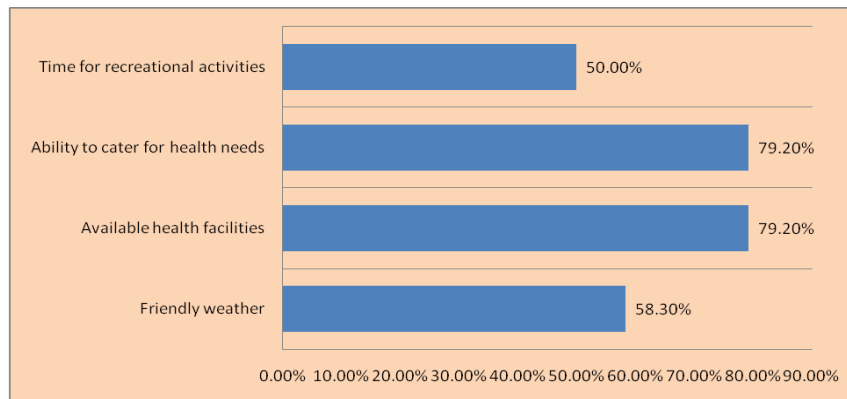
Figure 11. Health Concerns

On health matters, as shown in figure 11, majority of respondents were able to cater for their health needs (79.2%) as the health facilities were available too (79.2%). They also acknowledged the presence of friendly weather (58.3%).

The respondents were also asked whether there were other problems that they faced in field attachment, they pointed out the following:

- Students indiscipline issues
- Poor time management by students
- Harassment of female teacher trainees by university supervisors
- Transportation means and costs
- Inadequate accommodation facilities
- Differences in lesson plans formats between the attachment schools and the university one

Finally, the teacher trainees were asked whether they will like to be posted or continue working at their attachment stations. The results of analysis are shown in figure 12 below.
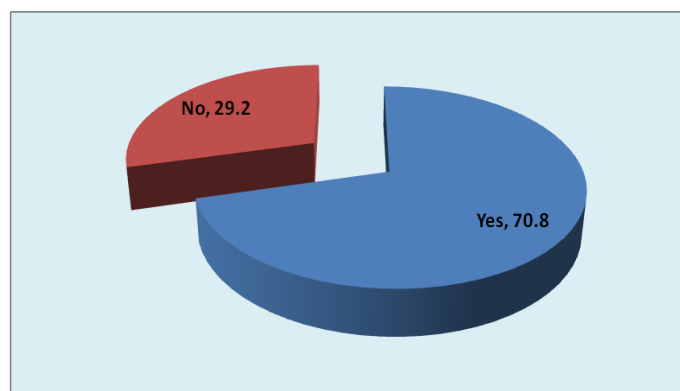
Figure 12. Posted to School of Attachment

As seen from figure 12 above, the findings indicated that majority of the respondents agreed to continue working in their schools of attachment. This is amidst some challenges they have faced during field attachment.

Conclusion

In conclusion, it is evident that there are factors on the ground which could jeopardize the training of high quality teacher trainees, hence contributing to low academic achievement in students in schools. Factors that need attention include availability of curricular materials, financial aid and some social amenities, particularly, road network, water supply and adequate accommodation facilities.

Recommendations

In order to enhance the quality of teachers from field experience, the following recommendations need to be considered:

- There is a need for the supply of adequate and sufficient curriculum materials, facilities and apparatus to schools by the Government, NGOs, Donors and the Community
- Social amenities near schools need to be improved, especially road network, water supply and accommodation, by the Government, NGOs, Donors and the Community at large.
- There is need for increased financial support to trainees from the Government, NGOs, Donors and the Community at large
- University supervisors need to improve their supervision services by incorporating pre-and-post lesson meetings with their trainees
- Issues of harassment of teacher trainees, especially the female trainees, need to be addressed soberly by the concerned universities and schools

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Challenges other Languages Spoken in Upper Primary Schools have on the Teaching and Learning of English in Kenya

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Abstract

This paper examines the influence Kiswahili and local languages have on the instruction of English. Specifically it examines how languages exposed to the learners in public primary school setting influence the manner in which they learn and use English. These are the underlying issues that emerge out of a research that was conducted in Marakwet District of Kenya, 2010-2011. The study adopted Vygotsky's (1978) social constructivism theory. It postulates that people use language influenced by various social factors and that the adult is a major facilitator and determiner in language acquisition and use. The study used the mixed method approach and descriptive survey design to collect qualitative and quantitative data. The study focused on public primary schools because they use mother tongue as the medium of instruction in lower primary, while English is used in upper primary as required by the Kenyan language policy. Simple random and purposive sampling was used to select 21 public primary schools from 70. Twenty standard seven pupils and one teacher of English were randomly selected from each of the sampled schools. The interview schedule and questionnaire were used for data collection. Data was coded and analysed with the help of SPSS through descriptive statistics, presented in frequency tables and thematically discussed. The study established that other languages: Kiswahili and mother tongue find their way into the classroom discourse, other languages used in school affect the learning of English, pupils' use of other languages other than English affects their pronunciation, finally other languages spoken cause incompetence in spoken and written English. The study recommends: teachers as role models should strive to use English all the time in their interaction with learners; teachers promote language proficiency among pupils in order to enhance the learning of English; schools should formulate school language policies to allow for meaningful learning of English.

Key words: multilingualism, mother tongue, challenges, other languages, learning of English

Introduction

Primary schools in Kenya are intrinsically multilingual and multicultural since both pupils and teachers bring their multiple identities and sociolinguistic practices into the school environment and classrooms. In almost all primary schools in Kenya, pupils and teachers communicate in at least three languages; their various mother tongues, Kiswahili and English. In lower primary classes, the varied linguistic situation is more pronounced since mother tongue is used as a medium of instruction across the curriculum except in English and Kiswahili as required by the national language policy.

Languages Spoken in Schools

Kenya is a multilingual country with over 40 languages Spoken. Barasa (2005) observes that, the Republic of Kenya has forty-one linguistic groups, while Kembo-Sure and Webb (2000) point out 42 indigenous languages spoken in Kenya alongside English and Kiswahili. The various roles played by each of these languages are determined by the language policy in Kenya. Kembo-Sure (2013, p. 50), describes the Kenyan language situation as follows: 'Kenya is one of the African countries which opted for a mix of a European language (official), an indigenous lingua franca (national) and local languages sharing the national socio-political space.' However, in social contexts these languages are used variously as determined by a variation of social, economic and political factors. As noted by Kamwangamalu, (2000, cited in Kembo-Sure & Webb 2000), these indigenous languages are spoken at home by family members. In the rural areas, especially in market places and shopping centres most speakers use either mother tongue or Kiswahili depending on who one is speaking with. If it is a member of the same linguistic group, the two will speak in mother tongue, they will use Kiswahili when the two speakers come from different linguistic communities with a different scenario in urban areas.

This linguistic situation finds its way into the school set-up affecting the way pupils learn and use English in primary schools. Most pupils in rural areas communicate amongst themselves using their various ethnic languages. They also speak in Kiswahili and English to a lesser degree. In urban areas, the situation is different as most of the pupils speak Kiswahili, '*Sheng*', and sometimes English. It can

thus be argued that the languages spoken in Kenyan schools that is, mother tongue, Kiswahili and 'sheng' affect the teaching and learning of English, this in turn impedes Pupils' proficiency and competence in the language. Kembo (1997) states that, language practice in primary schools is of concern because most of the pupils' English proficiency is either very low or non-existent by the end of primary 3. He further observed that while dealing with pupils especially in classes where English should be used, that is primary 4 onwards; the predominant language of the school environment is normally used. Omulando (2002) noting from a study conducted in Kenya observes that, teachers in secondary schools use English, Kiswahili and mother tongue interchangeably while in class during lessons and while outside depending on the situations and circumstances, for example, when giving examples for better explanation, and emphasis of certain points, ideas and concepts. Kiswahili is mainly used to break monotony after explanation of a concept, the teacher may crack a joke in Kiswahili or mother tongue. The use of several languages in schools impedes the learning of English among the pupils.

Language Teaching and Learning in Primary Schools

In Kenyan primary school, English and Kiswahili are languages taught and learnt from primary one up to primary eight, however apart from these two main languages, the indigenous languages or 'mother tongues' are used as the medium of instruction from primary one up to primary three while from primary four up to tertiary education, the medium of instruction is English, (GOK, 1976). The rationale for this language policy was that; most of the children in the rural areas can only speak their vernacular language at the time of starting primary education. Yet, they are expected to have learnt adequate English at the end of seven years to be able to do certificate of primary education in English. The policy is silent on Kiswahili as a language of instruction, however it can be presumed to be one of the languages of the catchment area in urban areas, and can be used as a medium of instruction in lower primary. The competition between English and Kiswahili has risen ever since the latter was given a new impetus and re-affirmed as a national language of the Republic of Kenya, apart from being declared the official language alongside English (GOK, 2010).

The teaching and learning of English in Kenyan primary schools faces a lot of challenges; apart from learning English, pupils have also to learn Kiswahili as a subject in addition to the various mother tongues they already are familiar with. Some scholars point out that teachers are not competent to handle multilingual classes. Obura (1986) reveals that teachers in primary school are ill prepared to cope with the demands of trilingual classrooms in primary schools leading to generally poor standards, not only in English but in other subjects too. When first learning a second or foreign language, speakers do transfer many of the characteristics of their native language into the new language, Brown, (1987) calls this interlingual transfer. This is mostly the case in the learning of English in Kenyan primary schools as pupils encounter English for the first time when they join school.

Statement of the Problem

Kenya is a multilingual society in which as Barasa (2005, p. 3) observes, "the Republic of Kenya has forty-one different linguistic groups. Nearly all the language groups have their own distinct languages, some of which are closely related"; this situation has influenced the teaching and learning of English in Kenyan schools in one way or another.

The Kenya government declared English as a medium of instruction from primary 1 after independence (GOK, 1964). This meant English was to be used for instruction in the Kenyan education system. Other indigenous languages including Kiswahili were not mentioned. This situation was reversed later through the GOK (1976) and the use of the predominant language spoken in the schools' catchment area for the first three years of primary education was introduced. English was also introduced as a subject from primary 1 to supersede the local language as the medium of instruction in primary 4. The situation still remains the same to date; this language policy implies that teachers should give instruction in the language of the catchment area from class 1 to 3 and use English as a language of instruction from class 4 onwards to institutions of higher learning, (Kembo- Sure & Webb, 2000). The language of the catchment area may be one of the over forty ethnic languages of Kenya. If this is a language other than English the official language, it is supposed to be phased out after the third year of primary schooling. In spite of the strong policy support for English, many children in Kenya have been observed not to be fluent in English, (Kembo Sure & Webb, 2000).

Pupils are exposed to several languages while in lower primary. This scenario negatively affects the pupils' proficiency in English language (Kembo, 1997). If there are several languages used at

the same time, then there is competition among the languages. One language tends to be used more than the others. This situation undermines the learning of English, thus leading to poor performance of pupils in English when in upper primary school due to limited exposure to this language in lower classes. This could be attributed to the fact that language determines how a person thinks as Tannen (2008) in Connor-Linton and Fasold (2008) observes that language frames the way a person sees the world. This is referred to as linguistic determinism; that is, the language one speaks determines how one thinks. If language shapes thought, it can be argued that it is possible for pupils to do things in the language they think in. The problem is that given the continued use of mother tongues either in the school environment or/and in class, this must surely have some impact on the teaching and learning of English. Therefore, this study set out to systematically investigate this position with a view to establish the multilingual influences on the teaching and learning of English in primary schools in Kenya.

Theoretical Issues

This study was based on the Social Constructivism and Language theory also referred to as Social Development theory of Learning by Levy Vygotsky (1978). It postulates that people use language based on various social factors within the environment and that the adult is a major facilitator and determiner in language acquisition and use. Thus the teacher in this study was viewed as the adult who should facilitate language acquisition and learning within the school environment and that there are varied factors within the school environment that determine how pupils and teachers are likely to use the various languages they are exposed to.

Materials and Methods

The study adopted the mixed method approach. Mugenda and Mugenda (2003) observe that it is advantageous because both quantitative and qualitative methods supplement each other in that, quantitative methods provide the in-depth explanation while quantitative methods provide the hard data needed to meet required objectives. The study utilized the descriptive survey design. Cohen and Manion (1992) observe that in a descriptive survey, the collection of information typically involves structured or semi-structured interviews and self-completion questionnaires among other instruments. This particular study utilised the questionnaire and interview schedule, which mainly yielded qualitative data..

In order to obtain the actual sample of schools that took part in the study, the study employed simple random sampling. Cozby (2001) observes that it is a sampling technique in which each and every member of the population has an equal and independent chance of being selected for the study. Twenty one (21) schools were selected for the study. This is 30% of the total 70 public primary schools, as observed by Kerlinger and Lee (2000), 30% is representative of the population to be studied. Stratified sampling was used to stratify the pupils into various classes, thus the selection of the standard seven stratum. Standard seven pupils were selected purposely to take part in the study because they are considered mature enough to describe their own language use patterns. Twenty standard seven pupils from each of the selected schools were randomly selected to take part in the study. The teachers who teach English in the selected schools and standard seven classes were automatically selected to take part in the study, thus the use of purposive sampling. In total, 420 pupils and 21 teachers participated in this study.

The main research instruments used were the teacher questionnaire and pupils' focus group interview. These were considered appropriate for this design because they were the most convenient to obtain data on languages spoken and used for instruction in upper primary schools and how they influence the teaching and learning of English. They mainly elicited qualitative data; however quantitative data was also obtained from some of the questionnaire items.

Results

Languages Spoken by Pupils

In the study it was established that 18 (85.7 %) of the pupils use other languages during English lessons, while 3 (14.3%) of them do not use other languages. This means that other languages find their way into the classroom discourse as summarized in Table 1.1.

Table 1.1. Pupils' Use of other Languages during English Lessons

Opinion	Frequency	Percentage
Agree	18	85.7
Disagree	3	14.3
Total	**21**	**100**

Teachers who agreed that pupils use other languages during English lessons, said pupils used these languages in group discussions during the course of the lesson, others when the content being taught was difficult; that is they resorted to ask questions in Kiswahili and mother tongue. Others used other languages during oral lessons particularly those involving the use of role play, songs and riddles. Other instances include times when the teacher introduces a media in class which the pupils did not know its name and use in English, but they knew it either in mother tongue or Kiswahili. Those teachers who disagreed that pupils did not use other languages during English lessons did not give explanations as to why that did not happen.

Influence of other Languages on Pupil's Pronunciation Competence

From the findings it was established that 12 (57.1%) of the teachers strongly agreed that the use of other languages other than English affects the pupils' pronunciation competence, 7 (33.3%) agreed, 1 (4.8%) disagreed and 1(4.8%) strongly disagreed as summarized in Table 1.2.

Table 1.2. Influence of other Languages on Pupil's Pronunciation Competence

Opinion	Frequency		Percentage
Strongly agree	12	57.1	
Agree	7	33.1	
Disagree	1		4.8
Strongly disagree	1		4.8
Total	**21**		**100**

Perceptions of Teachers on the Influence of other Languages on the Teaching and Learning of English

From the findings it was established that 13 (61.9%) of the teachers strongly agreed that other languages spoken by pupils in upper primary affected the teaching of English, 7 (33.3%) agreed, while 1 (4.8%) disagreed and none strongly disagreed as summarized in Table 1.3. It can thus be concluded that other languages spoken by pupils in upper primary affect the teaching of English.

Table 1.3: The Effect of other Languages Spoken by Pupils on Teaching of English

Opinion	Frequency	Percentage
Strongly agree	13	61.9
Agree	7	33.3
Disagree	1	4.8
Strongly disagree	0	0
Total	**21**	**100**

From the findings it was established that teachers hold varied opinions on how other languages influence the teaching and learning of English. Some of them said that other languages contribute positively towards the teaching and learning of English. Other languages make it easy for pupils to learn

English as mother tongue and Kiswahili make pupils to relate what is being taught to their background, they also cited that pupils first think in mother tongue or Kiswahili when dealing with difficult content or complicated concepts, finally some said the use of other languages makes it easy for pupils to understand content taught in class.

On the other hand, those who noted a negative influence said that other languages affected pupils' pronunciation and fluency in spoken English. This was because most pupils pronounced English words as if they were words in their native languages; other teachers said the use of other languages encouraged the pupils to translate words from either mother tongue or Kiswahili directly to English. Other teachers reported that other languages made the pupils incompetent in spoken and written English, while others said they impeded the objective of teaching English for communication as they made the pupils perceive English as a difficult subject.

Languages Spoken by Pupils and how they Influence the Learning of English

The pupils' focused group interviews revealed that the languages spoken by pupils in upper primary were mother tongue, Kiswahili and English. The order of frequency in which these languages were spoken by the pupils was; Kiswahili was mostly spoken, followed by mother tongue and English in that order. On the question, whether other languages spoken in class by pupils affect their learning and use of English, most of the pupils agreed that other languages they spoke in class affected their learning and use of English, while very few of them disagreed.

Those pupils, who reported that the other languages they spoke in class affected their learning and use of English, said that other languages interfered with the writing of English composition. They cited that during writing, they experienced serious spelling mistakes especially words that possessed confusing sounds like /p/ and /b/, /f/ and /v/, /k/ and /g/, /t/ and /d/, others said they found it difficult writing words which had sound /θ/ such as in the words fa<u>th</u>er, mo<u>th</u>er and <u>th</u>em. They reported that they wrote these words as 'fater', mater and 'tem'. Others reported that during speaking they used words from either mother tongue or Kiswahili when they did not get the correct English words to use.

Other pupils reported that their use of other languages especially Marakwet encouraged them to construct ungrammatical sentences, others explained that it made them to interpret questions poorly and hence write wrong answers and finally others said that other languages affected their pronunciation competence as they pronounced English words with deep Marakwet accent. It can thus be argued that Marakwet and Kiswahili spoken by pupils negatively influenced the learning and use of English.

Discussion

The pupils' focus group interview revealed that the languages spoken by pupils in upper primary schools were mother tongue, Kiswahili and English. Pupils were found to mostly speak Kiswahili, then mother tongue and English in that order. It was further established that pupils were mostly fluent in mother tongue, followed by Kiswahili and English in that order. It can thus be observed that linguistic competence alone does not have much bearing on the language most spoken by pupils, as it can be noted that the pupils mostly spoke Kiswahili although they were more fluent in their mother tongue. These findings support those of Kembo–Sure (1994) that linguistic competence per se is not a factor since most respondents claimed greater competence in mother tongue than Kiswahili, but use the latter most.

From the results it can be argued that the languages spoken by pupils in upper primary influence the learning of English, this can be deduced from the results of the pupils' focus group interview; most of the pupils reported that other languages they spoke in class affected their learning and use of English. On the contrary a few said that other languages they spoke did not affect their learning and use of English. Majority of the pupils said other languages they spoke interfered with their writing of composition, others reported that during speaking, they used words from either mother tongue or Kiswahili, others said, other languages made them write incorrect spelling and construct ungrammatical sentences. This confirms what Masinde (2005) established, that other languages made students to construct sentences in total disregard of English sentence structure rules. He also found out that students pronounced most of the English words with deep Kalenjin accent. He noted that this also affected their writing as most of them spelt words basing on their faulty pronunciation. These findings also support those of Saxena (2009) who found out that students in those classes which did not allow the use of Malay in class responded to questions in single words, short phrases and sometimes with silence or with some mumbling, while others provided a translation of English words in Malay. The above is reflected in the results from the teacher questionnaire which established that 18 (85.7%) of the

teachers agreed that pupils use the languages of the catchment area during English lessons, while 3 (14.3%) disagreed. This means that other languages find their way into the classroom discourse.

Those teachers who reported that pupils use other languages during English lessons said pupils did so when they were having group discussions. They also reported that the pupils also asked questions in mother tongue and Kiswahili when they found the content being taught was difficult. This is supported by Crystal (1987) who argues that speakers switch from one language to another because a speaker may not express himself or herself in one language so switches to the other to compensate for the deficiency.

This view however, seems to be contrary to that of other scholars like Cummins (1984), who believes that optimal first-language education provides a rich cognitive foundation that prepares for the acquisition of the second language, this means that the pupils can use either Kiswahili or mother tongue to assist in the learning of English, which in this case is the second language. This view is shared by Obura (1986), who recommends more imaginative methods of language teaching and materials production using locally available resources.

Based on the study theoretical framework, the findings established that 18 (85.7%) of the pupils use other languages during English lessons. These languages are mother tongue and Kiswahili. Teachers reported that pupils use these other languages when they were having group discussion during the course of the lessons, they also used them when they found the content taught by the teacher difficult; they asked questions in either Kiswahili or mother tongue. According to the teachers, other languages spoken by pupils in upper primary schools assist the pupils to learn English as they resorted to either Marakwet or Kiswahili whenever they encountered difficulties in English. Teachers reported that pupils first thought in Marakwet or Kiswahili when dealing with difficult content or complicated concepts. It can thus be posited that the different languages spoken by pupils in upper primary schools influence the way pupils think.

Conclusion

From the findings of this study, it can be concluded that other languages; Kiswahili and Mother tongue find their way into the classroom discourse. Pupils' use of languages other than English affects their pronunciation competence. Other languages spoken by pupils in upper primary school affect the teaching and learning of English and interfere with their writing of English composition hence make them incompetent in both spoken and written English.

Recommendations

Teachers, as role models, should strive to use English all the time and minimize the use of other languages, if necessary, in their interaction with pupils, both in and outside classroom settings. Teachers should also promote English language proficiency among the pupils in order to enhance the teaching and learning of English in school curriculum. Finally, teachers should formulate school language policies to be adhered to by pupils in order for meaningful teaching and learning of English to take place.

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Determinants of Smallholder Dairy Farmers Access to Credit: A Case of Uasin Gishu County

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Abstract

In Uasin Gishu County, smallholder dairy farming is of great importance as it provides a means of livelihood. Among other constraints, lack of finance is one of the fundamental problems plaguing dairy productivity and denying stabilising household income amongst the smallholder farmers. A substantial increase in provision of financial services by financial institutions to the smallholder dairy producers has been recorded in the recent past. However, there is limited information on their effective facilitation on access to credit and ultimate impact on performance in dairy production in Uasin Gishu County. The main objective of this study was to ascertain socio-economic factors that affect smallholder dairy farmer's access to formal and informal credit and also to evaluate its impact on animal performance in Uasin Gishu County. A sample of 64 smallholder dairy farmers was selected from Eldoret East, Eldoret South and Eldoret North districts of the County. Determinants of access to credit were estimated using descriptive statistics. The significant socio-economic determinants influencing borrowing were gender, age, marital status, religion, education, family size, farm size and interest rate. Results also revealed that access to credit enhanced animal performance and increased household income. Results obtained further indicated that commercial banks remain leading source of credit and, closely followed by friends, neighbours and relatives, with least attractive source being money lenders and traders. It is concluded from the study that socio-economic factors and collateral were highly important in influencing access to credit. Therefore, policy aimed to accelerate dairy productivity in Uasin Gishu County could be successful if these factors and problems are taken into consideration to access credit from both the formal and informal financial sources.

Keywords*: Determinants, Credit, Dairy, Uasin Gishu*

Introduction

The credit accessibility by rural households has increasingly been regarded as an important tool for raising the incomes to meet short-term requirements for working capital and for long-term investment in agriculture. Access to credit by smallholder dairy farmers is, by and large, seen as one of the constraints limiting their benefits from credit facilities. Smallholder dairy farming is often defined to include family farming, subsistence farming and low-income farming owning between one to three dairy cows. This sector is faced by various production constraints such as low reproductive performance, calf mortality, low growth rate and weight gain that requires working capital obtained from credit institutions. They comprise the largest group of the rural and peri-urban population, who are still poor, but actively trying to earn a significant part of their livelihood from farming activities. Thus, they are by far the most challenging potential client segment for the providers of financial services (Boucher *et al*., 2005b). However, smallholder dairy farmers of the country who do not have access to capital, encompasses the largest portion of the population. This lack of access to financial services is one of the reasons for rural households to live in the vicious circle of poverty for long period. The formal financial sector in Kenya has stringent lending conditions and therefore will not provide their services to the rural poor farmers.

According to Conning *et al* (2005), access to credit occurs when there is no non-price or credit rationing. Credit rationing is defined as a restriction of credit availability: the restriction or refusal of the availability of credit, even when an applicant is willing to pay more than existing borrowers, or when he/she cannot obtain the credit required. Access to credit can therefore be defined to include availability of finance, that is, when needed/desired, convenience, continuity and flexibility are guaranteed, and willingness to pay the price of the loan. Alternatively, access to credit can also be defined as a situation in which a borrower is able to obtain some amount of capital, either in cash or kind, regardless of his/her willingness to pay a higher price for credit, referring to an interest rate at which a loan is granted, from the particular source of capital, though he/she may choose not to borrow. Therefore, a household has access to a particular source of credit if it is able to borrow from that source. The extent of access to credit is measured by the maximum amount a household can borrow, that is, its credit limit. If this amount is positive, the household is said to have access to credit. Agricultural activities in rural areas are typically seasonal, and households need credit to smooth out seasonal fluctuations in earnings and expenditure. Agricultural dairy production is strongly conditioned by the fact that inputs are transformed into outputs with considerable time lags (Conning *et al*., 2005), causing the rural household to balance its budget during the season when there are high expenditures for input purchases and consumption and few revenues. Moreover, rural households need credit for other different types of consumption. These include expenditure on food, housing, health and education.

However, in most cases the access problem, especially among formal financial institutions, is one created by the institutions mainly through their lending policies. This is displayed in the form of prescribed minimum loan amounts, complicated application procedures and restrictions on credit for specific purposes (Schmidt & Kropp, 1987). For smallholder dairy farmers, reliable access to short-term and small amounts of credit is more valuable, and emphasizing it may be more appropriate in credit programmes aimed at such enterprises. Credit duration, terms of payment, required security and the provision of supplementary services do not fit the needs of the smallholder dairy producers, which renders them to be credit constrained, that is, they lack access to credit or cannot borrow as much as they want. Therefore, the budget balance within the year can become a constraint to dairy production and household income for consumption and welfare outcomes. When liquidity is a binding constraint, the amounts and combinations of inputs used by a farmer may deviate from optimal levels that in turn limit the optimum production or consumption choices. The marginal contribution of credit accessibility therefore brings input levels closer to the optimal levels, thereby increasing yield and output (Feder *et al*., 1990). In view of this, credit inaccessibility has significant adverse effects on farm dairy output, farm dairy investment, and farm dairy profit (Carter & Olinto, 2003). As is the case in many agricultural enterprises, smallholder dairy producers have been suffering from a lack of access to credit for capital (International Fund for Agricultural Development, 2001).

Despite the importance of smallholder dairy farming in Kenya, the strategic conceptual and empirical analysis in the context of the credits, which would guide policymakers and development practitioners in their efforts to revitalize dairy production through access to credit, is sparse. Knowledge in this area, especially a quantitative analysis of the main pre-requisites for accessibility to credit and the choice of credit sources is fragmentary. Further, there is limited knowledge on the extent to which socio-economic factors influence access to credit by smallholder dairy farmers. There is, therefore, need to analyse the access to credit in the formal and informal credit associations with the view of establishing their role in determining the access to credit. The main objective of this study was to ascertain socio-economic factors that affect smallholder dairy farmer's access to formal and informal credit in Uasin Gishu County.

Materials and Methods

Many surveys on formal and informal credit sources in Kenya have been mainly qualitative in nature (Daniels *et al*., 1995). Zeller *et al* (1997) used a univariate probit model to estimate the factors that determine an individual's borrowing decisions, in terms of their participation in informal credit markets. The results from several studies have always shown that among the formal and informal lenders, age, schooling, wage income, sick days and household headship are significant determinants of applications for credit. On the other hand, gender and social events are not significant. Age, the years of schooling and the ratio of outstanding loans increase the probability of being supply constrained. Higher household wealth reduces the probability of being constrained.

Conceptual Framework

A number of conceptual difficulties have been identified in estimating credit demand, especially in fragmented markets with imperfect information. In most models where there is the possibility of loan default due to imperfect contract enforcement, and an upward sloping supply curve, it is assumed that lenders offer borrowers a choice of points on the supply curve, to which they are restricted. It therefore becomes difficult to identify the loan demand schedule using information on observed loan amounts since this reflects only the existing supply. The credit demand function can only be identified from the borrower's participation decision; namely, the decision to borrow or not and from which sector to borrow. Apart from the conceptual difficulties in identifying demand for credit, Nagarajan *et al.* (1995) note that estimates of loan demand are often biased because they use models that do not adequately correct for selectivity bias or they use data that do not account for the existence of multiple loans.

Data Types, Data Sources and Data Collection Methods

In this study, data were collected on all loans from different formal and informal credit institutions available to the smallholder dairy farmers. Structured questionnaire was prepared to collect quantitative data for the study. Primary data sources were the sample farm households both male and female headed from different key informants. The questionnaire was pre tested to evaluate for consistency, clarity and to avoid duplication and to estimate the time requirement during data collection. To achieve the stated objectives, the study used descriptive methods. The study used mainly primary data from individual smallholder dairy farmers receiving credit from formal and informal credit institutions as well as those who did not. Informal finance has been used to refer to all transactions, loans and deposits occurring outside the regulation of a central monetary or financial market authority (Aryeetey & Udry, 2000).

Data Analysis

Qualitative data that were obtained by observation and interview were organized in the field. Data collected on factors influencing credit access was analysed using descriptive statistics such as means, percentages, tabulation, ratios and frequency distribution. Further, the t-test and Chi-square statistics were employed to measure the mean and percentage differences of the study. A binary logit, model which best fits the analysis for determinant factors that affects small holder dairy farmers' access to credit was employed (Yehuala, 2008).

Sampling Frame, Target Population and Research Sample Size

The target population or population of interest of the study was made up of all smallholder dairy farmers in entire Uasin Gishu County. The sampling frame was identified using all smallholder dairy farmers based on ownership of 1 to 3 dairy cows. This was those farmers who own at least a piece of land measuring not more than 2.5 acres, or, those who are living in rental houses but rearing dairy cattle and those who have no land but depend on road reserves as their grazing fields in the study area. Then sample farm households were taken farm households with a total of 64 farm households.

Results and Discussion

Demographic Characteristics of Sample Households

Table 1 shows the family size of the sample respondents. Accordingly, the average family size of the sample respondents was found to be 2 persons. The largest family size was 5 and the smallest was 1. The result from the table shows that from the total sample households about 60.9 percent of the respondents had the family size that ranges from 3-5.

Table 1. Family Size of the Respondents

Family Size	Credit users	
	N	%
1-2	4	6.3
3-5	39	60.9
6-8	17	26.6
9-10	2	3.1
>11	2	3.1
Total	64	100.0

Source: Survey results (2013)

With regard to sex the sample was composed of 75% male headed households and 25% female headed households (Table 2). The implication is that male headed households had more access to credit from the formal and informal financial sources. About 6.3 per cent of the sample households were illiterate, while 23.4 per cent of the sample households were primary. At the same time, 26.6 per cent of the sample households were secondary, 29.7 per cent college and 14.1 per cent university. This may probably mean that farmers with primary and above level of education have more exposure to the external environment and information that assists them easily access to sources of credit. Of the total sample respondents 17.2, 73.4, 4.7, 4.7 per cent of respondents were for single, married, divorced and widowed respectively (Table 2). This may imply that married farmers are more stable and focused than other groups. According to the survey result, 85.9 per cent of the sample respondents were Christians, 3.1 per cent Muslims and 10.9 per cent none Christians (Table 2). The percentage difference between religions in household heads in terms of faith mean that access to use credit could probably be influenced by their strong hope in succeeding. It was apparent in the results of the study that other sources of income were embraced to compliment income from dairy production. The survey result found out that 39.1 per cent of sample households also carried out small business. On the other hand, 9.4 per cent of sample households were dairy farmers who are also teachers. Among those sample respondents who owned land, 59.1% had land measuring 2.1-2.5 acres, while those who owned land measuring <0.5 acres were about 2%. Implying that probably those with land measuring 2.1-2.5 acres were able to access credit with ease.

Table 2. Demographic Characteristics of Sample Household Heads

Characteristics	Respondents (N=64)	
	N	**%**
Sex:		
Male	48	75.0
Female	16	25.0
Literacy level:		
Illiterate	4	6.3
Primary	15	23.4
Secondary	17	26.6
College	19	29.7
University	9	14.1
Marital Status:		
Single	11	17.2
Married	47	73.4
Divorced	3	4.7
Widowed	3	4.7
Religion:		
Christians	55	85.9
Muslims	2	3.1
None	7	10.9
Income from non-dairy activities:		
Small business	25	39.1
TSC	6	9.4
Civil servants	22	34.4
Private employee	11	17.2
Size of land in acres:		
0.5	2	3.1
0.6-1	6	9.4
1.1-1.5	6	9.4
1.6-2	19	19
2.1-2.5	31	59.1

Source: Computed from the field survey data, 2013

Source of Credit

Table 3 below shows 25% of the respondents interviewed were getting their credit from commercial banks, while 23.9% get credit friends, relatives and neighbours and 18.5% get their credit from ASCAs & ROSCAs, 15.2% get their credit from coop. Societies and MFIs.

Table 3. Sources of Credit

Credit source	Frequency	Percentage
Private moneylenders	2	2.2
Friends, relatives, neighbours	22	23.9
ASCAs & ROSCAs	17	18.5
Coop. Societies	14	15.2
MFI	14	15.2
Banks	23	25
Total	**92**	**100**

Source: Computed from the field survey data, 2013

Private Moneylenders

It is the lowest most attractive source of credit in the study area. The source of private moneylenders consists of those farmers who are better-off, tradesmen, and rarely government employees. The transactions are; private moneylenders provide cash advance before the milk is paid for by private buyers or milk processors and borrowers are then expected to repay in cash at the end of the month. However, low attraction to credit is probably due to characterized with higher interest rate (equal or greater than 100%). It was identified that sometimes there is a risk of default in case of drought and milk shortage due to a cow drying up.

Friends, Relatives and Neighbours

In Kenya, where there is a long tradition of mutual assistance, individuals who need funds call on friends, relatives and neighbours for help. Acceptance of such help, however, obligates the borrower to reciprocate by providing non-financial services or by supplying funds in turn when the lender needs to borrow. Lending between friends and relatives often carries low interest or no explicit interest charge. And oral promise, confidence, trust and mutuality are frequently all that is needed as collateral or security. In the study area friends, relatives and neighbours are the second most important sources of credit (Table 3). The credit from friends, relatives and neighbours was used for different purposes, like production, meeting consumption demands and social obligations. It is a custom of the people in the area to assist each other to smooth seasonal milk and cash flows. Credit from this source is not tied with any collateral requirements and no interest is charged from this source in the area.

Rotating Savings and Credit Associations (ROSCAs) and Accumulating Savings and Credit Associations (ASCAs)

ROSCAs are a form of social organization in which members come together for the purpose of savings in cash or in kind. The normal practice is that members contribute money or material on a monthly or a weekly basis, and lots are drawn every month so that the one who wins the chance gets the total sum. **ASCAs** are a type of traditional organization in which a small fraction of money is collected from members whose aim is to provide mutual aid and financial support under emergency situation. Though it is not common in the farming community, there are small numbers of accumulating savings and credit associations in the study area. It rarely provides cash in credit basis for members. ROSCAs and ASCAs are the third most important sources of credit in the study area.

Banks, MFIs and Cooperative Societies

Credit from these sources is tied with collateral requirements and interest is charged from this source in the area. However, banks remain most important source of credit in the study area with 25%. MFIs and coop. Societies tied with 15.2% in the context of popularity among the borrowers. This is probably associated with accessibility and availability of their services despite high interest rates.

Reasons for Borrowing

In the study area, sources of credit and the percentage share of borrowing money varied from institution to institution and the purpose of borrowing too. For instance, households who have borrowed

from credit sources used almost equal proportion for education (26.8%), purchase of in-calf heifers (21.4%), land operations (16.1%) and purchase of dairy feeds (12.5%) purposes respectively.

Table 4. Reasons for Borrowing in the Smallholder Dairy Farmers

Purpose for loans	Frequency	Percentage
Land operations	9	16.1
Purchase of in-calf heifers	12	21.4
Purchase of dairy feeds	7	12.5
Veterinary and AI services	5	8.9
Purchase of households	4	7.1
Health	1	1.8
Education	15	26.8
Social ceremonies	3	5.4
Total	**56**	**100**

Source: Computed from the field survey data, 2013

Constraints Limiting Credit Accessibility

Credit accessibility and factors affecting it were other features which this study undertook. These factors which were considered included high interest rates (60.9%), closely followed by inflexible repayment period (20%), demand for collateral (10.9%) and late loan approval and release (8.2%). Implication is that credit access from specific credit sources plagued by the above constraints may mean that the loans from them are not satisfying the credit requirements of smallholder dairy farmers in the study area.

Table 5. Constraints Limiting Access to Credit from Credit Sources

Credit source	Frequency	Percentage
High interest rates	39	60.9
Inflexible repayment period	13	20.
Late loan approval and release	5	8.2
Demand for collateral	7	10.9
Total	**64**	**100**

Source: Computed from the field survey data, 2013

Conclusions and Recommendations

From the results access to credit enabled smallholder dairy farmers to purchase in-calf heifers, dairy feeds or land operations, thus assisting to promote increased productivity and dairy production. Socio-economic factors played key role in determining access to credit among the dairy farmers. However, factors that affect participation in credit among households were high interest rates and inflexible repayment period. Likewise late loan approval and lack of collateral were additional constraints in accessing credit. Nowadays lending based on membership to ROSCAs and ASCAs becomes the most important method of providing rural credit to the poor who could not bring material collateral. However, poor farmers especially the very poor farmers find this type of lending inconvenient to access credit since they are rejected from the group by others. Therefore, there should be a policy environment whereby individuals may have access to ROSCAs and ASCAs credit, having advanced working capital by the government and without forming groups with savings as an initial requirement. Further, the results of the study revealed that most of the households borrowed relatively banks. Hence, there is need to formulate policies of agricultural credit whereby high interest rates and inflexible loan repayment and, even demand for collateral is addressed for smallholder dairy farmers to access credit with ease. The policies of credit like the loan size and duration should be designed according to the need of the local society, and the loan size ceiling should be flexible. Therefore, it is recommended that the government fund intervention should be injected in the whole activity to address this problem for smallholder dairy farmers' access to credit. Moreover, repayment period for smallholder dairy farmers' loans in the region is almost uniform and regular. These inflexible repayment schedules do not correspond to period of cash unavailability for the poor households. Therefore, participatory development of activity and income calendars could be used to synchronize repayment schedule with credit need and income flow of different households. The government can come up with strategy in supporting this viable intention in ensuring that loans from both informal and formal financial sector remain stable and running. Finally, the majority of the rural households, especially female headed households and the very poor farmers use credit from informal

financial sources. Therefore, high emphasis should be given in providing legal and policy framework to address the very poor and female headed households in the informal credit market.

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Determination of Optimum Dividend Policy: Empirical Evidence from Listed Firms at the Nairobi Securities Exchange (NSE) 2000-2010

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Abstract

Dividend decisions remain to be one of the most controversial subjects in corporate finance since the debate on its relevance was started by Lintner in the 1950s. Facts show that, while companies would prefer to pay dividends, they are more concerned with stability and growth of payout. Consequently, this study applied a simple linear regression model to determine stability of dividends for listed firms at the Nairobi Stock Exchange. The parameters estimated are adjustment rate and target payout ratio. Study objectives are: i) to determine the target dividend rate and adjustment rate for the market based on empirical data of listed companies for the period 2000-2010. ii) To determine the relationship between earnings and dividend policy of listed firms at the exchange. Empirical data of 40 listed companies at the Nairobi Securities Exchange was collected and analyzed statistically using a simple regression model (OLS) at the 5% level of significance for the period. Results of analysis from the empirical panel data indicate that overall, listed companies within the period had an average target payout rate of 3.5% of the changes in current earnings and an adjustment rate of 52%. The relationship between current earnings and dividend payout was positive and fairly strong (0.65) and was also statistically significant. Therefore data did not sufficiently justify dividend smoothing at the NSE. Optimum dividend policy for listed firms at the NSE is therefore determined by low target rate and moderately high adjustment rate. Consequently dividend payout is low and fairly unstable creating some uncertainty. Current earnings explained 42% of the variation in dividend payment from the sampled data.

Keywords*: Optimum Policy, Dividends, Earnings, Nairobi Securities Exchange*

Introduction

Dividend policy remains a controversial subject in corporate finance since the debate on its relevance was started by Lintner in the 1950's. Issues of dividend relevance or irrelevance have continued to be debated by various scholars in the field of finance. Modigliani and Miller (1961) posited that under perfect market conditions; where costs (taxes, transaction, agency cost) are zero and information asymmetry is nonexistent, dividend policy is irrelevant to firm value. These conditions are however unrealistic (Dhanani, 2005). As a result, dividend decisions indeed matter particularly because dividends are returns that are certain to investors. In his survey of managerial views and attitudes of corporate managers on dividend policy found that quite correctly- dividend policy serves to enhance corporate market value. It is said to take place through the stream of cash dividends that shareholders receive as interim dividend and or final/full dividend. Hence, this influences the value of a share and in turn shareholder wealth.

Dividend payment can only be possible if and when companies can afford and sustain the level of dividend payout. This means that profitability of a company should not be in doubt. Dividend payout is noted to act as a signal of confidence in the firm's future profitability and stability. Managers have all along been concerned with the stability of dividends. Dividend stability means that managers are able to maintain a given dividend trend line that is upward sloping. Investors it appears value stability possibly because this takes away any uncertainty they may have about their investment. Stability of dividends is also important to institutional investors that buy stocks of companies with a history of consistently paying dividends, like pension funds, insurance companies and savings banks. Besides, a number of companies have been observed to follow a policy of a target dividend payout ratio over the long run. This is the fraction of current earnings that is distributed to shareholders. It is given by dividends divided by earnings. Out of any targeted payout, the actual payment has also been observed to be reduced especially among publicly listed companies. This is an indication of a motive to smoothen dividend payouts by adjusting the rate by which any transitory earnings are distributed to stockholders. This rate has been termed speed of adjustment. Together with the target payout ratio, a company establishes its optimum dividend policy-either adjustment rate is significantly lower than target ratio indicating stabilization or vice versa for instability. Aivazian, Booth, and Cleary (2003) compared dividend policies between

developed and developing countries and concluded that emerging market corporations do not follow a stable dividend policy. This outcome is what motivated this study.

The paper is organized as follows; section one discusses the background and problem behind dividend payment by companies and particularly the issue of optimum dividend policy. Section two reviews literature on dividend relevance by examining the theories and concepts of dividend policy. Section three then describes the research plan and analysis carried out to determine numerical values for the coefficients for adjustment rate and target payout ratio. Finally, section four explores the results of empirical analysis and makes conclusion based on the objectives of the study.

Statement of the Problem

Several studies have been done on dividend policy with evidence suggesting that dividend policy for public companies vary from country to country. Lintner's (1956) study involving corporate managers established that paying dividends is critical for the creation of value for investors. Marsh and Marton cited in Stulz (2000) summarized Lintners findings in four stylized facts: (i) that firms have long term target dividend layout ratio (ii) that managers focus more on dividend charge than absolute levels, (iii) managers are reluctant to make changes in dividends that might have to be reversed (iv) managers increase dividends only when they feel they can maintain the increase in earnings. This study consequently intended to determine whether dividend "smoothing" is a motivation for corporate managers of listed companies at the NSE. The purpose of the study was to establish the adjustment speed and target payout for dividends at the exchange. By establishing these values, stability of dividends would be apparent for investors to make appropriate decisions regarding their investments. Corporate managers may review their approach to dividend policy with a view of maximizing shareholder value.

The overall objective of this study was to establish the optimum dividend policy for firms listed at the stock exchange (NSE). Specifically it sought to determine values for targeted payout ratio and the adjustment speed for dividends among the listed firms at NSE and to determine the relationship between current earnings and dividend policy of firms listed at the stock exchange.

Research Hypothesis

1. H_O: Optimum dividend policy by listed firms at the exchange does not indicate a smoothing motive.
2. H_O: Current earnings are not significantly related to dividend policy.

Related Literature
Dividend Policy

Dividend policy can be described as a firm's strategy with regard to paying out earnings as dividends versus retaining them for reinvestment in the firm. Three policies emerge as most widely supported in finance literature. First, is the 'Smoothed Residual Dividend Policy' which argues that dividend payment is kept at minimum. Companies using this policy delay paying dividend and do not react to short term changes in earnings. Dividend per share is kept stable and only altered if long term profitability forecast of the firm has been adjusted (Kyle & Frank, 2013).

Second policy is the 'Pure Residual Dividend Policy'. This policy compares between a firms return on equity and the rate of return that an investor could achieve if they invest their dividend in an alternative venture. By achieving a high return on equity than an equally risky investment in the market, a firm would rather reinvest dividends (plowback) rather than pay it out. Dividends can only be paid out as residual funds after the firm's capital needs have been met.

The third policy is the 'Constant Payout Residual Dividend Policy'. This policy advocates for constant dividend payout. Payout ratio is maintained constant by adjusting dividend paid out in relation to quarterly earnings results.

Theories of Dividend Policy

Dividend payout is explained by three schools of thought. First, those who believe that increasing dividends enhances firm value, second, paying out dividends reduces firm value and the middle of the road party championed by Modiglian and Miller (1961) who came up with the dividend irrelevance theory. It states that when other factors are considered fixed, an investor would be indifferent between receiving returns in form of dividends or capital gains from reinvestment. Particularly, in the absence of tax, the wealth of a shareholder remains constant regardless of payout policy as long as investment policy remains unchanged (Gordon and Shapiro, 1956). Those that subscribe to the relevance school have been categorized using different theories;

Al-Malkawi (2007) came up with the "bird in hand theory" stating that dividends are worth more than retained earnings to investors citing uncertainty of future cash flows. His theory assumes investors are risk averse preferring a predictable return on their capital.

Agency theory (Jensen and Mecklin, 1976) postulates that high payouts reduce internal resources and consequently the cost of monitoring managerial activities. The cost is transferred to lenders when capital is sourced from external sources particularly debt.

Signaling theory by Bhattacharyia, (1980) posits that dividend payment bridges the information gap between management and investors. Due to information asymmetry between investors and managers on the financial strength of a firm, companies choose to payout a dividend to send a signal to investors that their firm is financially stable and remains profitable.

The pecking order theory argues for low payout. It states that internally generated resources are a priority when sourcing funds needed for capital projects (Bradley et al, 1975) cited in Bhattacharyia (1980). Retained earnings are a cheaper source compared to external funding.

Miller and Scholes (1978) developed the tax preference theory which looks at effect of tax on clientele. He concluded that different tax rates on dividends and capital gain create different clientele. Life Cycle Theory explanation given by the Lease *et al*. (2000) and Fama and French (2001) is that the firms should follow a life cycle and reflect management's assessment of the importance of market imperfection and factors including taxes to equity holders, agency cost, asymmetric information, floating cost and transaction costs.

Catering theory given by Baker and Wurgler (2004) suggest that the managers should give incentives to the investors according to their needs and wants and in this way cater for the investors by paying smooth dividends when the investors put stock price premium on payers and by not paying when investors prefer non payers.

Dividend "Smoothing"

Lintner (1956) in his seminal paper questioned managers on their attitudes toward dividend policy and concluded that managers targeted long term payout ratio. Divided payment was found to be sticky, tied to long term sustainable earnings paid by mature companies and smoothed from year to year. Other scholars have since supported this argument (Fama & Babiak, 1968; Brar *et al.,* 2005). While literature has not adequately explained why firms are reluctant to cut dividend or even appear to smooth dividends, one of the reasons that can be attributed to this occurrence is investors' reaction to such announcement. Share value has been observed to decline by an average of 6.4% immediately after dividend omission announcement (Michaely *et al.,* 1995).

Smoothing of dividends has been explained by agency issues or information asymmetry. That in order to reduce the agency-principal conflict, dividend stability is pursued so as not to cause unnecessary price volatility for publicly listed firms due to uncertainty. Therefore, reducing uncertainty stemming from unpredictable dividend payouts make managers opt to establish a stable growth path of dividend payments.

The aim of this paper is to show whether publicly quoted firms at the NSE smoothen dividend payout or not. Smoothing dividend payout is said to be priority for public firms because they care about the volatility of stock price movement. A high adjustment rate signifies absence of smoothing while low rate would mean presence of smoothing relative to target payout ratios.

Empirical Review

Michaely and Roberts (2012) investigated how firms grouped into private and public, responded to transitory earnings in the United Kingdom. They discovered that response of dividends to transitory earnings shocks vary significantly across the three groups of firms (private, dispersed, private and public firms). They concluded that private firm's dividend policies are significantly more sensitive to transitory earnings shocks in contrast to public firms. Empirical evidence provided by Michaely et al., (2012) show that public firms follow a unique strategy of relatively numerous but small increases in their dividend coupled with a strong aversion to any negative or large changes. In their findings public firms in the UK targeted a payout ratio of 21% of any transitory earnings shock followed by an adjustment speed of 41% to smoothen the trend. Aivazian et al., (2003) indicated that for emerging markets, dividend payout depend on profitability and stability of earnings for the year in question. This means stability of dividends is not observed in these markets.

Dividend Model

The following is an econometric dividend model by Lintner (1956) illustrating how the coefficients relating to the speed of adjustment and target payout can be determined for a given level of earnings.

Δ Dividends$_{it}$ = α + σ (β_i (Profit$_{it}$) $-$ Div$_{it-1}$) + ε_{it} ....(i). This expression shows that Δ Dividend$_{it}$ is the change in dividend for firms from period t-1 to t, profit$_{it}$ is operating profit/loss and ε_{it} random error term for firm i in time t. β_i is target payout ratio which is a fraction of current profits, σ is the fraction that reduces the differences between last period's dividend and the target level in each period. This parameter matches the response of firm's dividend policies to transitory earnings shocks and is sometimes referred to as the speed of adjustment. Large values for σ suggest an erratic dividend policy, characterized by large changes driven by transitory shocks (Michealy et al, 2012). Conversely, small values of σ suggest smooth, persistent dividend policy characterized by insensitivity to transitory earnings shocks and a motive to smooth such shocks overtime. The parameters (α, σ and β_i) can be estimated for each individual firm (Brar et al, 2005). However this study mainly focused on the performance of the market as a whole to provide an overall picture of market dividend behavior.

Among public firms, a dividend smoothing behavior is evident by low values of σ (speed of adjustment). High values indicate no smoothing and thus evidence of wide swings in dividend payment. The motivation to smooth out dividend may be attributed to the scrutiny by the capital market where agency conflict and information asymmetry is prevalent. Low values for adjustment speed (σ) mean that with higher earnings shock, more of the surplus funds are retained and vice versa for lower earnings shock.

Methods

The study was designed as a regression and correlation analysis of empirical panel data of listed firms for the period 2000-2010. It is based on Lintner (1956) dividend model. It was tested by Wolmoran (2003) to establish its efficiency compared to the percentage model in explaining dividend pay out behaviour of South African firms.

Modelling for Empirical Data

Dividend policy according to the theory by Lintner depends on current earnings and previous dividends already paid (E$_1$ & D$_0$)

His model was thus;

Div$_1$-D$_0$ = adjustment rate * Target Change.

= adjustment rate* {(target ratio* EPS)- Div$_0$}..(i)

Re-writting the equation,

D$_1$-D$_0$ = a * (T*E$_1$ −D$_0$) = a T E$_1$ − aD$_0$ …….……………..(ii)

Where; a =adjustment rate

T= Target rate.

D$_1$= Current Dividend.

E$_1$= Current earnings.

D$_0$= previous dividends.

This equation was then fitted to empirical data by Wolmoran (2003) using OLS method in order to estimate values for adjustment rate 'a'and target rate 'T'. It was reconstructed to make it appear in linear form for the estimation of the parameters or coefficients. This attempt was achieved by first; dividing through by (D$_1$-D$_0$) assuming (D$_1$-D$_0$) ≠ 0. The equation becomes;

$$1 = aTE1/(D1 - D0) - aD0/(D1 - D0)$$ …………………………(iii)

Then dividing through by 'a'

$$\frac{1}{a} = \frac{TE1}{D1 - D0} - \frac{D0}{D1 - D0}$$

……...Assuming a ≠ 0… (iv)

Rearranging equation (iv)

D$_0$/D$_1$-D$_0$ = -1/a + T E$_1$/D$_1$ −D$_0$ ………………………………………………..(v)

Equation (iv) is in linear econometric form:

Y = α + βX + ε_{it}

Where; α= -1/a (adjustment rate), β= Target rate, Y = D$_0$/D$_1$-D$_0$, and X = E$_1$/D$_1$ −D$_0$,

$\varepsilon_{it=}$ error term for firm i in period t. Using D$_0$, D$_1$, and E$_1$, one can determine the values of α and β assuming α≠0 and (D$_1$-D$_0$) ≠0.

Empirical Data and Analysis

Empirical panel data of 40 companies was collected from stock market and financial reports of quoted companies based on firm year dividends and earnings for the period 2000-2010. Editing of data was done to ensure incomplete data was excluded and that $D_1 > D_0 > 0$ was also upheld for the entire duration 2000-2010. The final data yielded 106 firm-year observations from 420. Nine industries are represented namely; Manufacturing, Commercial, Insurance, Banking, Investment, Agriculture, Automobile, Construction and Energy. Statistical software (SPSS 17) was used to carry out the regression and correlation test at 5% level.

Results and Discussions

The dependent variable was dividend change (D_0/D_1-D_0), while independent variable was earnings change ($E_1/D_1 - D_0$). Results of descriptive analysis from Table 1 show that the change in dividends paid for the period had a mean of shs.1.016 while change in transitory earnings shock had a mean of shs. 14.8. In other words, for every shs.15.0 increase in earnings, additional dividends would be shs.1.00.

Table 1. Descriptive Statistics

	Mean	Std. Deviation	N
Dividend change	1.0461	1.17410	106
Change in Earnings	14.8143	21.71276	100

Table 2 below "correlations" between dividend change and change in transitory earnings shock indicate the coefficient as 0.653 which is significant. This means there is a fairly strong association between change in dividend payout and change in earnings.

Table 2. Correlations Table

		Change in Dividends
Pearson Correlation	Change in Dividends	1.000
	Change in Earnings	.653
Sig. (1-tailed)	Change in Dividends	.
	Change in earnings	.000
N	Change in dividends	106
	Change in earnings	100

The following Table (3) "Coefficients" show results of regression coefficients for the two variables under study-dividends and earnings.

Table 3. Coefficients Table

Model	Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	t	Sig.	95.0% Confidence Interval for B Lower Bound	Upper Bound	Correlations Zero-order	Partial	Part	Collinearity Statistics Tolerance	VIF
1 (Constant)	.523	.108		4.826	.000	.308	.738					
E1/ D1-D0	.035	.004	.653	8.536	.000	.027	.044	.653	.653	.653	1.000	1.000

a. Dependent Variable: change in dividends.

Estimated Equation.
$\hat{Y} = 0.523 + 0.035X_{it}$ …where X_{it} is earnings for firm i at time t.
Se=0.108   0.004
T=4.826   8.536
P=0.000   0.000

The estimated regression equation above shows that the adjustment speed is 52%. Targeted payout is 3.5% of the transitory earnings shock. This is considered a large variation signifying increased volatility in payout. Both values are also statistically significant. A similar study by Lintner (1956)

involving US firms realized a dividend speed of adjustment of 30% and a target ratio of 50% (Ahmed & Javid, 2009). From the results shown it is apparent that dividend smoothing is not a motivation for firm managers of listed companies. Managers distribute 52% of the targeted transitory earnings change (3.5%). This is inconsistent with Lintners hypothesis of dividend smoothing for US firms which returned 30% adjustment speed. The model fit was good and adequate, F =72.86 P=0.000 (Table 4, ANOVA). Therefore, results from NSE support the hypothesis by Aivazian et al (2003) that dividends in emerging markets are unstable and are guided by earnings level and stability.

Table 4. ANOVA Table

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	58.196	1	58.196	72.860	.000[a]
	Residual	78.277	98	.799		
	Total	136.473	99			

a. Predictors: (Constant), Change in earnings

b. Dependent Variable: change in dividends.

The Coefficient of determination (R^2) was 0.42, indicating current earnings and previous dividends explain 42% of changes in dividends payout (table 5 "Model summary"). A similar study in Pakistan by Ahmed and Javid (2009) returned R^2 of 39% using a random effects model (REM). Result for autocorrelation of the residuals was 1.669 (Durbin Watson d statistic). This value when placed against the critical values of d, d_L and d_u with 100 observations and one explanatory variable, falls within the confidence interval 1.654 and 1.694 respectively at 5% significance level. This means there was no evidence of serial correlation of the disturbance term. The coefficients are thus not only unbiased and consistent but also efficient.

Table 5. Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.653[a]	.426	.421	.89372	.426	72.860	1	98	.000	1.669

a. Predictors: (Constant) Change in Earnings

b. Dependent Variable: Change in dividends.

Conclusion

The findings appear to support a "pure residual dividend policy" for NSE listed firms where payout is purely a residual decision as indicated by a high adjustment speed and low target ratio. From the statistical tests, there is no sufficient evidence to support dividend stability hence no smoothing motivation for dividend policy (accept hypothesis 1). Secondly, Current earnings indeed are statistically significant in explaining dividend decisions for firms at the NSE (reject hypothesis 2). The listed firms have a low target ratio but fairly high adjustment rates of dividends from any earnings shock indicating absence of smoothing. A low target ratio and fairly high adjustment rate mean that for investors at the NSE, returns in form of dividends are not quite stable and certain. This may be explained by external capital either being uncertain or too costly in terms of restrictions and monitoring. Investors' risk and return by way of dividends is therefore marginally higher at the NSE compared to results from developed stock markets.

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Differences in Toxic Metals Bioaccumulation in Commercial Fish Species from Winam Gulf of Lake Victoria, Kenya

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Abstract

Fish have two main exposure pathways to external metal concentration: through the gills, water and diet. In freshwater, waterborne routes may be significant contributors to metal uptake in the tissues of fish. In this study, four toxic metals (Pb, Cd, Cr and Cu) were analyzed in three commercial fish species (Oreochromis niloticus, Lates niloticus and Rastrineobola argentea) relative to the metal concentration in the water to determine the metal concentration and bioaccumulation relative to changes in the external metal in Lake Victoria, Kenya under field condition. The fish were sampled at 5 sites on the lake, thus Site 1, Port Victoria; Site 2, Yala River Mouth; Site 3, Kisumu; Site 4, Kendu Bay; Site 5, Macalda.) The metals were analyzed by atomic absorption spectrophotometer (AAS). The results of heavy metal concentration in the fish are equivalent or lower than levels reported in ichthyofauna worldwide. Levels varied among tissues and species, but were seldom influenced by the gender and fish length (P > 0.05). Regression between metal levels in liver appeared stronger (R^2 > 0.6) than that between the metal levels in the whole body and in water (R^2 < 0.5) implying higher detoxification by liver and the existence of detoxification processes by the liver. However, level differences between fish from the five sites reflect differences of elemental availability and differences in uptake and/or depuration from both environments.

Keywords*: Bioconcentration, Toxic metals, Detoxification, Ichthyofauna*

Introduction

Pollution from elevated levels of heavy metals is an important environmental problem in many developed and developing countries (Davies, 1994; Ruiz, 2001; Guerra-Garcıá and Garcıá-Gómez, 2005; Hang *et al*., 2009; Bose-O'Reilly *et al*., 2010; Zheng *et al*., 2010). This holds true, particularly for Lake Victoria, the second largest fresh water body in the world. Lake Victoria, continues to receive increasing loads of various metals including lead, cadmium, chromium, zinc and copper all of which are mainly associated with various detrimental human activities within its catchment basin of Kenya (Wandiga *et al*., 1983; Onyari and Wandiga, 1989; Kishe and Machiwa, 2003; Mwamburi, 2003; Birungi *et al*., 2007; Lalah *et al*., 2008, Raburu *et al*., 2009a, b). Nevertheless, the lake constitutes a unique ecosystem inhabited by numerous endemic species of fauna and flora alongside an introduced species of fish such as *Lates niloticus.*

Like most aquatic organisms, the fish in this lake are exposed to both essential and non essential metals through their diet and media. Uptake of the metal through the gills during the physiologically important gaseous exchange is important while absorption and accumulation in the tissues depend on metals bioavailability (Rainbow & Wang, 2001). Comparative analysis of metal concentrations between closely related species living in similar geographical areas, relative to metal concentration in the environment, can allow the assessment of the influence of the environment on the metal uptake. Indeed, several studies have also demonstrated that the various organs of fish may play a major role in the bioaccumulation of metals, as these organs are deeply involved in the assimilation processes, detoxification, and storage of both essential and non-essential metals (Bustamante *et al*., 2002; Van Campenhout *et al*., 2009).

This study is focused on determining the accumulation of toxic metals in three species of fish of commercial importance from Lake Victoria (Nile tilapia [*Oreochromis niloticus*], Nile perch [*Lates niloticus*] and silver sardine [*Rastrineobola argentea*]). The *O. niloticus* and *L. niloticus*, are larger sized fish mainly for export while the latter is relatively smaller in size and is being consumed mostly by the

local communities. High concentrations of several metals, attributed to influx from surrounding geological sources and industrial activities, have recently been reported in the tissues of *R. argentea* (Ogola *et al*., 2002, Oyoo-Okoth *et al*., 2010a, b). The anthropogenic sources have so far not been delineated from the natural sources in this this species and in the other 2 study species and differential abilities of the different species to accumulate the metal contaminants is not well-known. The present study compared the capacities of three commercial species of fish (*O. niloticus*, *L. niloticus* and *R. argentea*) to accumulate four metals (Pb, Cd, Cr and Cu) in order to relate this to risk to consummers.

Materials and Methods

Study Area and Sampling Sites

Lake Victoria, the second largest freshwater body in the world (area 68,850 km^2), is generally shallow (mean depth 40 m) and lies in a catchments of about 184,000 km^2. The lake lies astride the equator between latitude 2.5^0S and 1.5^0N, and longitude 32^0 and 35^0E; shared by three riparian states (Kenya, 5% Tanzania, 50% and Uganda, 45%).

Experimental Design

In Kenya, Lake Victoria is fed by a number of large rivers in Kenya (Nzoia, Gucha-Migori, Sondu-Miriu, Mara, Yala, and Nyando) while River Nile is the single outlet. In the present study, the choice of the sampling sites along the shores of Winam Gulf of Lake Victoria was based on the anthropogenic activity profiles along the Lake Victoria coastline, which resulted in the choice of five sites (Figure 1). Site 1 (Port Victoria) is an urbanizing areas with a population of over 200,000 but is it still rural based. However, the areas receives continuous inflow of water from River Nzoia that contains inputs of industrial effluents from two sugar factories (Mumias and Nzoia), a paper mill factory (Webuye Pulp and Paper Mill) situated about 100 -200 km away from the Lake and major municipalities of Kitale (population = 712,000), Eldoret (population = 815,000), Kakamega (population = 1,660,000), and Bungoma (population = 1,630,000). Site 2 (Yala) is considered least polluted based on the population size (100,000) and lacks any industrial activity along the inflowing rivers. Site 3 (Kisumu City) has a population of about 1.2 million and is a centre of urban development with various industries and drainage of intense agriculture. Site 4 (Kendu-Bay) is a rural area with a population of about 50,000 and has light agriculture without fertilizer inputs. Site 5 (Macalda) has a population of slightly less than 100,000, rural based and currently received water passing through artisanal gold mines.
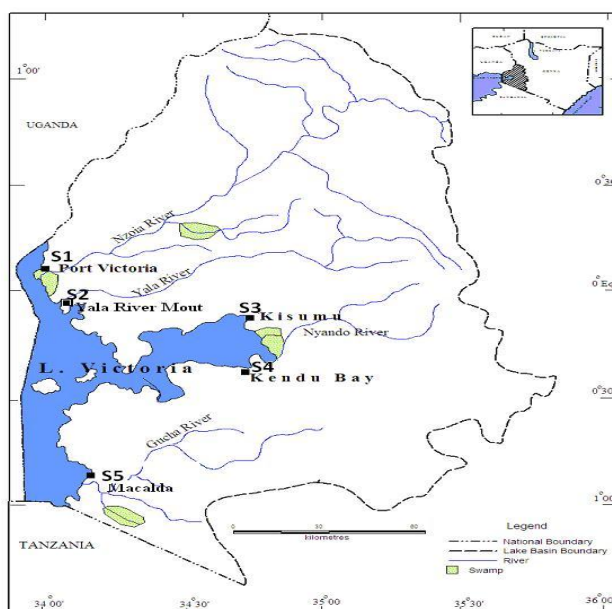
Figure 1. Map of the Study Areas Showing the Locations of the Sampling Sites

Water Sampling

A total of 60 water samples were collected at the five sampling sites (n = 12 per site). The lake water samples were obtained using 0.5 L, metal-free Van Dorn bottles. All the water samples were collected at 0.25-1.0 m depth in the lake. The water samples were then transferred to half-liter polythene

bottles pre-soaked in nitric and sulphuric acid solutions of 1:1 volume ratio, washed in 2-L of tap water and rinsed three times in distilled water dried prior to the fieldwork. The collected water samples were acidified to pH = 2 with concentrated nitric acid (APHA, 1998). The samples were then placed into an ice box and transported to the laboratory for chemical analyses.

Fish Sampling and Preparation

A total of 531 fish composed of the *L. niloticus*, *O. niloticus* and *R. argentea* were sampled in the five study sites. Each fish was measured using a meter rule. The standard length (SL) was measured on species of fish and weighed using beam balance. Individuals were sexed during dissection by gross examination of the gonads. The fish liver were removed and placed in plastic bags. White fish muscles were also sampled for analysis of metals' concentration. Samples were transported to the laboratory in coolers and kept frozen at -4°C at the laboratory. To prepare for elemental determination; livers and muscles were partially thawed out, blended, dried and ground to a fine powder. Muscles were dried in an oven at 50°C to constant mass for 72 h whereas liver samples were freeze dried.

Metal Analysis

Metals analyses of environmental and biotic tissues were performed through ultra-clean protocols. Equipment and containers were acid-cleaned and rinsed thoroughly. The samples were analyzed for total metals contents using Atomic Absorption Spectrophotometer (AAS, Model Spectra AA 10/20) at the School of Environmental Biochemical Laboratory of Moi University. A multi-metal determination of the six metals in the sample was done one metal at a time. Prior to the reading of the concentration of metals in the sample, at least three calibration standards were prepared for each metal. Each blank consisted of a mixture of 10 ml nitric acid, 10 ml sulphuric acid, 2 ml of 30% H_2O_2 and 25 ml of distilled water. The same procedure was done for various fractions. The concentrations of metals were calculated as µg/g dry weight. Accuracy and reproducibility of the preparation were tested by preparing replicates of fish muscle (NIST-CE278) reference standards (National Research Council, Canada) and blanks along with each set of samples.

Statistical Analyses

Statistical analysis was performed using the Statistica release 7. All statistical samples submitted to tests were first checked for normality and homogeneity of the variances by means of Shapiro-Wilk and Bartlett tests, respectively. In the case of non-departure from normality, parametric tests were used in the subsequent analysis; otherwise, non-parametric analogues were used. Metal concentrations in the biota were statistically analyzed using a one-way ANOVA. Post-hoc HSD was used for Post-hoc discrimination between the means. The relationships between metal concentrations in the water and the fish tissues were analyzed using linear regression analysis. In all statistical tests, the 5% significance level was applied. To relate the heavy metal accumulation of fish from the water source, the formula for the Bioconcentration factor (BCF) was used as:

$$BCH = \frac{\text{Metal concentration in fish}}{\text{Metal concentration in water}}$$

Results

Results of the total concentration of the heavy metals in water are shown in Table 1. Several samples of Pb in site 2 and 4 were below detection limits and therefore Pb was not used in subsequent analysis. The concentrations of Cd, Cr and Cu in the water samples were significantly different between the sampling sites (P < 0.05). The water samples from sampling site 3, which is located near an urban area, contained significantly (P < 0.05) higher Pb, Cd and Cr concentrations than the other sampling sites. In contrast, the Cu concentration was elevated for sampling site 5, than all the other sampling sites.

Table 1. Total Metal Concentration (µg/L) in the Water of Lake Victoria

| Metals | Sampling sites | | | | |
	1	2	3	4	5
Pb	0.06 ± 0.005[b]	0.03 ± 0.007[a]	0.09 ± 0.023[c]	0.03 ± 0.06[a]	0.04 ± 0.002[a]
Cd	0.07 ± 0.19[a]	0.05 ± 0.06[a]	0.22 ± 0.15[c]	0.06 ± 0.15[a]	0.11 ± 0.14[b]
Cr	0.18 ± 0.02[a]	0.19 ± 0.02[a]	0.47 ± 0.12[c]	0.34 ± 0.07[b]	0.36 ± 0.06[b]
Cu	0.29 ± 0.33[b]	0.17 ± 0.13[a]	0.32 ± 0.82[b]	1.21 ± 1.75[c]	3.56 ± 0.98[d]

Site 1, Port Victoria; Site 2, Yala River Mouth; Site 3, Kisumu; Site 4, Kendu Bay; Site 5, Macalda. Similar lettering represents concentrations that do not differ significantly (P > 0.05).

The concentration of metals in fish species of Lake Victoria were then determined (Table 2). In both species of fish, highest concentration of Pb, Cd and Cr occurred in site 3. Generally, *R. argentea* had accumulated higher concentration of all metals than both *O. niloticus* and *L. niloticus*.

Table 2. Concentration of Heavy Metals in the Muscles of Three Commercially Important Species (in mg/l) Sampled from Five Sites in Lake Victoria

		Sampling sites				
	Meta	1	2	3	4	5
Oreochromis niloticus	Pb	0.25 ± 0.08^a	0.25 ± 0.07^a	0.94 ± 0.22^c	0.46 ± 0.14^a	0.39 ± 0.03^b
	Cd	0.11 ± 0.06^b	0.08 ± 0.05^a	0.18 ± 0.03^c	0.12 ± 0.04^b	0.09 ± 0.14^a
	Cr	1.38 ± 0.26^b	0.95 ± 0.34^a	2.96 ± 0.47^c	1.34 ± 0.14^b	1.01 ± 0.45^a
	Cu	5.02 ± 1.29^c	3.12 ± 0.89^a	6.92 ± 2.19^d	4.33 ± 1.72^b	6.71 ± 2.57^d
Lates niloticus	Pb	0.48 ± 0.01^a	0.47 ± 0.01^a	0.91 ± 0.03^c	0.09 ± 0.02^a	0.11 ± 0.02^b
	Cd	0.12 ± 0.14^b	0.06 ± 0.13^a	0.16 ± 0.29^c	0.11 ± 0.14^b	0.07 ± 0.12^a
	Cr	1.28 ± 0.12^b	1.19 ± 0.32^a	2.51 ± 0.35^c	1.29 ± 0.04^b	1.21 ± 0.03^a
	Cu	5.17 ± 0.95^b	4.41 ± 0.89^a	6.58 ± 2.24^c	7.43 ± 0.75^d	9.79 ± 0.34^e
Rastrineobola argentea	Pb	0.23 ± 0.11^a	0.24 ± 0.12^a	0.89 ± 0.21^c	0.35 ± 0.09^b	0.33 ± 0.08^b
	Cd	0.22 ± 0.2^a	0.21 ± 0.13^a	0.57 ± 0.06^c	0.28 ± 0.07^b	0.23 ± 0.05^a
	Cr	1.92 ± 0.24^b	1.93 ± 0.26^b	3.91 ± 0.46^d	2.87 ± 0.12^c	1.53 ± 0.31^a
	Cu	13.61 ± 5.92^a	17.43 ± 4.68^a	25.3 ± 4.99^b	28.4 ± 9.2^b	49.32 ± 13.7^c

Site 1, Port Victoria; Site 2, Yala River Mouth; Site 3, Kisumu; Site 4, Kendu Bay; Site 5, Macalda. Similar lettering represents concentrations that do not differ significantly ($P > 0.05$).

The calculated BCF in the three species of fish at the four sampling sites in the muscles and liver of the fish is provided in Figure 2. With few exceptions, *R. argentea* accumulated more metals in the muscles and liver than the other three species of fish. In the muscle, highest accumulation of Cd and Cr occurred in site 2 while highest accumulation of Cu occurred in site 1. In the liver, highest accumulation of all metals occurred in site 2 while the least Cu BCF was recorded in site 5.
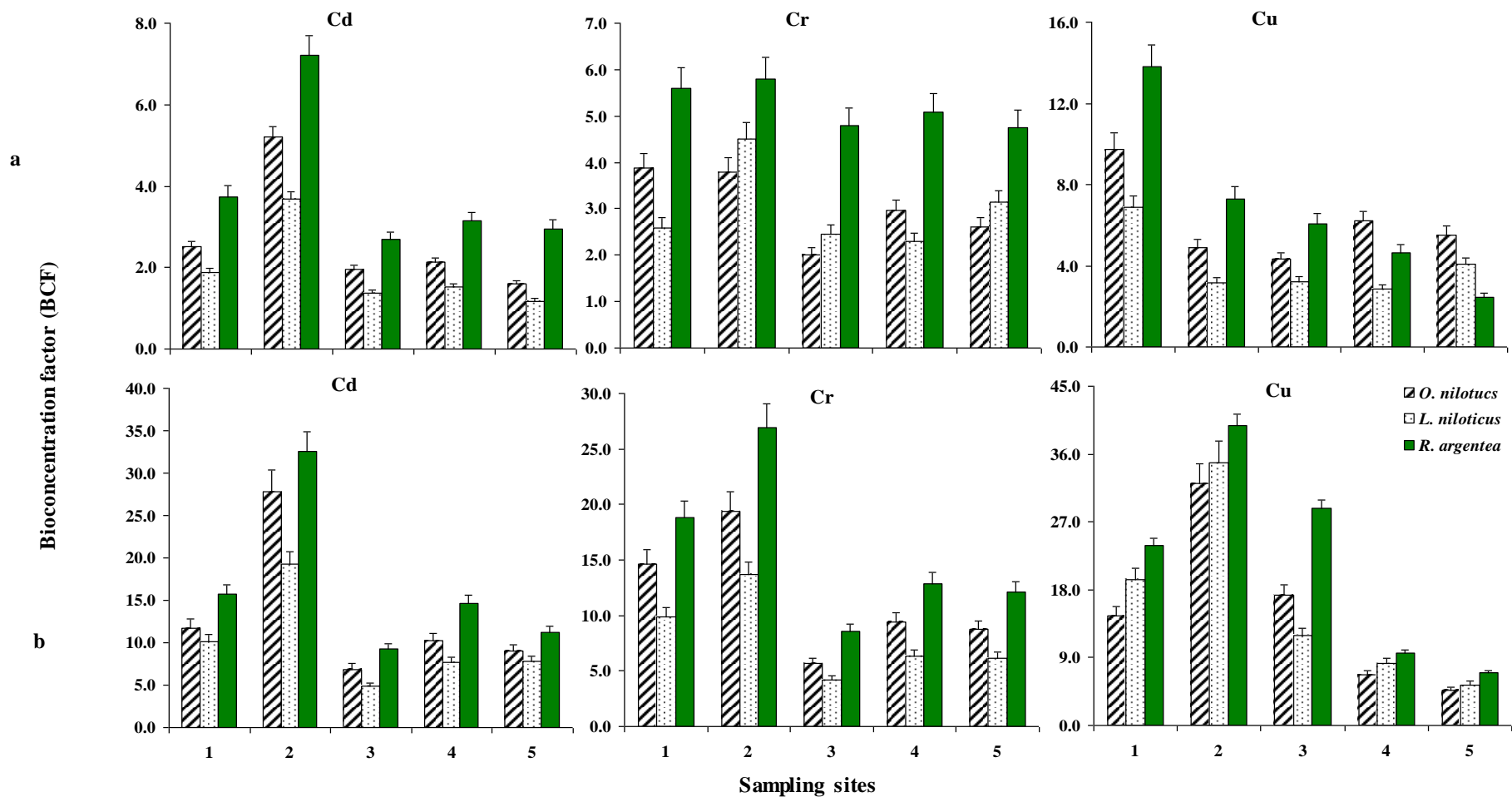
Figure 2. Bioconcentration Factors of Specific Heavy Metals in (a) the Muscle and (b) Liver of the Three Commercial Fish Species Sampled in Lake Victoria

The linear regression between metal concentrations in the whole body of different species of fish and in water is shown in Figure 3. Signficant (P < 0.05) positive correlation between Cr in the fish and in water was observed for all species of fish in the order *R. argentea > L. niloticus > O. niloticus*. There were weak but significant (P < 0.05) correlations between Cd in the fish and in the water only for *R. argentea*. Significant negative correlations between Cu in the fish and in the water were recorded for all the species in the order of decreasing strength as: *R. argentea > L. niloticus > O. niloticus*. There were no significant differences in the correlation between metals in the whole body with that of water in the fish (P > 0.05).

Metal concentration in water (µg/L dw)
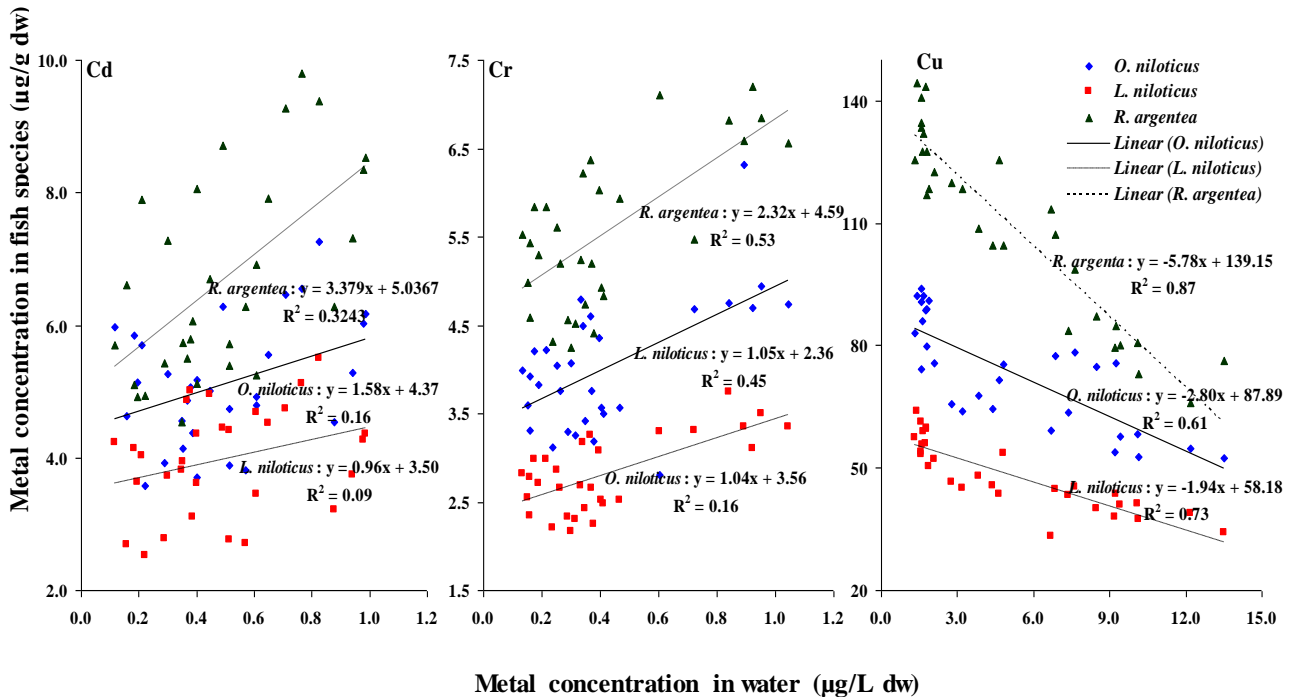
Figure 3. Linear Regression between Metal Concentrations in the Whole Body Tissues of Different Species of Fish (n = 30). For all the analysis P < 0.05

Discussion

The concentration of the four analyzed toxic metals in water displayed significant spatial distribution, suggesting differences in the input or enrichment by toxic metals in water. Differential enrichment of the water and other compartments with external source of metals has previously been established in Lake Victoria (Mwamburi, 2003). The elevated Pb and Cr and Cd in site 3 were linked to effluents discharged from nearby Kisumu City. However, the elevated Cu in site 5 was associated with geological sources from the catchment basin (Ogola *et al*., 2002). The differences in the enrichment of the water body have progressively resulted in increased levels of heavy metals in this lake over the past 20 years (Onyari & Wandiga, 1989; Mwamburi & Oloo, 1995; Kishe & Machiwa, 2003). It is this progressive increase of metals in water that continues to affect the organisms living in the waters of Lake Victoria and therefore worthy of ecological investigations.

The concentrations of metals in Lake Victoria fish species were similar to the patterns of metal enrichment in water and sediments. In all the three species of fish, the highest concentration of Pb, Cd and Cr occurred in site 3 near the urban Kisumu City probably due to continued discharge of contaminants from the high urban population and industries. The higher concentration of Cu in all the fish species in site 5 appear to be related to geological enrichment as was previously determined for humans in the area (Ogola *et al*., 2002). Clearly, fish accumulate a number of metals from the environment, with *R. argentea* accumulating higher concentration of all metals than both *O. niloticus* and *L. niloticus;* while *O. niloticus* accumulate more metals than *L. niloticus*. The consistent patterns of metals accumulation among the fish species appear related to body size of the fish, which followed: *L. niloticus > O. niloticus > R. argentea*. It is also possible to suggest that the pelagic nature of *R. argentea* where it feeds on the sediments and on zooplankton could have resulted to more metal accumulation in the fish because sediments contain more

metals than water column. Also, the zooplankton contains more metals than phytoplankton due to possible trophic transfers. Moreover, there are a number of factors that can also explain bioaccumulation of metals in fish including age, ecological conditions, predation pressure, reproductive levels, time of sampling, parasitization (DeForest *et al*., 2007), and therefore the main response factor for the metal accumulation in *R. argentea* is still unclear.

Results of the linear regression between metal concentrations in the whole body tissues of different species of fish and in water suggested that there was active uptake of Cd and Cr from the water by the fish species although *R. argentea* appeared to absorb more of the metals from water than the other species of fish. This suggest that waterborne routes is a major source of Cd and Cr in the fish tissues of the species of fish and that *R. argentea* appear to lack mechanisms to detoxify the metals or they accumulate metals more rapidly. Again the reason for the efficient elimination of Cu in *R. argentea* than other metals in increasingly contaminated environment remains unclear.

Conclusions

This study aimed at determining the bioconcentration of metals in the commercial species from Winam Gulf of Lake Victoria, Kenya. First the enrichment of the water followed patterns of anthropogenic influences where the site situated near an urban centre had higher concentration of Pb, Cd and Cr than other sites with Cu being highest in site with high geological Cu concentration. This pattern of heavy metal enrichment in water was similar in the three commercial fish species indicating uptake of metals from water at higher concentrations by the fish, even though *R. argentea* appeared to accumulate more metals from the aquatic environment than the other two species of fish. When correlation of metals in fish muscles and liver were performed against the concentration of metals in water, there were significant correlations between Cd and Cr in fish muscle and in water suggesting uptake from the aquatic environment relative to increase in external metal concentration. The uptake of metals from the water appeared stronger for *R. argentea*. Thus uptake of metals in water appeared to be species specific for essential and non essential metals. Given the ability of fish to increase their metal concentration due to increased metal in the aquatic environment, calls for broader policy aimed at controlling metal influx into the environment to control continued metal uptake by fish.

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Ecological Dynamics and Cultural Control of Eucalyptus Gall Wasp, *Leptocybe invasa* Fisher & *La Salle*

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Abstract

'Leptocybe invasa' Fisher & La Salle (Hymenoptera: Eulophidae) has been recorded in many tropical and sub-tropical regions of the world as a gall wasp attacking 'Eucalyptus' species. It completes much of its life cycle inside eucalyptus tissue thus hampering chemical control. These investigations were done to gather ecological information needed to make 'L. invasa' amenable within eucalyptus agroecosystems: (1) cues for 'L. invasa' oviposition in relation to olfaction and visual stimuli; (2) foraging and patch use by adult L. invasa; (3) plant host condition in relation to successful attack by 'L. invasa'; and (4) variability of 'L. invasa' attack between major Eucalyptus species. Caged, infested 'E. saligna' seedlings were used as sources of 'L. invasa' while caged healthy seedlings were used in 'L. invasa' ecological experiments with mean gall numbers per seedling as response variables. More eggs were laid by 'L. invasa' in response to oviposition cues in relation to olfaction stimuli than visual stimuli (p < 0.05) and patch residence time was greater than time spent in foraging from patch to patch (p < 0.05). Low nitrogen fertilization and moderate watering regime lowered the severity of attack by the pest (2.6 ± 0.9 galls per seedlings; p < 0.05). E. 'saligna' was the most susceptible species to 'L. invasa' attack (15.43± 0.29 galls per seedling) compared to E. globulus and 'E. citriodora', having only 0.86±0.07 and 0.94±0.07 galls per seedling respectively. The variability in 'L. invasa' attack between the major Eucalyptus species was significant (p < 0.05). Use of resistant Eucalyptus species like, 'E. camaldulensis'; having polycultures; and low application of N-fertilizers and moderate watering regimes have been recommended as cultural control strategies against 'L. invasa' gall wasp.

Keywords: *Eucalyptus, Leptocybe invasa, gall wasp.*

Introduction

Leptocybe invasa Fisher & La Salle (Hymenoptera: Eulophidae), commonly known as the blue-gum chalcid, is an invasive, gall-inducing insect pest of *Eucalyptus* trees (Myrtaceae), particularly *E. saligna*, *E. grandis, E. robusta* and *E. camaldulensis*. It is widely recognized in many tropical, sub-tropical and Mediterranean regions of the world as a gall inducer attacking *Eucalyptus* species, particularly seedlings (Ananthakrishnan, 2009; Hesami *et al.,* 2005). It induces galls on leaf midribs, petioles and twigs or stems, particularly of new re-growths. Repeated pest attack leads to twisted and knobbed appearance of the leaves. In East Africa, the pest was first reported in western Kenya and eastern Uganda in 2002. By 2007 it had spread to southern parts of Africa, including South Africa (Mendel *et al.*, 2004; Gupta & Poorani, 2009).

Eucalyptus is the third widely grown plantation tree genus in Kenya, after *Pinus* (Pineaceae) and *Cupressus* (Cupressaceae). It is estimated that 15,000 ha of Eucalyptus are grown by Kenya Forest Service (KFS) and 35,000 ha by private sector while small-scale farmers, urban and county councils have also put substantial areas of land under *Eucalyptus* trees (Oballa & Wamalwa, 2007). A survey by Mutitu *et al.* (2007) covering five Districts in western Kenya (Bungoma, Busia, Nyando, Nandi and Vihiga) showed that *L. invasa* pest attack is one of the constraints to *Eucalyptus* growing in the region where 60,000 ha are under threat, other constraints being limited land, effect of drought and other insect pests like termites.

Several control methods have been prescribed for various insect pests in many agroecological systems, including gall-forming types (Thacker, 2002). With regard to *L. invasa* pest, classical biological control and cultural control are some of the options that could recommended for use in Eucalyptus wood production sector but little effort, if any, has been put to explore such options due to scanty information on the pest's biology and ecology (Protasov *et al.,* 2007b). Chemical control strategy is generally hampered by the fact that *L. invasa* insect pests lives and completes much of its life cycle inside host tissue, well out of reach of contact insecticides. While systemic insecticides could be effective in controlling the blue-gum chalcid from economic point of view, increasing global concern on adverse

effects of chemical insecticides on the environment and application challenges in view of tree height and acreage limits their use in the control *L. invasa* pest. Cultural control methods like pruning and destruction of infested plant and plant parts could alleviate the pests' severity, but are labour-intensive (Buss, 2003) and can induce stress on the plants, thereby increasing their susceptibility to attack by secondary pests and diseases. Other cultural control methods, particularly those that do not involve tree mutilation, could be effective in controlling the pest but these need be empirically elucidated. This study was done to gather ecological information needed to make *L. invasa* amenable within eucalyptus agroecosystems by cultural control. Specific objectives were to determine: (1) cues for *L. invasa* oviposition in relation to olfaction and visual stimuli; (2) foraging and patch use by adult *L. invasa*; (3) plant host condition in relation to successful attack by *L. invasa*; and (4) variability of *L. invasa* attack between major Eucalyptus species.

Materials and Methods
Site Description
Pest infested Eucalyptus seedlings for these studies were collected from Kenya Forest Service Zonal tree nursery in Kisumu County (Kenya). The County lies between 1130 – 1835 metres above sea level (M.A.S.L.) with a mean annual rainfall ranging from less than 1000 mm to 1630 mm. It has mean annual maximum temperature of 25^0 – 30^0 C, and mean annual minimum temperature of 9^0 – 18^0 C (GOK, 1997a). Laboratory experiments were conducted at University of Eldoret, situated in Uasin Gishu County (Kenya). The County lies between 1200 – 2100 M.A.S.L. with a mean annual rainfall of 960 mm. It has mean annual maximum temperature of 24^0 – 26^0 C, and mean annual minimum temperature of 6^0 – 10^0 C (GOK, 1997b).

General Insect Rearing Procedure
Insect Colonization
Twenty potted and infested *E. saligna* seedlings measuring 10 – 25 cm in height were randomly collected from K.F.S. zonal tree nursery in Kisumu County and used as sources of insect larvae for colony establishment. In a well lit laboratory the seedlings were divided into two groups of ten and each group randomly arranged in a 1 m^3 ventilated glass emergence cage. The cages were managed at room temperature till insect emergence occurred, which took four and a half (4 ½) months. Temperature measurements inside cages were taken using thermometers centrally suspended from the roof of each cage. Mean room temperature was determined from three thermometers held outside the cages by means of retort stands. Temperature measurements were taken thrice a day at 8:00 a.m., 12:00 noon and 4:00 p.m.

Cage Management
Cage management included daily cleaning, watering, weeding and fertilizer application. Cage floor was cleaned thoroughly to remove abscissed leaves, excess water that spill after watering the seedlings, and soil. Watering was done after every two days by adding 20 cm^3 of water to each polythene tube containing the seedlings. Weeds were removed by hand daily, i.e. immediately they germinated. Fertilizer application involved putting five (5) pellets of urea 4 cm from the root collar of each seedling and was done once after four weeks.

Insect Rearing
Once the insects emerged from the caged *E. saligna* seedlings they were immediately transferred to 250-ml beakers where they were reared on artificial diet (15% sucrose solution). The beakers containing the insects were covered with cotton cloth and 15% sucrose was supplied on ball of cotton wool placed on the cloth cover. The insects, thus, fed from beneath the cloth cover. This was done to avoid accidental insect mortalities due to insects getting stuck on sucrose solution. An insecticide in powder formulation was sprinkled round a set of beakers containing *L. invasa* in order to prevent other crawling insects like ants from reaching the wools soaked in sucrose solution.

Cues for L. invasa Oviposition in Relation to Olfaction and Visual Stimuli
Twenty experimental trials were done using artificially fed insects in twelve (24) beakers (one insect per beaker) under room temperature (26^0C) and subjected to eight treatments with three replicates as follows:
Treatment A: An insect put together with a piece of host plant leaf (1 x 1 cm) in a vial.

Treatment B: An insect put together in a vial with a piece of host plat leaf (1 x 1 cm) that had been smeared with clear vanish and left overnight for the vanish odour to diffuse away.

Treatment C: An insect put together in a vial with a piece of host plant leaf (1 x 1 cm) and a piece of filter paper (1 x 1 cm) soaked in leaf extract.

Treatment D: treatment B was repeated with a piece of filter paper soaked in leaf extract added into the vial.

Treatment E: An insect put together in a vial with a piece of host plant leaf (1 x 1 cm) and a piece of filter paper (1 x 1 cm) not soaked in leaf extract.

Treatment F: treatment B was repeated with a piece of filter paper not soaked in leaf extract added into the vial.

Treatment G: An insect put together in a vial with a piece of filter paper (1 x 1 cm) soaked in leaf extract.

Treatment H: An insect put together in a vial with a piece of filter paper (1 x 1 cm) not soaked in leaf extract.

Oviposition behaviours shown by the insects were noted. Pieces of leaves and filter papers were removed from the vials after four days of exposure and inspected for oviposition punctures under microscope (x 100). The leaf tissue was then dissected under a microscope (x100) and any eggs revealed were counted. The resulting set of data was summarized and subjected to one-way ANOVA using SPSS version 17 software, and differences determined using multiple comparisons of Tukey test (Zar, 1984).

Foraging and Patch Use by Adult Leptocybe invasa

An equal number of singly caged adult *L. invasa* were provided with two different types of habitat structures repeated twelve times (12 trials). The first set of habitat structure presented vertical structure comprising four (4) seedlings each of *Eucalyptus saligna*, *Cupressus lusitanica* and *Grevillea robusta* ranging from 10 cm to 15 cm. A total of twelve (12) seedlings were therefore kept in each cage and exposed to *L. invasa* insect. The second set of habitat structure presented horizontal structure comprising four sets of petri dishes and each petri dish containing randomly arranged five 1 cm by 1 cm pieces of filter papers. Each of the filter papers had one of the following treatments: dry, moist (soaked in water), soaked in *E. saligna* leaf extract, soaked in *G. robusta* leaf extract, and soaked in *C. lusitanica* leaf extract. Patch use was predicted from travel time and time taken at a patch (residence time) on the premise put forth by marginal value theorem (Brown, 1988). Each was closely monitored one at a time with each set up lasting 20 minutes for the following variables: patch type landed on, time taken at a patch and time taken from one patch to another.

Host Plant Condition in Relation to Successful Attack by Leptocybe invasa

Eucalyptus saligna seedlings of two age categories were used. One-week old *E. saligna* seedlings constituted one age category while six-weeks old *E. saligna* seedlings another age category. For each age category, a randomized complete block design (RCBD) was used to subject groups of nine caged seedlings to all possible combinations of the following treatments for two months: Factors: Age (A), watering regime (W) and N-fertilization (N). Each factor had the following levels: none, low and high based on the scale presented in Table 1. Treatments given to *E. saligna* seedling before being exposed to *L. invasa* attack are shown in Table 2. Thereafter, an equal number of ten *L. invasa* were introduced into the cages and monitored for gall formation. The numbers of galls per seedling were recorded at week 20 from exposure time. The resulting data were subjected to univariate ANOVA and means separated by Tukey HSD test sing SPSS version 17.0 software.

Table 1. Factors under Consideration in Determining *E. saligna* Host Condition in Relation to Successful Attack by *Leptocybe invasa* (Hymenoptera: Eulophidae)

Factor	Level
Age*	One week old *E. saligna* seedlings (A1)
	Six weeks old *E. saligna* seedlings (A2)
Watering	No watering (W1)
	10 cm^3 of water added once a week (W2)
	10 cm^3 of water added thrice a week (W3)
Nitrogen fertilization	No fertilization (N1)
	1g CAN fertilizer added every after 6 weeks (N2)
	1g CAN fertilizer added every after 2 weeks (N3)

*Age after transplanting seedlings in polythene tubes

Table 2. Treatments Given to *E. saligna* Seedling before being Exposed to *L. invasa* Attack

S/NO.	CODE	TREATMENT
1.	**A1W1N1**	one week old seedling + no watering + no fertilizer
2.	**A1W1N2**	one week old seedling + no watering + 1g CAN* fertilizer applied after every 6 weeks
3.	**A1W1N3**	one week old seedling + no watering + 1g CAN fertilizer applied after every 2 weeks
4.	**A1W2N1**	one week old seedling + 10 cm^3 water added once a week + no fertilizer
5.	**A1W2N2**	one week old seedling + 10 cm^3 of water added once a week + 1g CAN fertilizer applied after every 6 weeks
6.	**A1W2N3**	one week old seedling + 10 cm^3 of water added once a week + 1g CAN fertilizer applied after every 2 weeks
7.	**A1W3N1**	one week old seedling + 10 cm^3 of water added thrice a week + no fertilizer
8.	**A1W3N2**	one week old seedling + 10 cm^3 of water added thrice a week + 1g CAN fertilizer applied after every 6 weeks
9.	**A1W3N3**	one week old seedling + 10 cm^3 of water added thrice a week + 1g CAN fertilizer applied after every 2 weeks
10.	**A2W1N1**	six weeks old seedling + no watering + no fertilizer
11.	**A2W1N2**	six weeks old seedling + no watering + 1g CAN fertilizer applied after every 6 weeks
12.	**A2W1N3**	six weeks old seedling + no watering + 1g CAN fertilizer applied after every 2 weeks
13.	**A2W2N1**	six weeks old seedling + 10 cm^3 of water added once a week + no fertilizer
14.	**A2W2N2**	six weeks old seedling + 10 cm^3 of water added once a week + 1g CAN fertilizer applied after every 6 weeks
15.	**A2W2N3**	six weeks old seedling + 10 cm^3 of water added once a week + 1g CAN fertilizer applied after every 2 weeks
16.	**A2W3N1**	six weeks old seedling + 10 cm^3 of water added thrice a week + no fertilizer
17.	**A2W3N2**	six weeks old seedling + 10 cm^3 of water added thrice a week + 1g CAN fertilizer applied after every 6 weeks

* CAN- Calcium ammonium nitrate

Variability in Leptocybe invasa Attack between Major Eucalyptus Species

A total of forty (40) caged three-weeks old seedlings of four *Eucalyptus species* (*E. saligna, E. camaldulensis, E. citriodora* and *E. globulus*) of 12.5 ± 2.5 cm height were divided into five groups of eight (8) as follows:

(i)   Eight (8) *E.saligna* seedlings caged a lone;
(ii)   Eight (8) *E. camaldulensis* seedlings caged alone;
(iii)   Eight (8) *E. citriodora* seedlings caged alone;
(iv)   Eight (8) *E. globules* seedlings caged alone; and
(v)   Two (2) of each of the four seedlings caged as a mixture (i.e. eight seedlings of different species caged together).

Seedlings in each cage were then exposed to *L. invasa* by releasing ten (10) of the insects into the cages. The seedlings were managed till gall development occurred. The number of galls per seedling was recorded and the resulting data subjected to one-way ANOVA at 95 % confidence interval using SPSS version 17 software. Means were separated by Tukey HSD test (Zar, 1984).

Results
Cues for L. invasa Oviposition in Relation to Olfaction and Visual Stimuli

Mean *L. invasa* egg counts (± SE and ± SD) in response to cues for oviposition in relation to visual and olfaction stimuli are presented in Table 3.

Table 3. Mean *Leptocybe invasa* Egg Coont Following Four Days of Exposure to Different Visual and Olfaction Treatments

S/N.	Treatment	N	Mean	SD	SE
1	Unvanished *E. saligna* leaf	60	5.30	1.14	0.15
2	Vanished *E. saligna* leaf	60	1.72	1.15	0.15
3	Unvanished *E. saligna* leaf with soaked filter paper	60	4.85	2.33	0.30
4	Soaked filter paper with unvanished *E. saligna* leaf	60	3.25	0.65	0.08
5	Vanished *E. saligna* with soaked filter paper	60	1.28	0.76	0.09
6	Soaked filter paper with vanished *E. saligna* leaf	60	5.20	0.68	0.08
7	Unvanished *E. saligna* leaf with unsoaked filter paper	60	6.33	2.23	0.29
8	Unsoaked filter paper with unvanished *E. saligna* leaf	60	1.40	0.64	0.08
9	Vanished *E. saligna* leaf with unsoaked filter paper	60	2.92	1.14	0.15
10	Unsoaked filter paper with vanished *E. saligna* leaf	60	0.47	0.50	0.06
11	Soaked filter paper	60	4.58	1.68	0.22
12	Unsoaked filter paper	60	1.12	0.78	0.10
	Total	**720**	**3.20**	**2.30**	**0.08**

The highest mean ($\pm$ SE) *L. invasa* egg count (6.33 $\pm$ 0.29) was recorded on unvarnished piece of *Eucalyptus saligna* leaf presented together with a piece of filter paper not soaked in *E. saligna* leaf extract. The lowest egg count (0.47 $\pm$ 0.06) was recorded on piece of filter paper not soaked in *E. saligna* leaf extract and presented together with vanished piece of *E. saligna* leaf. Vanished pieces of *E. saligna* leaf presented together with unsoaked pieces of filter paper had higher *L. invasa* egg counts (2.92 $\pm$ 0.15) as compared to unsoaked pieces of filter paper presented alone (1.12$\pm$0.10). There were significant differences between effects of the twelve treatments on mean *L. invasa* egg count ($p < 0.05$) and *L. invasa* had a preference for vanished *E. saligna* leaf over unsoaked filter paper as surface for oviposition (Table 4).

Table 4. Tukey HSD[*] Homogenous Subsets of Mean *Leptocybe invasa* Egg Count Following Four Days of Exposure to Different Visual and Olfaction Treatments

S/ NO.	Treatment	N	Subset for alpha = 0.05				
			1	2	3	4	5
1	Unsoaked filter paper with vanished *E. saligna* leaf	60	0.47a				
2	Unsoaked filter paper	60	1.12a	1.12b			
3	Vanished *E. saligna* with soaked filter paper	60		1.28b			
4	Unsoaked filter paper with unvanished *E. saligna* leaf	60		1.40b			
5	Vanished E. saligna leaf	60		1.72b			
6	Vanished *E. saligna* leaf with unsoaked filter paper	60			2.92c		
7	Soaked filter paper with unvanished *E. saligna* leaf	60			3.25c		
8	Soaked filter paper	60				4.58c	
9	Unvanished *E. saligna* leaf with soaked filter paper	60				4.85c	
10	Soaked filter paper with vanished *E. saligna* leaf	60				5.20c	
11	Unvanished *E. saligna* leaf	60				5.30c	
12	Unvanished *E. saligna* leaf with unsoaked filter paper	60					6.33d
	P		0.195	0.307	0.960	0.095	1.000

Means for groups in homogeneous subsets are displayed. Those with same letters are not significantly different.

[*] Uses Harmonic Mean Sample Size = 60.000.

Foraging and Patch Use by Adult Leptocybe invasa

Results on foraging and patch use by adults of *L. invasa* are presented in Figures 1 and 2. Travel time from patch to patch was longer (4 - 6 min) when *L. invasa* landed on plants other than *E. saligna* than when the insect landed on *E. saligna* (1-2 min) (Figure 1). For both vertical and horizontal habitat structures, time taken by *L. invasa* on the patch of *E. saligna* (i.e. residence time) was longer and marked by shorter travel time from patch to patch compared with corresponding duration when the insect was on other patch types (i.e. *G. robusta* and *C. lusitanica*) (Figures 1 and 2).
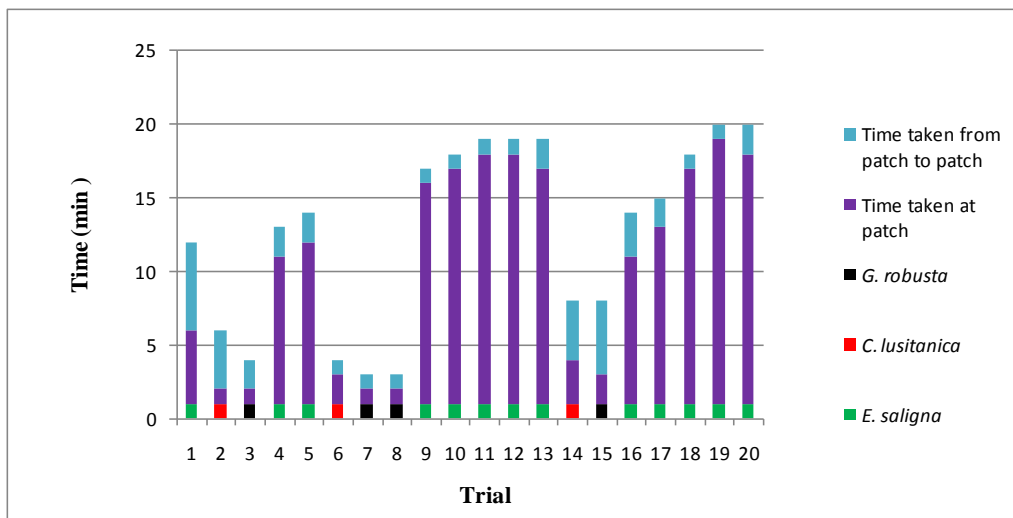
Figure 1. Travel and Residence Time Taken by *L. invasa* in Relation to Different Vertical Patch Types
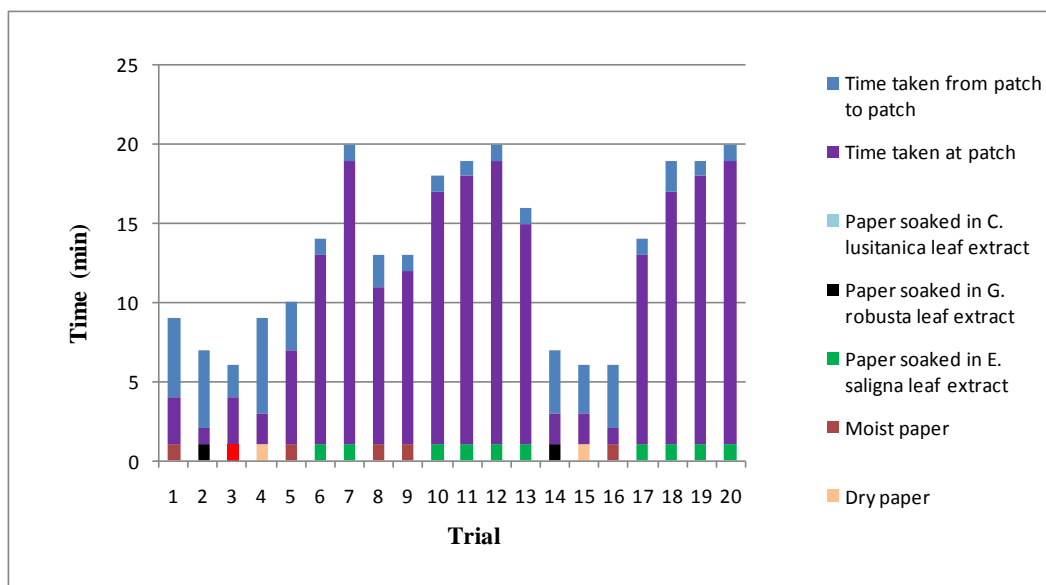
Figure 2. Travel and Residence Time Taken by *L. invasa* in Relation to Different Horizontal Patch Types

Host Plant Condition in Relation to Successful Attack by Leptocybe invasa

Mean gall numbers per seedling due to attack by *L. invasa* in relation to host condition are presented in Table 5. High nitrogen fertilization and high watering regime for newly pricked out (transplanted) *E. saligna* seedlings rendered the plants more susceptible to attack by *L. invasa* as indicated by higher counts of galls per seedling (13.1 ± 0.9 galls per seedling) (Table 5). Old (six weeks old) subjected to low regimes of nitrogen fertilization and watering were less susceptible to attack by the pest

$(2.6 \pm 0.9$ galls per seedlings) (Table 5). The differences in mean gall numbers per seedling as a response to host condition in relation to attack by *L. invasa* were significant ($p < 0.05$).

Table 5: Mean Gall Numbers per seedling in relation to *E. saligna* host condition for Successful Attack by *L. invasa*

Treatment	Mean ± SE
A1W1N1	6.3 ± 0.9abcde
A1W1N2	7.8 ± 0.9bcdef
A1W1N3	7.3 ± 0.9bcdef
A1W2N1	9.5 ± 0.9cdefg
A1W2N2	11.0 ± 0.9fg
A1W2N3	11.2 ± 0.9fg
A1W3N1	10.1 ± 0.9defg
A1W3N2	10.6 ± 0.9efg
A1W3N3	13.1 ± 0.9g
A2W1N1	7.1 ± 0.9bcdef
A2W1N2	6.8 ± 0.9abcdef
A2W1N3	4.9 ± 0.9ab
A2W2N1	2.6 ± 0.9a
A2W2N2	3.4 ± 0.9ab
A2W2N3	4.1 ± 0.9abc
A2W3N1	5.1 ± 0.9abc
A2W3N2	5.9 ± 0.9abcd
A2W3N3	5.3 ± 0.9b

Means with same letters are not significantly different at 95% CI

Variability in Leptocybe invasa Attack between Major Eucalyptus Species

Results on variability of *Leptocybe invasa* attack between major *Eucalyptus species* indicated that *E. saligna* was the most susceptible species to *L. invasa* attack (15.43 ± 0.29 galls per seedling) while *E. globulus* and *E. citriodora* seemed to tolerate *L. invasa* attack by > 150%, having only 0.86 ± 0.07 and 0.94 ± 0.07 galls per seedling respectively (Figure 3 and Table 6). Whereas *E. camaldulensis* seemed resistant in the presence of *E. saligna*, the species also appeared slightly susceptible to *L. invasa* attack when exposed to the insect alone. In the presence of *E. saligna*, gall count per seedling on *E. camaldulensis* was 3.21 ± 0.33 while 7.11 ± 0.24 galls per seedling was recorded when the species was alone. The variability in *L. invasa* attack between the major *Eucalyptus species* was significant ($p < 0.05$).
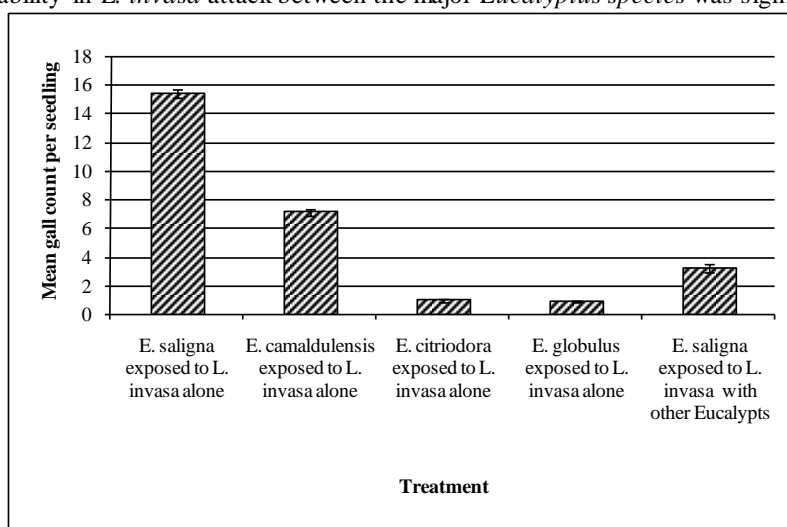
Figure 3. Mean Gall Count on Different Species of *Eucalyptus* Seedlings Following Exposure to *L. invasa* Attack Alone or together with other *Eucalyptus* Species

Table 6. Tukey's (HSD) Homogenous Subsets of Mean Gall Count per Seedling of *Eucalyptus* Species Following Attack by *L. invasa*

Treatment	N	Subset for alpha = .05			
		1	2	3	4
E. globulus exposed to *L. invasa* alone	160	0.86a			
E. citriodora exposed to *L. invasa* alone	160	0.94a			
E. saligna exposed to *L. invasa* with other Eucalypts	160		3.21b		
E. camaldulensis exposed to *L. invasa* alone	160			7.11c	
E. saligna exposed to *L. invasa* alone	160				15.43d
P		0.999	1.000	1.000	1.000

Means for groups in homogeneous subsets (with similar letters) are displayed.
*Uses Harmonic Mean Sample Size = 160.000.

Discussion

Animals usually require information about the state of their environment to take adaptive decisions (Tentelier & Fauvergue, 2007). A forager may assess current habitat profitability, based on cues it has perceived in the past, through a learning process (Ollasson, 1980; McNamara *et al.*, 2006). In these studies, a greater the number of eggs was laid by *L. invasa* in response to olfaction than visual stimuli. Thus, based on the premise that host plant semiochemicals can influence infestation by *L. invasa,* the planting of susceptible Eucalypts in polycultures together with strongly aromatic and resistant species like *Eucalyptus citriodora* may alleviate the pest problem.

Shorter travel time from patch to patch by *L. invasa* on *E. saligna* than on other plant species (this study) suggests that the insect has perfected its host finding and recognition, probably through co-evolution with *E. saligna*. These results suggest that polycultures of *E. saligna* and other non-host plant species can increase travel time from plant to plant for *L. invasa* and lower residence time taken on a given plant. In effect, this would lower chances for host finding and oviposition by the pest. Other than finding and recognizing a suitable host, the host condition in relation to successful attack is an important factor in severity of attack by a phytophagous insect. In this study, low nitrogen fertilization and moderate watering regime seem to lower the severity of attack by the gall wasp, *L. invasa* (Hymenoptera: Eulophidae). This has implications on tree nursery practices where *L. invasa* infestation is common. High nitrogen levels in plant tissues promote succulence and luxuriant growth of plant tissues, providing suitable oviposition sites for *L. invasa*.

Eucaluyptus citriodora and *E. camaldulensis* seemed resistant to *L. invasa* attack while *E. saligna* appeared highly susceptible to *Leptocybe* attack. In a separate work by Kulkarni *et al.* (2010), *Eucalyptus tereticocornis*, *E. camaldulensis*, *E. grandis* and their hybrids were severely affected by the gall wasp, *Leptocybe invasa* (Hymenoptera: Eulophidae) while *E. alba, E. urophyla, E. citriodora* and *E. torelliana* were gall free. From these studies, however, *E. camaldulensis* appear resistant only in the presence of *E. saligna*, but is equally susceptible to *L. invasa* attack when it is grown in monocultures.

Conclusion

The following conclusions were made: (1) Olfaction stimuli elicits more cues for oviposition in *L. invasa* than visual stimuli, hence egg-laying by the insect pest can be disrupted by growing *Eucalyptus saligna* in polycultures stand. (2) Host plant finding by *L. invasa* is not a chance occurrence as patch residence time by the insect is greater than time spent in foraging from patch to patch. (3) Host plant condition influences chances of attack by the pest and *E. saligna* seedlings subjected to low nitrogen fertilization and watering regimes become relatively less susceptible to attack by *L. invasa*, and (4) *E. camaldulensis* in polycultures with *E. saligna* is less susceptible to *L. invasa* attack but is equally susceptible to the pest attack when in monoculture. *E. saligna* is the most susceptible Eucalyptus species to *L invasa* attack.

This study recommends use of resistant *Eucalyptus species* like, *E. camaldulensis*; growing *E. saligna* in polycultures with resistant and aromatic species like *E. citriodora*; application of nitrogen fertilizers to six-weeks old (or older) seedling at low rates (0-1g CAN fertilizer per seedling); and optimal watering of seedlings (10 cm^3 of water per caged seedling per week or equivalent volume) as cultural control strategies against the gall wasp, *Leptocybe invasa*.

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Methemoglobin in *Chironomus* Larvae as Potential Biomarker of Nitrate Contamination in Water

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Abstract

Nitrate contamination of groundwater and surface water has been found to be high in various areas. Nitrates are known to have health impacts if consumed in different concentrations. The study set out to investigate the potential of using methemoglobin within chironomid larvae as a biomarker for nitrates in water. The ubiquitous and hemoglobin – containing chironomid larvae from Lake Victoria basin were identified using morphological characteristics and Chironomus was found to be the most common genera. The larvae can also withstand polluted waters. The Chironomus was therefore chosen for the study and was exposed to different concentrations of nitrate in water in the laboratory. The Chironomus larvae were analyzed for methemoglobin using a spectrophotometer and the levels compared to the exposure nitrate concentration of the test solution. Acute toxicity test was carried out by exposing the larvae to different concentrations of nitrate and determining the LC_{50}. Results showed a positive correlation between nitrate concentration and hemoglobin absorbance in the tested cases. The LC_{50} after 48hrs was found to be 34.2 (30-39; 95% confidence limit) mgL^{-1} NO_3-N for third instar larvae and for first instar larvae after 96hrs was 41.3 (35.9-50.0; 95% confidence limit) mgL^{-1} NO_3-N. From the results it can be seen that chironomid larvae have the potential to be used to indicate differences in nitrate concentration in water containing nitrate concentrations of upto 40 mgL^{-1} NO_3-N. The study can help in the development of a bioassessment tool for nitrates in water. However, further work needs to be carried out on effect of age of the larvae on methemoglobin formation.

Keywords*: Chironomus, Biomarker, Methemoglobin, Nitrate*

Introduction

Chironomids, one of the widespread insect groups in the world, belong to the dipteran family hironomidae (Marziali, Armanini, Cazzola, Erba, & Toppi, 2010; McGavin, 1992). Its first three life stages are aquatic; with the larval stage consisting of four instars, with a complete molt between each instar, while the adult stage is aerial (McGavin, 1992; Péry, Mons, & Garric, 2005). Some chironomid's contain hemoglobin, synthesized in the larval fat body and then secreted into the hemolymph (Weber & Vinogradov, 2001), making it easy to identify due to the red color of the hemolymph (Hankeln *et al.*, 2002). Due to the hemoglobin, chironomid larvae can tolerate polluted waters and have been known as potential indicators of water quality (Eggermont, Verschuren, & Dumont, 2005) being used for different studies, as well as biomarkers for different substances (Park & Kwak, 2010). Biomarkers are biochemical or physiological indicators of either exposure to, or effects of, environmental contaminants at the suborganism or organism level (Hyne & Maher, 2003). Researchers have recently been using chironomids as a tool of environmental impact assessment, toxicity testing and evaluation of aquatic ecosystem health (Carew, Pettigrove, & Hoffmann, 2003).

This study need arises because of the widespread contamination of nitrate in both surface and groundwater here as well as worldwide. Maximum contaminant level (MCL) for nitrate in drinking water is 10 mgL^{-1}Nitrate-Nitrogen (NO_3-N), given by various authorities (Almasri, 2007) as well as the Government of Kenya (Republic of Kenya, 2006). Elevated nitrate concentrations in drinking water are linked to health problems such as methemoglobinemia in infants (Almasri, 2007) among others. Methemoglobin has been detected in bullfrog (*Ranacatesbeiana*) tadpoles exposed to nitrites (Rouse, Bishop, & Struger, 1999) and even in cattle (Al-Qudaha, Rousan, & Ereifej, 2009), reptiles and fish (Aime *et al.,* 1992). Methemoglobin expected to be produced in chironomids through the oxidation of hemoglobin by nitrate, was to be used as a biomarker in this study. No literature on use of methemoglobin

in chironomid larvae as a biomarker for nitrates in water was found as well as information on the most common genera in the Lake Victoria Basin. The study intends to make a contribution towards knowledge in this direction.

Nitrates are analysed using different chemical methods (APHA, 1992), but in the third world countries well-equipped laboratories are scarce and costly. The study can also help in the development of a bioassessment tool which, if availed, will result in value addition. Bioassessment is a cost effective means, which makes it possible to involve the local community in the monitoring of river health and would therefore be beneficial to third world countries.

Materials and Methods
Experimental Design
The experimental design involved exposing the *Chironomus* larvae, which was found to be abundant in the Lake Victoria basin from an earlier study, to different concentrations of nitrate in water for a period of time. Methemoglobin levels of these larvae were then determined.

Organisms
The larvae used in the study were obtained from two sites (Huruma and KCC) on River Soisani in Eldoret. A D-frame net sampler of mesh size 0.5mm was used to scoop sediment from the river as described in (Khazenzi, Osano, Wakhisi, & Raburu, 2011). The live larvae were placed in cleaned open-mouthed 1-L plastic bottles containing river water and taken to the laboratory within 6 h where they were left overnight to acclimatize under room temperature with natural lighting conditions, before exposing them to water containing different concentrations of nitrate.

A proportion of these larvae were cultured in a 3- L aquarium containing the river water and sterilized sand that provided the sediment for the larvae. The sterility of the sand was achieved by heating in the oven at 160^oC for 2 h. The culturing procedure followed was that described in APHA (1992). The aquarium was placed in a cage with inner dimensions of 60 cm by 36 cm and whose sides and top were covered with 0.5 mm mesh netting material in order to retain the adults after emergence. The culture medium was continuously aerated using a Sera air 550R aeration pump and the oxygen concentration was maintained at above 40%. The larvae were kept at a light: darkness ratio of 16: 8 hours and fed on food prepared by blending 5g of fish food and 1g of dry grass per litre of water twice a week (APHA, 1992). The larvae were fed on floating fishmeal manufactured by Ungachick Poultry Breeders Ltd, Kampala Uganda, blended with crushed dry grass stalks of Nandi *Setaria* obtained from the study area, where it is commonly found. The adults laid eggs in the water which were removed carefully with the aid of a blunt pipette dropper. The eggs were then placed in a 50 - mL petri dish (10 cm diameter) containing the river water until the eggs hatched. The hatched larvae were then moved to 1- L plastic bottles containing water obtained from a treatment plant before chlorination and whose nitrate content was 0.05 mgL^{-1} NO_3-N. Sterilized sand was added to the bottle to provide sediment and the water was aerated constantly to maintain an oxygen concentration of above 40%. The larvae were fed twice a week. This was done for different egg masses found on different days, therefore hatched larvae of the same age were kept in the same container.

Test Media
The test media were prepared by adding different volumes of 100 mgL^{-1} NO_3-N potassium nitrate solution to some of the river water and the volume brought to 100 mLs. Nominal concentrations of 3.9, 6.4, and 8.9 mgL^{-1} NO_3-N were prepared and used in the test with the control (river water) containing 1.4 mgL^{-1} NO_3-N. A replicate with nominal concentrations of 2.3, 2.8, 5.3 and 7.8 mgL^{-1} NO_3-N and a control (river water) containing 0.3 mgL^{-1} NO_3-N was carried out. Twenty, fourth instar larvae were placed in each of the test media under room temperature (18 – 20^oC) and light: darkness regime of 12:12 hours, the natural equatorial cycle. The control was the group of larvae exposed to the river water only. All the containers were not provided with extra aeration during the test. No food was provided during the experiment. The tests were carried out in duplicate. After 48 h all the larvae were still alive and were tested for methemoglobin as described below. The methemoglobin levels were compared with the different serial nitrate concentrations for the specific sites.

Methemoglobin Analysis
This was carried out as described in (Khazenzi, Osano, Wakhisi, & Raburu, 2011). It involved obtaining hemolymph by gently breaking open the body walls of twenty larvae. Twenty-five microlitres of the fluid was then carefully taken, avoiding particles, and added to 2.5 mLs of the buffer in a cuvette.

The absorbance of the hemoglobin in the sample was measured using a Jenway 6505 UV/Vis Spectrophotometer over a range of wavelengths between 528.3 nm and 589.3 nm and compared to absorbance of Hemoglobin Standard (13.4 g.dl^{-1}, Biosystems S.A Costra Brava 30 Barcelona: Spain). The standard solution was made by taking 2.5 μLs of the standard and adding this to 3 mLs of the buffer; the absorbance was then read over a range of wavelengths between 528.3 nm and 589.3 nm.

Acute Toxicity Test

This was a static test (APHA, 1992). The aim of the test was to find out the maximum concentration of nitrate in water for which the larvae may be used as a biomarker. Third instar chironomid larvae (based on the size of larvae) obtained from the river were exposed to different concentrations of nitrate solutions for 48 hours. They were observed for deaths over time and the percentage of dead larvae calculated. The nitrate solutions were prepared using river water as the solvent. The concentrations used were 10, 20, 30, 40, 50 and 100 mgL^{-1}NO$_3$-N. Hundred mLs of the solutions were taken in beakers and 15 larvae added to each beaker. The river water was used as the control; the nitrate concentration of the river water was 1.4 mgL^{-1}NO$_3$-N. The test was carried out in duplicate. The beakers were covered with perforated filter paper to reduce evaporation.The larvae were observed after 4 hours, 24hours and 48 hours. The larvae were not fed during this duration. The number of dead larvae was recorded each time and removed from the beaker. A criterion for death was no movement (APHA, 1992). The nitrate concentration that resulted in the deaths of half the number of larvae after 48 hours, LC$_{50}$, was calculated using the ProbitAnalysis (SPSS Programme).

The toxicity test was also carried out using first instar larvae that were hatched in the laboratory. Different concentrations of potassium nitrate solution made using river water as the solvent were prepared for the test. The concentrations used were 10, 30, 50, 75, 100, 150 and 200mgL^{-1} NO$_3$-N. Batches of fifty larvae each were counted with the help of a Gallenkamp dissecting microscope and transferred into petri dishes using an eyedropper. The larvae were then added at once into 100 mLs of the solution in a beaker for each of the different concentrations. The beakers were covered with perforated filter paper to reduce evaporation. The larvae were observed after 24hours, 48 hours, 72 hours and 96 hours. The larvae were not fed during this duration.The number of dead larvae was recorded each time, with the aid of the dissecting microscope, and removed from the beaker. A criterion for death was no movement (APHA, 1992).The nitrate concentration that resulted in the deaths of half the number of larvae after 96 hours, LC$_{50}$, was calculated using the ProbitAnalysis (SPSS Programme). The test was carried out in triplicate.

Data Analysis

Correlations were carried out between the nitrate concentrations and cyanmethemoglobin absorbance. The t-test was used to compare differences in absorbance. Lethal concentrations, LC$_{50}$, were calculated using SPSS Package.

Results
Methemoglobin Levels in Chironomid Larvae

An increase in hemoglobin absorbance with increase in nitrate concentration was observed in 72% of the 18 tests in which the larvae were placed in different concentrations of nitrate. However it was noted that in 60% of all the cases, the control group had higher hemoglobin absorbance than some groups from solutions that had higher nitrate concentration. Fig.1 shows absorbance curves obtained from hemoglobin of larvae from one site (Huruma) exposed to different concentrations of nitrate solution when mean absorbances at different wavelengths were plotted. The peak at 540 nm (when both cyanmethemoglobin and carboxyhemoglobin absorb highly) was higher than the peak at 568 − 570 nm (when only carboxyhemoglobin absorbs highly). This implies formation of methemoglobin. There was a positive correlation between the nitrate concentration and the cyanmethemoglobin absorbance. Pearson's correlation r = 0.998 (p < 0.05).The concentrations of NO$_3$-N given are the mean concentrations found in water from the Site. The absorbance of the standard gave a similar trend as that of the hemoglobin of the larvae.
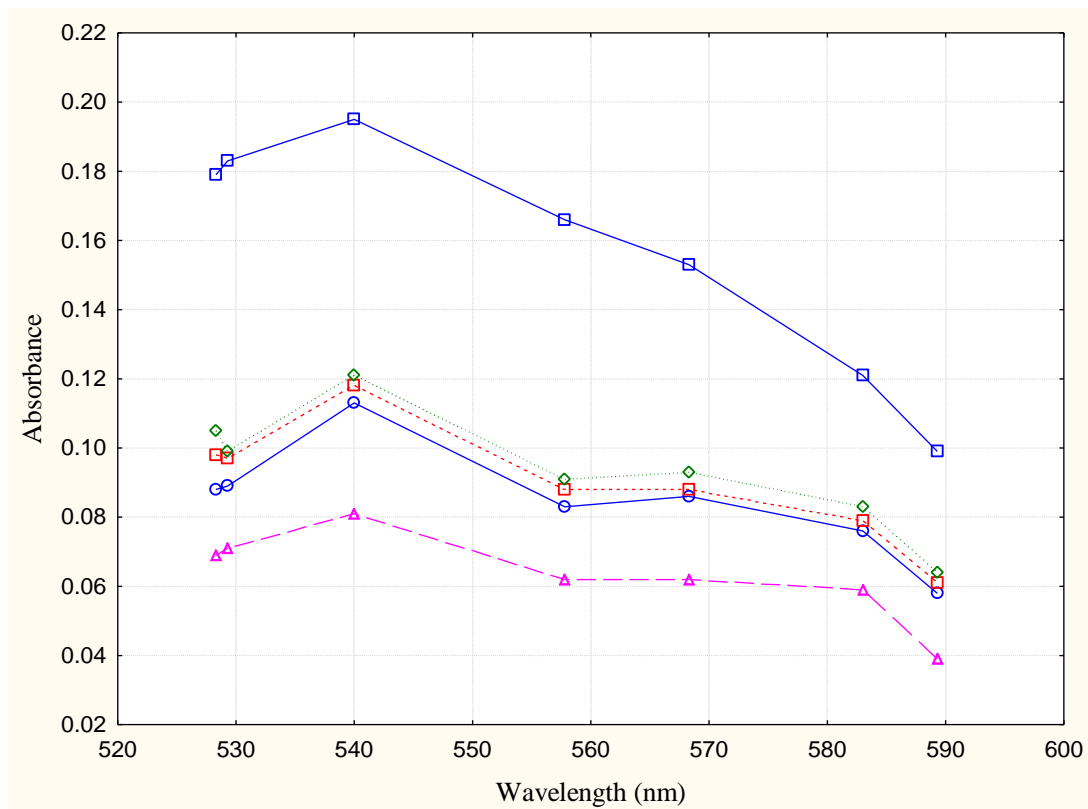
Nitrate concentration exposure

○ 3.9 mgL^{-1} NO$_3$-N
□ 6.4 mgL^{-1} NO$_3$-N
◇ 8.9 mgL^{-1} NO$_3$-N
△ Control 1.4 mgL^{-1} NO$_3$-N
□ Standard: 0.1115 gL^{-1}Hb

Figure 1. Absorbance of Cyanmethemoglobin at the Different Wavelengths, Obtained from Hemoglobin of Chironomid Larvae from Huruma Site, which had been Exposed to Different Nitrate Concentrations during the Study Period

Fig.2 shows absorbance curves obtained from hemoglobin of larvae from the other site (KCC) exposed to different concentrations of nitrate solution when mean absorbances at different wavelengths were plotted. A positive correlation was observed between the nitrate concentrations and the cyanmethemoglobin absorbances; Pearson's correlation r = 0.874 (p = 0.05) was used. The concentrations of NO$_3$-N given are the mean concentrations found at the different sites. The absorbance of the standard gave a similar trend as that of the hemoglobin of the larvae.
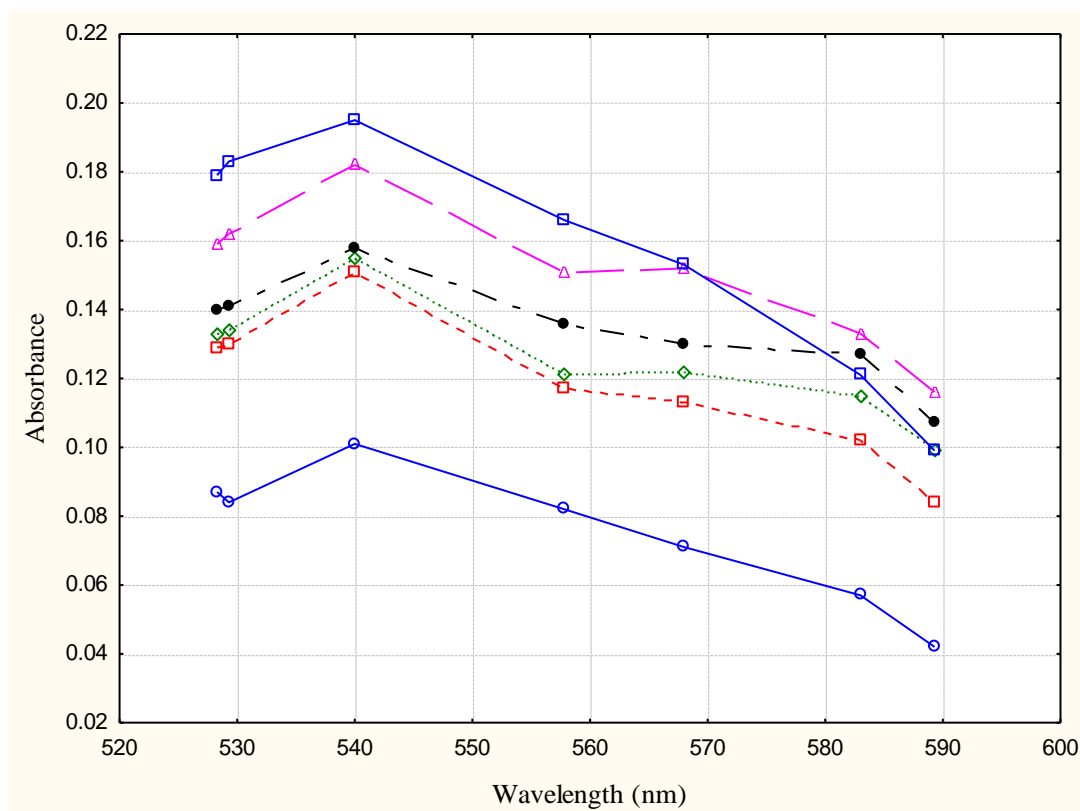
Nitrate concentration exposure

- ⊖— 2.3 mgL^{-1} NO_3-N
- ⊡— 2.8 mgL^{-1} NO_3-N
- ◇··· 5.3 mgL^{-1} NO_3-N
- △— 7.8 mgL^{-1} NO_3-N
- ●— Control 0.3 mgL^{-1} NO_3-N
- ⊟— Standard: 0.1115 gL^{-1}Hb

Figure 2. Absorbance of Cyanmethemoglobin at Different Wavelengths, Obtained from Hemoglobin of Chironomid Larvae from KCC Site, that had been Exposed to Different Nitrate Concentrations during the Study Period

Acute Toxicity Test

The 48hr LC_{50} for 3rd instar larvae was calculated using the ProbitAnalysis (SPSS Programme) and was found to be 34.2 (30-39; 95% confidence limit) mgL^{-1} NO_3-N. From the same tests the 48hr LC_{90} was found to be 49.0 (43.2-60,5; 95% confidence limit) mgL^{-1} NO_3-N. The 96hr LC_{50} for 1st instar larvae was calculated using the ProbitAnalysis (SPSS Programme) and was found to be 41.3 (35.9-50.0; 95% confidence limit) mgL^{-1} NO_3-N. From the same tests the 96hr LC_{90} was found to be 75.4 (68.0-85.9; 95% confidence limit) mgL^{-1} NO_3-N.

Discussion
Biomarkers

Chironomus has been used extensively as a field bioindicator because it is relatively sensitive and tolerates poorer environmental conditions than other genera (Hudson & Ciborowski, 1996). The hemoglobin it contains can also be used as a biomarker by reflecting the changes it undergoes when exposed to pollutants that can affect it. The increase in levels of methemoglobin with increase in nitrate concentration in 72% of the tests shows some potential of using it as a biomarker.

Methemoglobin Levels

Methemoglobin formation in chironomid larvae has been implied in literature where oxyhemoglobin levels were measured and found to vary after exposure to various environmental contaminants. The difference in the oxyhemoglobin levels was explained to be a result of auto-oxidation of the hemoglobin to methemoglobin (Ha & Choi, 2008). In this study, the absorbance curves obtained for larvae exposed to different concentrations of nitrate (Fig.1 and 2) imply formation of methemoglobin because of the lowering of the carboxyhemoglobin absorbance peak at between 568 and 570 nm, one of carboxyhemoglobin peak absorbances (Zijlstra & Buursma, 1997) in comparison to that at 540 nm where cyanmethemoglobin has a peak absorbance (Wylie & Lovric, 1988) as well as carboxyhemoglobin (Zijlstra & Buursma, 1997). Although this was expected to result in the lowering of the absorbance at 568-570 nm as the nitrate concentration increased, the opposite occurred for 72% of the tests. This is most likely because of increase in hemoglobin concentration that has been stimulated by low oxygen concentration in order to try and maintain oxygen delivery. This has been observed in other studies (Avilez, Altran, Aguiar, & Moraes, 2004). There was a positive correlation between the nitrate concentration and absorbance shown by Pearson's Correlation (at 0.05 significance). With very high nitrate concentrations (50 mgL^{-1} NO_3-N and above) it was noted that there was no significant difference in absorbance (Khazenzi, Osano, Wakhisi, & Raburu, 2011). This could have been due to a mechanism of adaptation which reacts quite rapidly to increased exposure of nitrates (Gruener & Toeplitz, 1975) such as an antioxidant system. The same has been observed in other studies (Avilez, Altran, Aguiar, & Moraes, 2004; Sadeq, Attarassi, Cherkaoui, ElAouad, & Idrissi, 2008). The differences in absorbance can be used as an indicator of the presence of nitrates in water but this can be improved by either quantifying the amount of methemoglobin formed or identifying any other substance that forms as a result of nitrate reaction with hemoglobin to be used as a marker.

In the methemoglobin tests, the absorbance readings were not able to quantify the amount of methemoglobin for different concentrations of nitrate. It was also not possible to equate a certain absorbance to exposure of a certain concentration of nitrate, although an increase in absorbance was noted at all wavelengths. This is because larvae exhibit stage-specific and tissue- specific single-chain globin synthesis throughout the four larval and the pupal stages (Weber & Vinogradov, 2001). Seasonal variability of hemoglobin content and component composition has also been found in chironomid larvae (Leyko & Osmulski, 1985). The hemoglobin concentrations in larger larvae are higher than those of smaller larvae because the larger larvae have more hemoglobin (Panis, Goddeeris, & Verheyen, 1995). This was observed in this study and hence makes them more suitable for the tests as they can be used in smaller numbers. The larvae can be used for concentrations less than 34.2 (30-39; 95% confidence limit) mgL^{-1} NO_3-N comfortably as this is the calculated LC_{50} but may go as far as the LC_{90}, 49.0 (43.2-60, 5; 95% confidence limit) mgL^{-1} NO_3-N if enough numbers are available.

Conclusion

The increase in absorbance with increased nitrate concentration in water, together with the implication of methemoglobin formation indicates the possibility of using chironomids as biomarkers of nitrate in water. The larger larvae (over 10 mm) may be better indicators than the smaller ones because of their higher hemoglobin content. The study can help in developing a fast bioassessment tool for *in situ* nitrate detection in surface waters. So far the methods available for nitrate assessment in water are all chemical. Although reliable, most of them are time consuming due to the reduction processes involved. This study opens avenues for further work using cultured larvae and other oxidants as a way of improving towards the development of the bioassessment tool.

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Factors Influencing Smallholder Dairy Farmers' Choice of Milk Marketing Outlet in Nandi North District, Kenya

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Abstract

Smallholder dairy farmers make up the bulk of milk producers in Kenya yet there is fragmented information on determinants of the choice of milk marketing outlet. The main objective of this study was to determine factors which influence smallholder dairy farmers' choice of milk marketing outlet in Nandi North District. Rational choice theory was employed and a conceptual framework developed to link the study variables. Survey research design was employed in this study. Simple random sampling was used with a study sample size of 185 household heads. The study employed interview schedule as the data collection instrument. Descriptive and inferential statistics were used to analyze data and present the study result. Chi-square test was used to test the hypotheses with the level of significance set at 5 percent. The results indicated that there exist factors which influence smallholder dairy farmers' choice of milk marketing outlet in the district. The state of road infrastructure, ownership of means of transport and services offered by the milk chilling plants influences the choice of milk marketing outlet. The results revealed that smallholder dairy farmers look for both milk price and a market outlet offering other services. Farmers forego high milk prices in urban areas in order to access credit and farm inputs offered by the chilling plants. The study concluded that it is important to invest in rural infrastructure especially roads in order to reduce marketing cost. Moreover, there is huge potential in the farmer producer groups in marketing of farmers produce. The study recommended that the government needs to remove barriers inhibiting their functioning and increase their capacity by offering training. Further research should be carried out to come up with strategy to improve policy makers understanding of the dairy industry in Kenya.

Keywords*: Smallholder, Milk, Market Outlets, Kenya*

Introduction

Background Information

The study focused on factors influencing small holder dairy farmers' choice of milk marketing outlets in Nandi North District, Kenya. Efficient marketing structures has been quoted by the World Bank as one of the key indicators in improving farmers earnings which in turn has a potential of reducing rural poverty and inequality within regions (World Bank, 2008). Kenya is one of the largest producers of dairy products in Africa, with estimated dairy herd of 3.5 million improved breeds and 9 million Zebus (MOLFD, 2007). The country also has the highest per capita milk consumption in Africa, consuming about 90 kg per capita annually compared to average 25kg per capita annually in Sub- Saharan Africa (MOLFD, 2007). Dairy farming is one of the most developed sectors in Kenya with estimated annual revenue of close to Ksh. 160 billion. The milk industry represents between 6-8% of GDP and supports over 1 million smallholder dairy farmers' households (Land O'Lakes, 2009). There are about 600,000 commercial smallholder dairy farmers in the sector most of them in central highlands and Rift Valley. These dairy farmers on average keep 1-4 cows and deliver their milk to hawkers/milk vendors, their cooperatives or local milk cooling centers. Notwithstanding, 50% of the smallholder dairy farmers rely on daily milk sales as a source of income (Institute of Economic Affairs, 2001). Dairy farming contributes to poverty reduction and equity in gender distribution of incomes since it is easily undertaken in small scale by women. Based on dairy farming experience accumulated over 90 years, Kenya has a relatively large herd of improved dairy cattle compared to other countries in the region (Ngigi 2005). The traditional milk drinking culture and keeping of traditional cows have also helped in the development of the sector. Dairy production in the district is largely for the domestic market i.e. Kenya Cooperative Creameries, Chilling plants and Brooside dairies. Occasional surpluses may be exported to regional markets and shortfalls in Kenya are met through imports of milk powder most notably, droughts in 1980 and 1984 led to increased imports.

Statement of the Problem

The dairy sector has undergone a lot of upheavals especially in 1990s. The Structural Adjustment programme of late 1980s and early 1990s forced the government to fully liberalize the sector in 1992. Liberalization was followed by entry of other milk processors ensuring a diverse market outlet to choose from by farmers. The dairy sector in Kenya has undergone a lot of changes and challenges before and after independence. Before independence and up to 1969, the dairy sector was largely unregulated with Kenya Co-operative Creameries (KCC) formed in 1925 playing a dominant role in milk processing and marketing. Indigenous Africans were not allowed to be involved in commercial dairy production until 1954 when the Swynnerton plan allowed them to produce and sell milk to KCC on quota basis (Jaffe & Morton, 1995). Starting with privatization of Artificial Insemination services in 1980s, the government fully liberalized the monopoly of the giant KCC in milk marketing in urban areas in 1992 (MOLFD, 2007). With liberalization, there was entry of various processors and marketers in the sector bringing about competition and thus the start of decline of KCC and its eventual collapse in 1999. The collapse of KCC changed milk marketing system from a highly controlled production and marketing chain supported by the government to a market driven system subject to forces of demand and supply. The liberalization increased marketing opportunities for smallholder dairy farmers and the participation of the informal sector in milk marketing increased. With the collapse of the giant KCC in 1999, milk marketing was thrown into disarray with most smallholder dairy farmers losing out. Eventually, informal milk marketing or hawking grew tremendously and being preferred with the smallholder dairy farmers. With the revival of KCC into new KCC in 2003, the dairy industry started to pick up again with non-governmental organizations (NGOs) investing in milk chilling plants. Smallholder dairy farmers have had to contend with lows and highs in marketing their milk and at some point in late 1990s the dairy industry declined due to marketing problems. What influences a smallholder dairy farmer to choose one market outlet over another has not been known for a long time. Different studies had looked at the trends, growth and impact of the dairy sector in Kenya but none had conclusively analyzed the factors influencing smallholder dairy farmers' choice of a marketing outlet. Therefore there was an existing knowledge gap. Understanding the dairy marketing system and dairy farmers' choice of marketing outlet was seen to be critical in influencing policy, thus bringing about a more efficient dairy marketing system and improving incomes for smallholder dairy farmers. It is hoped that other researchers will find the resultant report a handy link to not only new knowledge but also a key to further research opportunities.

District Milk Production and Use

Small holder dairy farmers in the district	32, 409
Crosses and grade cattle	75,493
Zebu cattle	3,783
Total	79,276
Total milking cows	21,405
Total number of calves	17,125
Average production per lactating cow	7.6
Total daily milk production	164,597
Milk consumed by calves (1.2 litres per calf) 12%	20,548.3
Milk consumed by households (1.2 Litres per HH) = 24%	38,890.8
Formal - Milk Marketed – 43%	70,000
Informal – Milk Marketed	35,157

Source: MOLD, 2012

This study sought to determine the influence of the various selected factors in smallholder dairy farmers' choice of milk marketing outlet. It sought:
   i. To determine the influence of the state of road infrastructure on smallholder dairy farmers' choice of milk marketing outlet.
   ii. To determine the influence of means of transport to the market on smallholder dairy farmers' choice of milk marketing outlet.
   iii. To determine the influence of services offered by the dairy marketing groups in smallholder dairy farmers' choice of milk marketing outlet.

The study was based on three hypotheses.
   i. H_O2. The state of road infrastructure has no statistical significant influence on smallholder dairy farmers' choice of milk marketing outlet in the district

ii. H_O3. The means of milk transport to the market has no statistical significant influence on smallholder dairy farmers' choice of milk marketing outlet in the district

iii. H_O4. Dairy marketing groups and the services they offer have no statistical significant influence on smallholder dairy farmers' choice of milk marketing outlet in the district

Methods and Procedures
Theoretical Framework

The study was based on rational choice theory. Rational choice is a choice made out of many alternatives through rational thinking. Theories of rational choice are guided by the assumption that people are rational and base their decisions on what they perceive to be the most effective means of achieving their goals (Wallace, 1991). The theory was broken down into various concepts key to the study as presented in figure 1.

Independent Variable   **Dependent Variable**
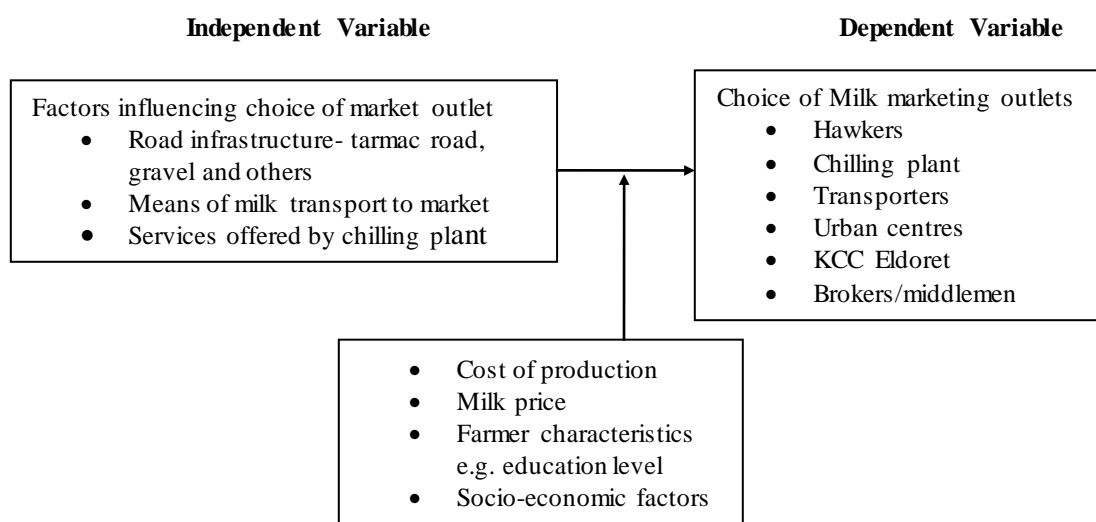
Figure 1. Conceptual Framework

Procedures

This study was done in Nandi North District. The dairy industry is the most popular, valued and highly developed enterprise in the district. Most farmers keep dairy crosses, few have high-grade animals and there are few Zebu cattle in lower parts of the district where agro-ecological conditions are hot and dry. Dairy cattle are kept for both subsistence and commercial use. Survey research design was employed as the data gathering technique. The population of study constituted household heads who were either male or female and practiced mixed farming .i.e. both dairy and crops farming. The population of study was rural based and made up of large and smallholder farmers. The study used a sample size of 185 dairy farmers; simple random sampling procedure was then employed before actual interviews in the field. The study used questionnaire and interview schedule to collect data from the respondents. The validated interview schedule was pilot tested with a sample of 30 household heads within the district. The completed study instruments were serialized, coded and double checked to ensure quality control. Data was analyzed using SPSS where inferential statistics, chi square test (X^2) and descriptive statistics were applied in data analysis. Measures of central tendency were derived to show the most common reason for choosing a marketing outlet. Frequency distribution tables were used for descriptive presentation of the data. Chi-square test (X^2) was chosen because of its appropriateness where data is nominal or ordinal.

Results and Discussions
Introduction

This section presents the results and discusses the key findings of the study in line with its stated objectives.

Descriptive Results

Category	Description	Percentage
Gender	Males	73%
	Female	27%
Age	18-27 Years	7%
	28-37 Years	38%
	38 -47	38%
	48 - 57	11%
	58 - 67	5.5%
	>67	0.5%
Household head	Male headed	78.9%
	Female headed	21.1%
Marital status	Single	13%
	Married	71.4%
	Separated	1.1%
	Widowed	14.6%
Education	Primary	39.5%
	Secondary	30.3%
	Middle level colleges	26.5%
	Bachelor's degrees	1.6%
	Masters	0.5%
	No formal education	1.6%
Occupation	Farmers	61.1%
	Professionals	22.7%
	Businessmen	14.1%
	Stay at home	2.2%

Source: Field Data 2012

Table1. Milk Marketing Outlets in Nandi North District

Characteristic	Number of farmers	Percentage (%)
Chilling plant	116	62.7
KCC	3	1.7
Transporters	4	2.2
Brokers	6	3.2
Hawkers	55	29.7
Other farmer	1	0.5
Total	185	100

Source: Field Data (2012)

The finding of this study indicate that formal market absorbs 81% of milk while informal market absorbs 19% of all milk produced by both smallholder and large scale milk farmers indicating a tremendous growth in the past three years. The formal milk marketing outlet has been growing over the years especially after the establishment of Tanykina dairies in 2005. Farmers prefer an organized marketing outlet that offers more than just a good price but also stable prices, credit and input supply. But still, the data indicates that some farmers access more than one market outlet at a time with the same farmer selling his milk to the chilling plant and to the hawkers in order to maximize the benefits of different marketing outlets.

Table 2. Market Outlet with Impassable Feeder Roads

Variable	Chilling plant	KCC	Transporters	Brokers	Hawkers	Other farmers
Frequency	114	3	1	6	54	1
Percentage	60%	1%	2%	3%	29%	5%

$\chi^2 = 21.92$, $df = 1$, *Cramer's V* = 0.747, $p < 0.05$ $(p = 0.015)$

Source: Field Data (2012)

The chi-square (0.015) is less than 0.05 indicating existing relationship between choice of market outlet and road status. The Cramer's V value is 0.747 indicating a strong relationship between the two variables.

Table 3. Market Outlet when Feeder Roads are Improved

Variable	Chilling plant	KCC	Transporters	Brokers	Hawkers	Other farmer
Frequency	127	27	0	2	28	1
Percentage	68.7%	14.6%	0	1.1%	15.1%	0.5%

$\chi^2 = 26.452$, $df = 8$, *Cramer's V* = 0.867, $p < 0.05$ ($p = 0.001$)
Source: Field Data (2012)

The chi-square value indicated that there exist a relationship between road status and choice of milk marketing outlet. The Cramer's V value is 0.867 indicating a strong relationship between the two variables. There is a change in respondents view on the choice of milk market if the road would be improved. 68.6% would market their milk to the chilling plant, 24.6% would market their milk to KCC Eldoret indicating 23% change in market preference, 1.1% would market their milk to brokers, 5.2% to hawkers and 0.5% to other farmers.

Table 4. Market Outlet if Feeder Roads are Worse

Variable	Chilling plant	Transporters	Brokers	Hawkers	Other farmer	Local hotel
Frequency	92	31	2	53	1	6
Percentage	49.7%	16%	2%	28.6%	0.5%	3.2%

$\chi^2 = 26.623$, $df = 10$, *Cramer's V* = 0.668, $p < 0.05$ ($p = 0.003$)
Source: Field Data (2012)

The chi-square value shows that there exist a relationship between road status and choice of milk market outlet. The Cramer's V value is 0.668 indicating a strong association between choice of milk market and the status of road. The respondents' view on market choice if the feeder roads would be worse changes with less people preferring chilling plant at 49.7% and more smallholder farmers preferring hawkers 28.6%, transporters 16.8% and a new variable local hotels at 3.2%. Brokers scores 1.1% and other farmer 0.5%. KCC scores 0% indicating that the further a market outlet is, the less likely it is preferred with bad roads. Some development thinkers have even argued that the reason for failure of SAPs in Africa was because most governments misinterpreted their disengagement in economic activities to even neglecting building of rural roads to facilitate agricultural growth. This has been emphasized by International Food Policy Research Institute, (2011) that, lack of investment in roads results in high transportation costs and forcing farmers to remain within a traditional subsistence mode of production. The study results indicated that the state of road infrastructure in the district is bad especially during the rainy season. This limits the smallholder dairy farmers' choice of milk market outlets. The freedom to choose a market outlet among existing outlets is drastically reduced because of the transport barriers as well as the high cost of transport that might accrue due to the bad roads. A survey of rural roads in Kenya in 2002 indicated that only 60% of the rural roads which service the poorest sectors in Kenya were found to be in maintainable conditions (Rabinowitz, 2008). Recently, there has been an increased investment in road construction but this has not been extended to the rural feeder roads where the poor are found. This scenario can be found in the district where the road network is in bad condition especially during the rainy season.

Table 5. Market Choice with Ownership of Means of Transport

Variable	Chilling plant	KCC	Transporters	Hawkers
Frequency	95	60	0	30
Percentage	51.8%	32.2%	0%	16%

$\chi^2 = 13.404$, $df = 2$, *phi, Cramer's V* = 0.697, $p < 0.05$ ($p = 0.0406$)
Source: Field Data (2012)

The p (0.0406) value is less than 0.05 thus the null hypothesis is rejected and alternative accepted implying that ownership of means of transport to the market influences small holder dairy

farmers choice of milk marketing outlet in the district. The Cramer's *V* value of 0.697 indicates a strong association between ownership of means of transport and choice of milk market outlet.

Table 6. Market Choice without Ownership of Means of Transport

Variable	Chilling plant	KCC	Transporters	Hawkers
Frequency	160	0	20	5
Percentage	86.5	0%	10.8%	2.7%

$\chi^2 = 14.16$, *df* = 6, *Cramer's V* = 0.616, *p* < 0.05 (*p* = 0.035)
Source: Field Data (2012)

The p value (0.035) indicates that choice of milk market is dependent to the ownership of means of transport to the market i.e. farmers base their decision on choice of milk market to ownership of means of transport to the market. The Cramer's *V* value of 0.616 indicates that there is a strong association between ownership of means of transport and choice of milk market. Transport of agricultural produce to the market is closely linked with the road infrastructure. It is hard to discuss transport issues in agriculture without touching on road infrastructure, they both affects and complement each other. An improvement in road leads to better performance of the transport and most development literature discusses these at the same time. The better the road conditions the easier it is to transport produce to the market and vice-versa. Thus road status eventually has an influence on the smallholder dairy farmers' choice of the means of transport to the market. The data also indicates that the most preferred means of transport is the pick-up truck 47.6%, followed by tractor at 40%, then motor cycle at 11.9% and bicycle at 0.5%. The status of the road within the area has a big influence on the preferred means of transport to the market. Most farmers indicate their preference of either the tractor or the pick-up truck because of their ability to be used on bad roads and to carry more milk. Despite the fact that most farmers own bicycle which they use to transport milk to the market, most of them would prefer to use either the pick-up truck or the tractor in order to overcome challenges brought by the bad roads and to enable them access farther markets in urban centers.

Table 7. Preference of Services Being Offered by Chilling Plant

Variable	Frequency	Percentage
Dairy management training	23	19.2
Subsidized A.I	7	5.8
Subsidized inputs	34	28.3
Access to credit	56	46.7
Total	120	100

Source: Field data (2012)

Table 8. Milk Market with Low Prices but Services Retained in the Chilling Plant

Variable	Dairy trainings	subsidized A.I	Subsidized feeds	Access to credit
Frequency	12	2	27	24
Percentage	7.8	1.3	17.5	15.6

$\chi^2 = 4.140$, df = 3, *Cramer's V* = 0.747, p < 0.05 (p = 0.047)
Source: Field data (2012)

The p value of 0.047 is less than 0.05 thus the null hypothesis is rejected while the alternative hypothesis is accepted indicating that the services offered by the chilling plants have an influence on small holder dairy farmers choice of milk marketing outlet. The Cramer's V value of 0.747 indicates a strong association between services offered by the chilling plant and smallholder dairy farmers' choice of milk marketing outlet. Farmers prefer a marketing outlet that offers more and with added services. In terms of the reason for joining the chilling plant, 5,8% joined because of the stability of milk price, 32.5% joined because of the good/high milk prices while 61.9% joined because of the services being offered. A majority of the smallholder dairy farmers indicated that the services offered by the Dairy Management Groups were the main attraction. The chilling plant offers a variety of services which are not offered by other market outlets and since smallholder dairy farmers would want more than just a good price, they end up joining the chilling plants. Among the services being offered, most respondents 46.7% indicated that they preferred easy access to credit facility, 28.3% indicated their preferred service was affordable

inputs, 19.2% indicated they preferred the free trainings on dairy management while 5.8% indicated they preferred the affordable A.I services.

Conclusions and Recommendations

The study found that the state of road infrastructure has an influence on smallholder dairy farmers' choice of milk marketing outlet. Farmers' access to market outlet is hugely influenced by the state of roads within an area. It determines if one can access a near market or a further outlet depending on preference. Thus, roads play a critical role in marketing of milk and other produce. The better the roads the more price benefit for farmers and the more the buyers thus competitive prices are offered by different buyers. It is therefore important that road infrastructure is improved within rural areas in Kenya especially the high agricultural potential areas. The study also found that most farmers who own pick-up trucks accessed further markets in Eldoret such as KCC while those with motor bikes and bicycle delivered their milk to chilling plant or transporters. Some who do not own any means of transport sold to hawkers or transporters despite their preference for KCC in Eldoret. A farmer's ownership of appropriate means of transport put him at an advantage to access any market outlet he prefers which is not the same with those who do not own any means. Finally, the study found that the services offered by milk chilling plants have an influence on smallholder dairy farmers' choice of milk marketing outlet within the district. From the study finding, farmers are looking for more than a better price. Most of the farmers who joined the Dairy Management Groups did so because of the services being offered with credit availability being the major attraction. They are able to offer credit to poor farmers because of low transaction cost involved compared to large commercial bank which fears the high transaction costs and risks involved in giving loans to farmers. At the same time, their role in providing inputs and trainings to farmers is also of importance and an alternative way of availing extension to farmers. Producer organizations have a major role to play in marketing of farmer's outputs as they avail other services to farmers as well as giving the smallholder farmers a bargaining power in marketing their produce. Yet still challenges exist for these organizations which face high transaction costs and a low bargaining power in product market. Thus they need support in-order to be able to overcome these challenges. These organizations have also given smallholder farmers avenues to air their voices in policy forums where issues that affect their survival are being discussed.

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Factors Motivating Graduate Students to Enrol for Post Graduate Studies at the University of Eldoret, Kenya

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Abstract

In Kenya, potential students have the opportunity to acquire tertiary education through several avenues including; diploma, bachelors', masters' and doctorate degree programs. Presently, undergraduates comprise the largest number of students at the University of Eldoret, (UoE). Little is known about the factors motivating some students to pursue post graduate studies. This study sought to establish factors that motivate graduates to enroll for postgraduate studies at the UoE. The study analyzed personal, environmental, and institutional factors as determinants of the academic self-efficacy. This study was conducted using ninety four participants at the UoE. Survey research design was used with instruments that measure the extent to which various factors influenced one's motivation to enroll for postgraduate studies. The study found that predictable time of course completion, favorable learning conditions and affordability of programs acted as motivators for masters' students. Friendly and qualified teaching staff and affordability of the program appeared to be the most important institutional motivating factor for doctoral students. However, the findings reveal that doctoral students expect to gain more respect than master degree students. Master students expect to acquire new jobs and cope with the current work place demands. The study recommends that the UoE should not only consider programs that are geared specifically to income, job, or career enhancement but also programs that offer personal motivation to the students. Additionally, the university should roll out a scholarship program for qualified and deserving students. Lastly, the study recommends that UoE should design programs that meet work place demands.

Keywords*: Motivation, Self-efficacy, Social Cognitive Theory*

Introduction

According to Maslow (1943), human needs are arranged in hierarchies. Subsequent psychologists suggested that these needs could be put in form of a pyramid in order of potency. The basic needs are placed at the bottom while the less pressing needs are placed at the top of the pyramid. Maslow lists five basic needs: physiological, safety, love, esteem and self-actualization. He described 'higher' needs as those that emerge after basic needs are satisfied. An individual may seek to acquire a new house, new clothes or higher education if physiological needs are satisfied, but not before, because the 'thirst' for these needs would become the primary importance if not satisfied. This order of needs is the hierarchy of basic human needs, according to Maslow.

Albert Bandura, on the other hand, put forward the social cognitive theory which provides a framework for understanding, predicting, and changing human behavior. This theory identifies human behavior as an interaction of personal, behavioral, and environmental factors (Bandura, 1986). According to Bandura's theory, a student acquires knowledge as his or her environment converges with personal characteristics and experiences. In other words, interactive learning allows students to gain confidence by developing skills learned in classes. According to Bandura (1986), People are self-reactors with a capacity to motivate, guide and regulate their activities.

Review of Literature

The term motivation is defined by Marshall as "the meaningfulness, value, and benefits of academic tasks to the learner—regardless of whether or not they are intrinsically interesting" (Marshall, 2007). Motivation is also considered as a complex concept, closely aligned with "the will to learn," and encompassing self-esteem, self-efficacy, effort, and goal orientation (Harlen & Crick, 2003).

This paper borrows largely from the concept of self-efficacy that lies in Albert Bandura's social cognitive theory, which postulates that human achievement depends on interaction between one's personal behaviors, personal factors (e.g., thoughts, beliefs), and environmental conditions (Bandura, 1986). In the context of this study, Bandura's theory of self-efficacy maintains that students are more likely to attempt, to persevere, and to succeed at tasks they pursue, if, from the start, they possess a "can-

do" sense of efficacy (Bandura, 1997). Bandura further describes his theory as determinant measures of how people think, behave, and feel (Bandura, 1994).

According to Ryan et al. (2000) people possess different degrees of motivation, and operate from different kinds of motivation. Students with a strong sense of self-efficacy are more likely to be internally motivated, challenging themselves with difficult tasks. These students will put more effort to meet their academic challenges to attain success. However, motivation is also influenced by external factors, such as the environment (extrinsic). When motivation is external, it is imposed on the student from the outside, such as from family members or teachers.

Personal Factors

Maslow (1943) described man as a being always in need, and that his physiological needs are the starting point for his needs. Of the physiological needs, food is the most important. An individual who lacks food would look for food much more strongly than for safety, love, esteem, and self-actualization. Everything else in life, goals, desires, and many more, would be defined as unimportant if the need for food is not being satisfied but once satisfied, one would move into the next level of needs. After a person satisfies his/her basic needs, then the other needs become of potency.

According to Maslow these 'other needs' are called esteem needs and include, improving one's job performance, to make more friends, to develop one's potential among others. For these individuals, education can be viewed as a hobby, by taking classes for fun or just to gain additional knowledge. Some students may also wish to pursue a career that has always interested them, as well as improve the overall quality of life for themselves and their family.

Environmental Factor

Environmental factors of motivation refer to tangible rewards such as compensation, fringe benefits, work environment, work conditions, and job security. Environmental factors fall under the 'Esteem' and 'Belonging' category in Maslow's Hierarchy of Needs. The environmental factors include: respect from others, love, affection, and being a part of group. Environmental motivation cannot be satisfied by the work itself, which means external rewards such as food, money, praise, and others are the main reason for a person to engage in activities (Deci, 2005). A student might pursue an advanced degree in order to fulfill the esteem need from his/her family, thus the student receives satisfaction, love, and affection from family members in return. Another reason could be to comply with peer pressure in one's extended or professional family, or to follow peers in order to be part of the group. Individuals may differ in their preferences. Some individuals may prefer economic rewards, while other individuals will favor intrinsic satisfaction and social relationships. Because preferences change over time, motivation needs to be sustained and developed as individual and organizational factors change (Mullins, 1999).
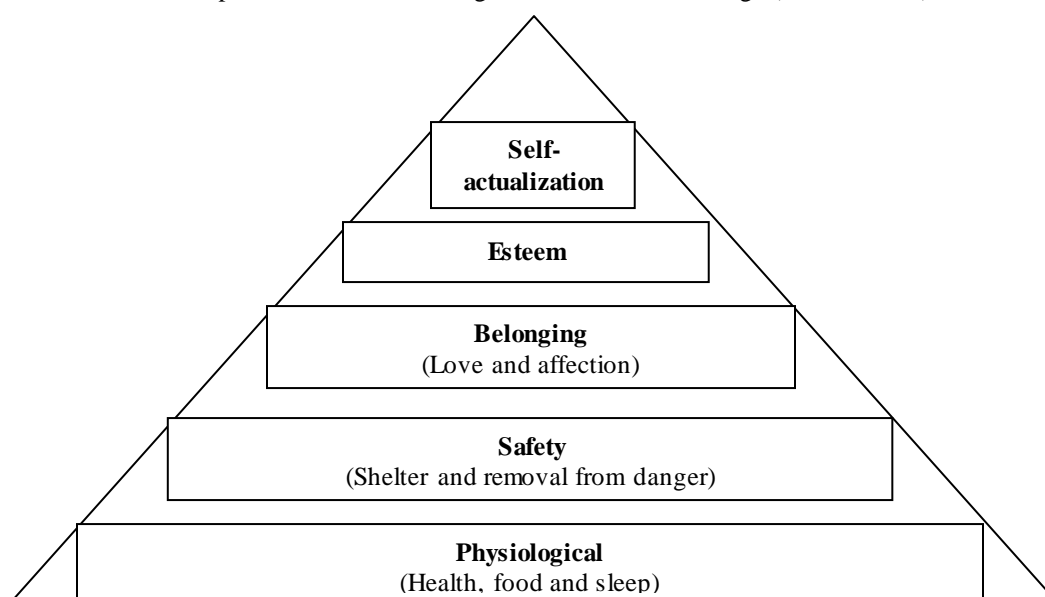
Figure 1. Maslow's Hierarchy of Needs model (Maslow, 1943; Gawel, 2008)

Statement of the Problem

Pursuing post graduate studies is both time consuming and expensive. Most decisions involve some form of costs and benefits considerations. Thus, people end up deciding to take an action only if the benefit is greater than the costs and the same holds true when deciding upon whether or not one has to enroll for postgraduate studies. With regards to this, the costs are not just those that are paid out in the form of tuition and books. The biggest cost in deciding whether or not to pursue such studies is the earnings a person could earn from a full-time job while still studying at the university. In addition to the costs, there is a lot of time commitment since most students pursuing such programs have other responsibilities such as part-time or full-time employment and family duties. In spite of the costs involved and the tremendous time commitment, students still enroll for postgraduate studies. Little is however known of the factors that motivate them to further their studies. The study at hand sought to establish the different motivating factors that make graduates to enroll for postgraduate studies at the University of Eldoret. The following questions were used as a guide to the paper.

- i. What are the personal factors that motivate graduates to enroll for postgraduate studies?
- ii. What are the environmental factors that motivate graduates to enroll for postgraduate studies?
- iii. What are the institutional factors that motivate graduates to enroll for postgraduate studies?

By establishing the factors that motivate graduates to enroll for postgraduate studies, university administrators and curriculum planners may be able to develop programs that will promote an environment that supports education advancement.

Methodology

A survey research design was used to carry out the research. This is a method of collecting information by interviewing or administering a questionnaire to a sample of individuals (Orodho, 2003). Cohen and Manion (2005) argue that the attractions of a survey lie in its appeal to generalisability or universality within given parameters, its ability to make statements, which are supported by large data banks, and its ability to establish the degree of confidence, which can be placed in a set of findings.

The study population consisted of all Masters and Doctorate (Ph.D.) students of The University of Eldoret. The population was stratified into Ph.D. and Master's degree participants. Participants were drawn from the different schools in the university. From these strata, ninety four participants were randomly selected and participated in the study. Structured and unstructured questionnaires were used to collect data. Additionally, interviews were conducted to respondents to obtain further information. The study had both dependent and independent variables. The independent variable was academic self efficacy while the dependent variables were personal, environmental and institutional factors.

Findings and Discussions
Personal Factors that Motivate Graduates to Enroll for Post Graduate Studies

The study sought to establish the personal factors that motivate graduates to enroll postgraduate studies. The findings of the study are summarized in the table 1.0 below:

Table 1.0. Group Mean for Personal Motivating Factors

Survey item	Doctoral students	Masters students	Overall
To develop my potential	5.91	6.40	6.20
To perform my job better	6.33	5.10	5.80
To be respected by peers	5.05	6.00	5.53
To gain more self confidence	5.24	5.61	5.40
To fulfill my personal objectives	6.50	6.42	6.53
To take the challenge of being in a postgraduate class	4.01	5.24	4.73

For purposes of this study, personal motivating factors refers to the acts of doing an activity for itself and the pleasure and satisfaction derived from participation (Deci & Ryan, 2001). An analysis of the means among the personal factors presented in table 1.0 shows that for both the doctoral and masters students, 'to fulfill my personal objectives' had the highest mean of 6.50 and 6.42 respectively. 'To take the challenge of being in post graduate class had the lowest mean for the doctoral group scoring a mean of 4.01.

It appears that the doctoral students were motivated to pursue Ph.D. studies to fulfill their own egos rather than for acceptance from their peers. This could be attributed to the fact that most doctoral

students have already acquired acceptance from their peers by virtue of being in possession a master's degree. Table 1.0 shows that 'to be respected by peers' had a mean of 5.05 way below 'to perform my job better' which had a mean of 6.33. This may be due to a possibility that doctoral students have already achieved their basic needs and are at the top of Maslow's pyramid where they need esteem needs.

Masters students however had 'to perform my job better' scoring the lowest mean at 5.10. This may be attributed to the thought that most masters' students had not been employed and thus had no jobs to improve on. Interestingly, most of the masters' students had 'to be respected by peers' as being among the major motivating factors. It may be explained by looking at masters students as still trying to achieve the belonging needs as put in Maslow's pyramid.

In general, the participants had differing opinions on personal motivating factors to pursue postgraduate studies.

Environmental Factors that Motivate Graduates to Enroll for Postgraduate Studies

The study also sought to establish the environmental factors that motivate graduates to enroll for postgraduate studies. The findings were recorded and summarized in a tabular form and are presented in table 2.0.

Table 2.0. Group Mean for Environmental Factors

Survey item	Doctoral students	Masters students	Overall
To get a job promotion	6.00	6.67	6.40
To acquire job security	5.27	5.59	5.53
To increase my income	5.22	4.63	5.00
Availability of a scholarship	4.42	1.42	3.12
To attain a higher social status	7.69	3.87	5.83
To acquire new job opportunities	3.12	7.23	5.31
To cope with work place demands	4.00	7.90	5.54
To obtain better working conditions	6.23	4.30	5.46
To work in an improved environment	6.15	5.47	5.80

This study looked at environmental factors as motivators that lead to tangible rewards such as compensation, fringe benefits, work environment, work conditions, and job security. These factors cannot be satisfied by the work itself, which means external rewards such as food, money, praise, and others are the main reason for a person to engage in activities.

An interesting survey item was 'to obtain better working conditions' for the doctoral students. This item scored a mean of 6.23 being the topmost ranked mean among other items. The reason for this may be perhaps majority of doctoral students already have jobs which they are not satisfied with making them advance their education and would therefore want to obtain better working conditions. When replying to 'to acquire new job opportunities', majority of the doctoral students did not find this as being one of their motivators. Perhaps this is because most doctoral respondents are in employment and thus are pursuing higher education for other purposes. Majority of the doctoral students however were of the opinion that 'to attain a higher social status' was an important motivating factor. Maybe, this could be attributed to Maslow's theory of needs which opines that after an individual satisfies the basic needs, he may continue up the pyramid to achieve self actualization.

Majority of the masters' students thought that 'to cope with work place demands' acted as a motivator for advancing their degrees. This had a high mean of 7.90. Perhaps this may be attributed to the ever increasing number of first degree graduates churned out of universities each year putting a lot of pressure on the limited jobs available in the market. Additionally, a significant number of masters' students thought that 'to acquire new job opportunities' acted as a motivator. This had a mean of 7.23. It may have been due to the limited job opportunities that a first degree holder could get and therefore they had to make themselves competitive in the job market. 'Availability of scholarship' scored the least mean among this group of students. Apparently, the harsh economic situation in the country has lead to considerable drop in the scholarships being offered. Therefore, very few students have access to this and may be the reason to the low mean mark posted in the table 2.0.

Overall, the respondents had differing opinions on the environmental factors that motivated them to enroll for postgraduate studies.

Institutional Factors that Motivate Graduates to Enroll for Postgraduate Studies

The study finally sought to establish the institutional factors that motivate graduates to enroll for postgraduate studies. A summary of the findings is presented in table 3.0.

Table 3.0. Group Mean Statistics for Institutional Factors

Survey item	Doctorate students	Masters students	Overall
Awarded a scholarship	1.30	0.00	1.30
Proximity to Eldoret town	5.49	5.00	5.49
Favorable learning conditions	6.10	4.47	5.31
Affordability of their programs	7.79	7.42	6.61
Advice from friends/parents etc.	4.22	5.23	4.80
Availability of the desired program	6.57	6.43	6.50
Predictable time of course completion	4.23	6.63	5.47
Competent and friendly teaching staff	3.79	5.55	6.53

Institutional factors for this study were taken to mean the variables that uniquely described the University of Eldoret. These were thought as a comparison of the university to the rest of the universities. For this particular factor, it was assumed that the respondents had adequate knowledge of other universities within the North Rift region. 'Affordability of their programs' emerged as the most important motivating factor for both doctorate and masters students. This had a mean of 7.79 and 7.42 respectively. In pursuit of education, the question of tuition fees acts a major hindrance to potential students. When the fees are high, generally the number of registered students is significantly reduced and vice versa. This may have been the reason of the mean posted in the table 3.0.

Most doctoral students thought that 'availability of the desired programs' acted as a major motivating factor, scoring a mean of 6.57. This may be as a result of the university rolling out several postgraduate programs for its potential students. However, 'award of scholarship' scored the least mean for the doctorate students, posting a mark of 1.30. Perhaps the university has not had a scholarship program for its students. It may be thought that since the university was recently a university college, maybe the program was restricted by the mother university.

Masters students additionally thought that 'predictable course completion time' acted as a major motivating factor. This scored a mean of 6.63. It may be thought that most master's students tend to inquire a lot before taking a course. Therefore, the possibility of advice from past students from the university could have been the reason of the mean scored by the respondents. Of the surveyed respondents, none had been offered a scholarship by the university. It is possible that none may have applied for a scholarship consideration by the university or the scholarship program is unavailable in the university or that none of those who applied qualified for the scholarships hence the score posted in the table 3.0. Generally, both doctorate and masters students seem to hold a common motivating factor in 'affordability of their programs'.

Conclusion and Recommendations

From the research results, it has been revealed that both doctorate and masters students have different motivating factors as pertains to personal and environmental factors. However, both groups of students appear to agree on one major institutional motivating factor- affordability of the university's postgraduate programs.

Based on the research findings, it is recommended that;

i. The university should not only consider programs that are geared specifically to income, job, or career enhancement but also programs that offer intrinsic motivation to the students.

ii. To increase enrolment in postgraduate programs, the university should roll out a scholarship program to qualified and deserving students.

iii. The university should design programs that cope with the market place demands of its graduates.

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Gender Inequality: Implication for Socio-Economic Development in Nigeria

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Abstract

This study used secondary data to examine Gender and Development in Nigeria. Human development is people-oriented in the sense that human beings are the end objectives of development. The search for freedom, well-being and dignity of individuals in all societies when individuals are not just passive recipients of progress has called for gender equality. Gender inequality is strongly correlated with poverty, making women at the low end of income distribution, at greater risk to sources of insecurity with implications for life expectancy. The study revealed that the ratio of male to female in socio-economic and political development is very low. This is evidenced in the great disparity of women participating in politics, access to education and public goods, employment opportunities, access to bank loans, land and property, high rate of maternal mortality and many more. The paper recommends that there is the need to bridge the gap between the male and female for any meaningful development to take place. This can be done by allowing people to have equal opportunities to education, effectively adopted and appropriately enforced gender quota, changing cultural beliefs, empowering women to contribute to economic growth and allow women to have access to land like their male counterparts.

Introduction

Gender deserves central attention in any discussion of economic and social development. No one would deny the major significance of demographic change for development and policy-making including its impact on the gender division of labour (Beneria, 2003). The United Nations Nigeria Common County Assessment has remarked that little regard is paid by policy makers to gender issues. The report states that females in Nigeria have a lower social status than their male counterparts, despite their crucial role in society; Nigerian women are dominated, discriminated against and even disinherited by their relatives (Hodges, 2001). Women constitute half of the world's population and have contributed significantly to the well-being of the human race. In Nigeria, for instance, women have always played five key roles - mother, producer, home manager, community organizer, socio-cultural and political activist (UNDP, 1996). In the vast majority of African countries, women and girls are less well nourished, more prone to poor health, sexual abuse and violence and have less legal protection including fewer legally guaranteed property contract and religious rights. They are frequently subject to the double burden of employment and household responsibilities, which can take a toll on their emotional and physical well-being (Rosenberger & Sauer 2012, p.9).

Socio-economic inequality describes the disparity not only in income but in education, health, employment and political participation. It is an established fact that all forms of inequality are detrimental to socio-economic development and well-being. Their severity seems to be more pronounced when viewed from the gender perspective, more so, if the distribution or allocation of those resources is biased against women (ADB, 2002a; Evans, 2001). As Safilios-Rothschild (1991) puts it "a society that has a powerful gender stratification system that tends to place men in decision making positions with men relegated to traditional training and economic activities with limited demand that do not provide them with adequate means of livelihood is an endangered society. For instance, if the gender inequality is such that leads to women's having less access to education and skills for productive employment, it will have a far-reaching effect in terms of poverty creation and perpetuation in the present as well as in the next generation"(Quisumbing & Maluccio 1999; Filmer 1999; Klasen 1999).

Measures that have been developed in the past to track socio-economic gender inequality remain an unfounded issue because women have continued to be at the disadvantaged end. In the United Nation Development Programme gender-related measures suffer from a range of flaws and have it has also not been able to fill this gap. The focus of this paper, therefore, is to examine gender inequality and its implications for socio-economic development in Nigeria.

Statement of the Problem

The growing concern for gender equality is an attempt to search for freedom, well-being and dignity of individuals in all societies when individuals are not just passive recipients of progress. Inequality is a key factor in producing a wide range of social ills such as education disadvantage, health inequality, crime and may undermine social cohesion. It relates with economic performance but in a much more complex fashion than a simple trade- off between growth and inequality (Nolan, 2009). The existing literatures in Nigeria attest to the male dominated agriculture linked to the disproportionate male access to resources and information required to produce crops more efficiently than their female counterparts (Fasoranti, 2006; Otitoju & Arere 2010; Liverpool-Tasie *et al.,* 2011). Low female capital relative to male levels may lead to slow growth of incomes and of well-being, and conversely, the pattern of economic growth may not benefit different genders fairly (Palmer-Jones, 2008).

In Nigeria, gender inequality in disfavor of women features prominently in access to and control of land, credit facilities, technologies, education and health and as a result, women are more vulnerable to poverty than men. In Nigeria, the inequality level is said to have worsened and many studies using household survey income and consumption concept document this fact. Gender inequality has made women and girls to be more prone to poor health, sexual abuse, violence and be less well nourished. The problem of this study therefore, is that of great disparity between men and women which could be attributed to their level of participation in politics, access to education and public goods, employment opportunities, access to bank loans, land and property, high rate of maternal mortality.

This study sought to find out the socio-economic implications of gender inequality in Nigeria. It sought to find out the reasons for gender inequality in Nigeria, examine the ratio of men and women in employment and politics, discuss the socio-economic implications of gender inequality and suggest possible solutions.

Conceptual Framework

There are two basic concepts that are central to the title of this paper, these are gender and gender Inequality.

Gender

In understanding the concept of gender, there is a need to make a clear distinction between sex and gender. Sex refers to biological differences between male and female, whereas gender refers to socially constructed differences between men and women. It is preferable to talk about gender instead of sex because sex is typically not socially interesting (D'Amico & Beckman, 1995). Sen (1999) states that there is a danger to confuse the term 'gender' with women. He posited that the concept of gender is not limited to the male or female species, but goes further to assess the relationship between them.

According to Cassell (2002), gender refers to a sense of being male or female or having the recognizable traits of one's sex. The characteristics and behaviours that are generally associated with being a male are called masculine and those associated with being a female are called feminine. Masculine and feminine usually refers to a combination of physical traits such as bodily shape, voice and facial hair and acquired characteristics such as hair style, clothing, body movements and display of emotions. Olujobi (2001) refers to it as a division of humanity into two distinctive categories based on their sex. To the sociologists, it is used to denote the roles played by women and men and deals not only with the differences but also with how the society confers power on each of the sexes.

Gender, therefore, in a simple term is the established socio-cultural dichotomy drawn upon biological categorization of male and female. This singular biological difference has far reaching effects on these established categories: male and female in relation to status, roles, power and privilege. It has for a long time been the determinant factor for social relations and economic activities in our society (Chikwe, 2003).

Gender Inequality

Canada-Ukraine Gender Fund (2004) states that gender equality means that women and men enjoy the same status and have equal opportunities for realizing their full human rights and potentials to contribute to national, political, social, cultural development and to benefit from the result. On the other hand, inequality is often referred to as lack of equality; being unequal in amount, size, value or ranks; lack of eveness, uniformity; lack of due proportion or even distribution of resources (World Book, 2002). Gender inequality also means a situation where women do not have the same rights and enlightenments as men to human, social, economic and cultural development and where women do not have equal voice in civil and political life (Evans, 2001). It is a situation of uneven distribution of income, lack of access to

productive inputs, such as credit and education, lack of command over property or control over earned income as well as gender biases in labour market and social exclusion between men and women (Cagatay 1998; Harris-White & Saith 1997; Ravari 1998).

Klasen (2002) observed that gender inequality in education may undermine a number of development goals. First, gender inequality in education and access to resources may prevent reductions in fertility and child mortality and the expansion of education of the next generation. Second, gender inequality in education may reduce economic growth, which if it is low, investment rate will also be low because countries with lower human capital are said to always have smaller returns on investments. An index called gender inequality index is used for measurement of gender disparity that was introduced in the 2010 Human Development Report 20th anniversary edition by United Nations Development Programme. According to UNDP, this index is a composite measure which captures the loss of achievement within a country due to gender inequality, and uses three dimensions to do so: reproductive, health, empowerment, and labour market participation.

Theoretical Orientation

Gender inequality is a concept that is often used by scholars without a vivid understanding. In this paper, a theoretical framework is required to enrich our knowledge and to form the basis of moving forward. Bras (1987, p. 7), observed that "good theory is the accurate generalization of practice". The theoretical orientation adopted is the Liberal Feminist theory. The feminist political theorists have argued that the appearance of neutrality toward gender or equality between men and women in government actually hides substantial gender inequality (Rosenberger & Sauer, 2012). This theory challenges male dominance and advocates social, political and economic equality of women and men in society (Riger, 1998). The theory grew out of the social contract theories of the 16th and 17th Centuries and flowered in the 18th Century when its ideals in individual rights, freedom and equality were put to test in the French and American revolutions. It begins with the assertion that, as human beings, women have a natural right to the same opportunities and freedom as men. Their approach has been to fight these by campaigning for changes in laws that discriminate against women, gaining rights for women that were previously enjoyed by men (For example, Suffrage); Within the Nigerian context,these ideals were first tested during the Igbo Women's riots of 1929 and the demonstration of Egba women against flat rate tax (Udegbe, 2001).

From the above, it is obvious that gender inequality fits into this orientation in view of the disparities between men and women in employment, income, access to resources etc.

The Need for Gender Equality

The Food and Agricultural Organization (2001) listed the benefits of taking gender concerns into consideration in the design, implementation and review of development programmes as:

    a. Enhanced social and economic impact;
    b. Increasing possibilities for successful action;
    c. More efficient use of resources; and
    d. Tapping local knowledge.

Enhanced social and economic impact: Sustainable development depends on integrating environmental, technical and economic consideration with social and cultural aspects. The active participation of men and women in gathering information differentiated by gender and the analysis of this information will lead to a more positive social impact. Economic impacts will also be reinforced because the possibilities for consolidating and increasing income related to natural resources will take into account income generating activities carried out by both women and men.

Increasing possibilities for successful action: Sustainable rural development should take into account gender based division of labour and gender-based access to resources. Control of resources will result in development initiatives based on more complete information. Furthermore, rural development based on the full range of social, economic, technical and environmental issues opens up the opportunity for greater exchange of ideas and approaches among the different sectors.

More efficient use of resources: Taking into account social, environmental, technical and economic considerations will ensure that development activities make better use of often increasingly diminishing resources available.

Tapping local knowledge: Tapping the respective knowledge of women and men regarding the management and conservation of natural resources and biological diversity increases the possibilities of successful programmes. Thanks to the collection of gender inequality data for planning and management. It is possible to guarantee that this invaluable source of local technical knowledge is fully utilized

Causes of Gender Inequality in Nigeria

Lack of access to resources: The existing literatures in Nigeria attest to the male dominated agricultural linked to the disproportionate male access to resources and information required to produce crops more efficiently than their female counterparts (Fasoranti, 2006; Otitoju & Arere 2010, Liverpool-Tasie *et al.,* 2011). According to Ajani (2008), women are marginalized in their access to economic, political and social resources compared to men, rendering them relatively less powerful than their male counterparts. Duflo(2006), points out that weak or non-existent property rights for women, especially in Africa; are identified as creating production ineffectiveness. He argues that weak property rights prevent women from renting land to their husbands because if the husband works the land long enough, the wife may lose her property rights.

Employment opportunities: The gender dimension for 2004 and 2005 revealed that unemployment rate was higher for the female group at 11.2 per cent and 14.1 per cent in 2004 and 2005 respectively. Mustapha (2004) linked the historical foundation of inequality in Nigeria to difference in education. Women generally have less education than men, particularly so among some social groups in the northern regions.

Cultural practices: Cultural practices of many contemporary societies are biased against women and serve to subjugate them to men and to undermine their individual self-esteem. For example, the Nigerian society is permeated by patriarchy whereby women are expected to conform to and confine themselves to male dominance and female subservience. Women are seen to belong to the home, be incapable of making sound decisions and it is unbecoming of women to expose themselves in public for political activities such as campaign rallies. Men often find it incredible and impracticable to see them participating in politics (Iloh & Ikenna, 2009, p. 124; 2003, p.336).

High rate of maternal mortality: In the vast majority of African countries, women and girls are less well-nourished and more prone to poor health. Poor nutrition creates special health risks for pregnant and lactating women. With the Millenium Development Goals (MDGs) that set to expire in 2015, studies show that the goals have spurred significant progress, but yielded uneven results, including continuing lack of progress in reducing maternal mortality. About 800 women die every day due to childbirth and other pregnancy related complications (United Nation, 2013).

Unequal access to education: On the national level there continue to be disparities in access to education and other public goods. The inequality between men and women in educational attainment has encouraged low level of participation of women in politics. Some women in Nigeria naturally subject themselves to domestic activities and the need to prevent broken homes. The United Nations (1995) posits that education is the basic tool that should be given to women in order to fulfill their role as full members of society.

Government legislation: The position of women in any given society is less governed by the existing legislation on equality of opportunity than by institutional factors such as action labour market policies, the allocation of time in paid and unpaid work (Beneria, 2003).

Poverty: Gender inequality is strongly correlated with poverty, making women at the low end of income distribution at greater risk to sources of insecurity with implications for life expectancy (Rosenberger & Sauer, 2012).

Violence against women: Women are regularly exposed to various forms of physical, psychological, sexual and emotional violence. This can be traced to the unequal power relations in society between men and women and the pervading patriarchal norms that support the inequality.

Implications of Gender Inequality for Socio-Economic Development in Nigeria

Klasen (2002) observed that gender inequality in education may undermine a number of development goals. First, gender inequality in education and access to resources may prevent reductions in fertility and child mortality and the expansion of education of the next generation.

Second, gender inequality in education may reduce economic growth. This is drawn from the importance of human capital to economic growth, which if it is low, investment rate will also be low because countries with lower human capital are said to always have smaller returns on investments. Palmer-Jones (2008), asserted that low female capital relative to male levels may lead to slow growth of incomes and of well-being, and conversely, the pattern of economic growth may not benefit different genders fairly. Klasen (1999) points out that the period 1960 to 1992, between 0.4 and 0.9 per cent of annual per capita growth differences between East Asia, Sub-Saharan Africa, South Asia and the middle-East can be attributed to gender basic differences in education.

Studies have shown that gender inequality has continually increase maternal mortality. Africa has the highest rate of maternal mortality in the world (roughly 50times higher than developed countries) (Rosenberger & Sauer, 2012). About 800 women die every day due to childbirth and other pregnancy related complications (UN, 2013).

Gender inequality breeds poverty. As Safilios-Rothschild (1991) puts it, a society that has a powerful gender stratification system that tends to place men in decision making positions with women relegated to traditional training and economic activities with limited demand that do not provide them with adequate means of livelihood is an endangered society. For instance, if the gender inequality is such that leads to women having less access to education and skills for productive employment, it will have a far-reaching effect in terms of poverty creation and perpetuation in the present as well as in the next generation (Quisumbing & Maluccio 1999; Filmer 1999; Klasen 1999).

Materials and Methods

The study adopted descriptive survey research design. It describes in a systematic manner the characteristic features or facts about a given population. It specifies who and what to be measured (Adekoya & Adetore, 2007). The method of data collection was through secondary sources such as books, journals, magazine, newspapers, and internet materials. Descriptive method was used to analyze the data collected.

Results and Discussion

Gender Inequality in Nigeria: An Overview

The idea of gender equality in the decision-making process is considered pertinent for the proper development of any country. A recent publication by the Federal Office of Statistics, FOS (1998/99) contains gaps between women and men in policy, investment and employment in Nigeria and what is needed to reduce the gaps and create equal opportunities for women in health, in education, in work and in decision making at all levels (Owo, 2010). Table 1 shows the summary of employment by year and gender between 2001 and 2005 in Nigeria.

Table 1. Summary of Employment by Year and Gender (2001-2005)

Year	2001	2002	2003	2004	2005	Total	Average
Women	19.28	20.05	20.78	20.95	21.06	19.95	20.42
Men	80.72	79.75	79.22	79.05	78.94	80.05	78.58
Total	100	100	100	100	100	100	100

Source: National Board of Statistics, 2006

In table 1, the average employment of women between 2001 and 2005 was 20.42 per cent while the average employment of men within the same period was 78.58 per cent of the population. This implies that men constituted the largest percentage of population that was in the labour force. This showed a wide disparity between men and women in relation to employment in the country. The study revealed that over a period of five years, there was a stable growth of 20 per cent of women in employment.

Table 2. Percentage of Women and Men in Federal Civil Service

Year	2001	2002	2003	2004	2005	Total	Average
Women	28.5	28.7	30.7	29.5	39	61	31.28
Men	71.5	71.3	69.3	70.5	78.94	80.05	68.72

Source: National Board of Statistics, 2006

In table 2, the average percentage of women employed in the federal civil service between 2001 and 2005 was 31.28 while the average percentage of men employed within the same period was 68.72. This is an indication that men had greater employment opportunities in the federal civil service than women.This may be due to the low level of education of women during this period. It can also be attributed to the fact that women decided to take up low-paid jobs in the private sector.

Table 3 shows gender representation in National Assembly (Senate and House of Representatives) in the election of 1999, 2003, 2007 and 2011.

Table 3. Percentage of Men and Women in the National Assembly

House of Senate	Total Number of Seats available	Men	Women	% of Men	% of Women
1999	109	106	3	97.2%	2.8%
2003	109	105	4	96.3%	3.7%
2007	109	100	9	91.7%	8.3%
2011	109	102	7	93.6%	6.4%

Source: The Nigeria CEDAW NGO Coalition Shadow Report (2008), New York, United Nations Committee on the Elimination of all Forms of Discrimination against Women.

The above data indicates that the 2007 polls witnessed a slight increase in the number of women in the Federal legislature. In 2003, the percentage of females was 3.7% for the Senate and 6% for the House of Representatives while that of males was 96.3% for the Senate and 94% for the House of Representatives. In 2007, the figure rose to 8.3% in the Senate and 7% for the House of Representatives for females.

In 2011 polls, 7 female Senators (6.4%) and 19 Representatives (5.28%) were elected while 102 male Senators (93.6%) and 341 Representatives (94.72%) were elected.

Table 4. Participation in Elections by Gender in April 2011 Nigeria

Office Contested	Female Candidates	Male Candidates	Total
President	1 (0)	19 (1)	20
Vice President	3 (0)	17 (1)	20
Governor	13 (0)	340 (36)	353
Deputy Governor	58 (1)	289 (35)	347
House of Representatives	220 (19)	2188 (341)	2408
Senatorial	90 (7)	800 (102)	890

Source: Salihu (2011: 70-71) in brackets are the elected

Table 4 shows participation in elections by gender in April 2011. It reveals that the number of female participants in each position was relatively too low when compared with the number of male participants. Also, in all the positions 27 females were elected while 516 males were elected. This makes one to conclude that women level of participation in politics and their representation in government is very low compared to their men counterparts.

House of Representatives	Total Number of Seats available	Men	Women	% of Men	% of Women
1999	360	347	13	96.4%	3.6%
2003	339	318	21	94%	6%
2007	358	333	25	93%	7%
2011	360	341	19	94.72%	5.28%

In summary, the available statistics on gender representation at all levels of public decision-making especially in the two houses of National Assembly shows that political participation by the female is still very much in its infancy. In other words, representation of female in National Assembly is relatively low compared to their male counterparts.

Conclusion

From the above discussion, the following are the summary of the findings:

1. There was a great disparity between men and women in employment in Nigeria. Men constituted largest percentage of the population in the labour force.
2. The percentage of women employed in the federal civil service was relatively low compared to their men counterparts.
3. In decision making process, women were few in number when compared to men. The study revealed that the percentage of women in the house of senate was as high as 8.3% and as low as 2.8% while that of male was as high as 97.2% and as low as 91.7%. In the house of representative, the percentage of women was as high as 7% and as low as 3.6% while that of men was as high as 96.4% and as low as 93%.
4. In their participation in election for the position of the President in 2011, 1 female candidate contested while 19 male candidates contested.

This paper has focused on gender inequality in Nigeria and its implications for socio-economic development. It has been established that there is a great disparity between men and women in income level, employment opportunities, education and public goods, health facilities, access to resources etc. Invariably, this inequality has led to poverty among women, high rate of maternal mortality and dwindling economic growth. What has been responsible for this inequality was not unconnected with women lack of access to resources like land, cultural practices of the society especially the patriarchal nature of Nigerian society among others. Thus, there is the need to bridge the gap between men and women so that socio-economic and political development of the society can be enhanced.

Gender quota should be effectively adopted and appropriately enforced, land reform that can enhance the contribution of women to socio-economic development should be designed in their favour. Also, an empowerment programmes that will help in full utilization of women should be introduced. Finally, an enlightenment programmes that promote gender training and raise women cultural awareness should be introduced.

Recommendations

From the above discussion, the results show that there was a great disparity between men and women in employment opportunities, decision-making, labour force and participation in election. The findings derived from this study have serious socio-economic and political implications for development of the country.

The United Nations Organization has fostered several declarations and conventions aimed at ending all forms of discrimination, including specifically discrimination against women. Among such international documents that prohibit discrimination based on sex are the Universal Declaration of Human Rights, the International Covenant on Civil and Political rights (UNDP, 1997). The Nigerian government has also formulated National Policy on Women (Dauda, 2004, p. 93) which aimed at effective enforcement of the principles and provisions contained in the Nigerian constitution. In this case, gender quota should be effectively adopted and appropriately enforced.

Socio-economic development can take place when men and women are given equal opportunities. Therefore, women should have access to more resources. Also, land reform that takes into consideration the contribution of women to socio-economic development should be in favour of women.

Entrepreneurship programmes that will empower women should be organized; this can be done by setting up micro-credit institutions to make funds available to the women folks. Hassan-Liman (2005), asserts that full utilization of women in the development of human resources would bring about their acceptance in every phase of national development.

UN women has launched a call to galvanize the gender equality agenda and ensure concrete action that will enable women and girls to truly live as equal citizens everywhere (Pravada.Ru, 2013). The Civil Society Organizations in Nigeria should organize awareness programmes that promote gender training and raise women cultural awareness, particularly in the areas of gender relationships.

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How Student Characteristics Influence the Performance in Biology Subject in Secondary Schools in Eldoret Municipality, Kenya

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Abstract

Performance in Biology has continued to be poor yet it is an important subject for the attainment of the Millennium Development Goals (MDGs) and vision 2030. Poor performance would not be able to keep abreast with the opportunities and better off, face the challenges of the MDGs on science and technology and vision 2030 which are part of the competitive growing globe. This paper focuses on student characteristics that influence performance of students in Biology subject in secondary schools in Eldoret municipality. The study was conducted through an ex post facto design. A total of ten secondary schools out of 30 were selected to make up the sample. Target respondents were form three students within Eldoret municipality. The study sample made up of 200 respondents was obtained using stratified sampling, due to differences in characteristics, such as single sex schools versus mixed schools and differences in school category. Simple random sampling was used to pick the streams and specific students who participated in the study. Purposive sampling was used to obtain Biology students. The data was collected using questionnaire and interview schedule, before it was coded and analysed using statistical package for social science (SPSS). The results were presented using inferential and descriptive statistics and analysed using both qualitative and quantitative techniques. It was established that student characteristics affecting performance of Biology subject in Eldoret municipality are: students' interest in Biology (theory and practical), ambition, attitude and ability to do practical. The study is in order with the education policy in Kenya, which emphasizes continuous development of science education. The study sought to fulfil this policy by finding areas that need improvement in performance of Biology.

Keywords: *Student Characteristics, Performance, Biology Subject, Secondary Schools, Eldoret*

Introduction

Students' academic achievement is usually an important aspect in the process of teaching and learning at all levels of the academic ladder. Teachers would want to see the kind of progress the learners make after undergoing a certain course. The same case applies to the education stakeholders – government, parents and learners too. Academic performance is usually established through tests or examinations, which consist of set questions or problems that seek to determine how much an individual knows about the subject area as a result of learning experience.

Science and Biology specifically are important to an individual because it provides knowledge that is useful in healthcare, careers such as medicine, agriculture, public health, veterinary practice and environmental conservation. Kenya can employ Biology in solving issues such as food shortage, climate change, poor health services and misuse of environmental resources, for example forests, wildlife, water and soil.

Kenya's ability to manage its resources effectively is geared towards the attainment of the millennium development goals (MDGs) to which Kenya is a signatory. Fulfilment of the MDGs can steer Kenya towards achieving the vision 2030 of being an industrialized nation.

The world is dominated by technologies, which force every nation to strive to keep abreast with the scientific and technological advances besides integrating it into its education system (Jebet&Naserian, 2003). It is a fundamental requirement if the world is to be transformed into a better place to live in, because Science plays a key role in a country's everyday life. Many African countries treat the training of scientific and technological personnel as a top priority. This is due to the recognition of the fact that rapid social and economic development is not easy to achieve in the absence of qualified doctors, engineers, researchers, teachers and technicians, among other professionals.

As a country, Kenya must address herself to the quest for scientific knowledge in order to develop and sustain the necessary technologies to compete effectively in the global scene. Science education is an important component for technological development in the Kenyan society. Eshiwani (1982) argues that more formal and intensive Science education at secondary level is necessary in order to

prepare the future scientists and technicians. The skills acquired by such people will be useful in areas such as health, agriculture and industry.

The study sought to look into the student characteristics that influence students' performance in Biology subject in secondary schools in Eldoret Municipality of the former Uasin-Gishu district, now Uasin-Gishu County. Uasin-Gishu is part of Rift Valley region which is regarded as the food basket for the country, due to its production of maize, wheat and livestock farming. This area of production requires adequate knowledge in Biology among students most of whom will revert to farming after school. Biology subject has been characterized by poor performance in national examinations (MoEST, 2005). There is a nation-wide outcry that performance in Sciences (Biology included) is poor and the trend has been observed for some years. An outcry was expressed through a press statement by the minister of education after the 2008 KCSE results were released. The minister lamented over the poor performance in Biology among other Sciences (Aduda, 2009).

It is difficult to envision a developing nation being unable to achieve technological advancement with a large manpower base ignorant or unable to handle the same technology, owing to inherent phobia to Sciences. It calls for concerted efforts to reverse this trend, if the projected growth is to be achieved. Education stakeholders continue to invest heavily in the education of young Kenyans year after year with the hope that the inputs would be equivalent to the outputs if not better. The immediate expected output from the education system is good performance in examinations. However, the performance continues to be poor in general. Of great concern is the learners' performance in Science given that it is core to the attainment of the national goal of industrialization by the year 2030.

Attitudes affect achievement and achievement affects attitudes (Owiti, 2001). Owiti in his study revealed that attitude influences performance and performance influences attitude. This study will determine whether students' attitude (positive or negative) influence their performance in Biology. Njuguna (1998) argues that, emotional attitudes can have a profound effect on our learning efficiency. The kind of attitude one holds in a learning situation therefore is of great significance. The attitude aspect has caused considerable concern in education. Munn, Fernald and Fernald (1972, p.606) argue that "attitudes are learnt predispositions towards aspects of our environment". They involve the tendency to evaluate something in a positive or negative way. An attitude consists of three basic components these are, thinking, feeling and reacting. The thinking component involves self-belief. Feeling component involves issues related to value. Reacting component involves tendency to behave in a certain way.

Njuguna (1998), further argues that a human infant is born without any concept of themselves, any attitude or value system. Their self-concept and attitudes towards other objects develops with the development and their interaction with their "significant others". Such persons are teachers, peers and parents. A child who receives positive perceptions and expectations from their significant others develops a positive self-concept. Positive self-concept influences motivation and performance in tasks. If a child is motivated and achieves highly in a task, that child will have positive attitudes towards that task. However, low motivation leads to negative attitudes thus low performance. Children in our schools fail to benefit from teaching, not because they do not have the ability but because of their self-view, which determines to a great extent what they do or avoid, and what they see or ignore (Njuguna, 1998). The home, school and society offer varied and important conditions for the child's acquisition of values, cultures and or development of self-concept all of which influence academic performance.

One major problem of Science education in developing countries, identified by students, is the feeling that school Science is like a foreign culture to them (Maddock, 1981) cited by Aikenhead (1997) and Jegede (1995). Their feelings stems from fundamental differences between the culture of western Science and their indigenous cultures.

One may wonder whether the kind of attitudes held towards learning by students is related to the failure or passing usually noted in many examination situations. A clear answer to such an issue may help us to know how to respond to both encouraging and discouraging learning situations. Physiological factors play a major role in learning. Driver and Bell (1986) as quoted by Fensham says:

> "Learning outcomes depend not only on the environment, but on the knowledge, purposes and motivations that the learner brings to the task. That is, the ideas and beliefs we already hold will be of major influence on the interpretation we place on what we are taught"(Fensham,1988, p.77).

According to Driver and Bell (1986 in Fensham 1988, p.78), "the learners have the final responsibility for their learning…. in that they decide what attention they give to a learning task, construct their own interpretations of meaning for the task and evaluate those meanings". Norwich and Jaeger (1989, p.314) indicate that, "there is at best an explicit or implicit assumption that the attitude to school subjects should be related to achievement, if only on the grounds that positive attitude leads to greater

achievement". Further, Shumba (1993) agrees that attitude is related to achievement. Those who have positive attitudes are viewed as people who achieve highly while those holding negative attitudes have low achievement. Shumba (1993) also notes that it is generally assumed that attitudes influence future behaviour and career choices. Considering the above, it is worth launching an endeavour based on a rationale that, a child's attitudes may be related to his/her achievement in Science subject; specifically, in Biology. This paper, thus, sought to establish whether student characteristics such as interest, ambition, attitude and ability to perform practical tasks influence their performance in Biology.

Materials and Methods

The paper adopted an ex-post-facto design. This is a design in which the study variables are not exposed to direct manipulation or intervention on part of the research. However, the researcher provided as much control as possible under the existing conditions. The research control was limited to the responses to specific category of form three students in the selected schools.

The study was conducted in 10 selected secondary schools in Eldoret municipality, Uasin-Gishu county. There were 30 secondary schools within the municipality at the time of the study, schools were selected on basis of whether they were boys', girls', or mixed schools using stratified sampling. During sampling, 75% of girls' and 100% boys' schools were selected while 20% of the mixed category were sampled. Simple random sampling was used to select the girls', and mixed category. Purposive sampling was used to pick twenty students in the sampled stream because only students who studied Biology were used for the study.

Data was collected from the sample selected using questionnaires and interviews. Both qualitative and quantitative data analyses were used. Qualitative analysis involved derivation of explanations and interpretations of results and trying to establish relationships from gathered information. Quantitative analysis involved derivation of statistical descriptions and interpretation of data by use of descriptive statistics.

This study sought to answer the following questions:
1. Do Students' Interest in Biology influence performance?
2. Do Students' Interest in Practical Influence Performance in biology?
3. Do Students Ambition Influences Performance?
4. Do Students Attitude towards Biology Influence Performance?
5. Do Students Ability to do Practical Influences Performance in biology?

Results and Discussions
Do Students' Interest in Biology Influence Performance?

The study sought to establish whether students' interest influences performance in the subject. It was found that majority (92%) of the respondents agreed that students' interest influences performance in Biology. This is so because having interest in Biology cultivates students' positive attitude towards the subject, hence enabling the student to work hard. Respondents mentioned doing self study on the subject, asking for assistance from teachers in areas of difficulty, forming discussion groups, high scores in the subject, dedicating more revision time for the subject, having a personal time table which guides students' private studies, and working under less supervision, as some of the attributes that trigger improved performance in Biology. The study established that an interest in Biology influences performance because it provides the drive within students to participate in the learning process.

Do Students' Interest in Practicals Influence Performance in biology?

Practical exercise entails application of theoretical concepts by performing experiments. Having interest in something drives an individual towards working hard to achieving it. The study therefore, sought to establish whether student having interest in practical exercises influences performance in Biology. The findings showed that 81.5% of the respondents indicated that student interest in practical influences performance in Biology.

Student's willingness to participate in practical activities especially when in groups improves the performance in Biology (SMASSE INSET, 2004). Through participation, scientific skills for hands on/practical skills are developed. Moreover, Biology practicals supplement good marks to those students who are weak in theory (KNEC, 2007), hence influencing the performance. One student respondent in an interview said, "*Biology practical is my savior, I love it since I am weak in the theory section*". From the findings, respondents indicated that other than an interest in the subject, an interest in the practicals greatly influences performance in Biology.
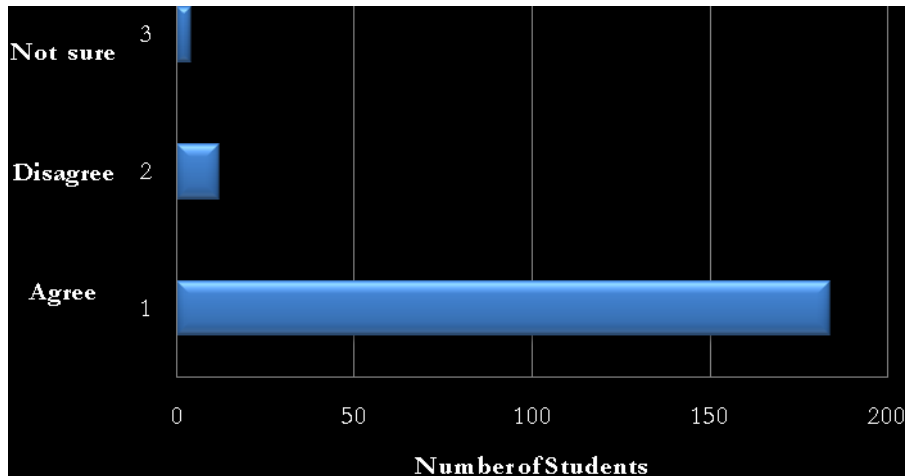
Figure 1. Does Students Interest in Practical Influence Performance in Biology?

Do Students Ambition Influences Performance?

Most students have got a personal ambition/dream for the future career and therefore, work towards accomplishing the ambition. Therefore, the study sought to establish whether students' ambition influences performance in Biology. The study found that majority (76.5%) of the respondents indicated that student ambition influences performance in Biology.

Majority of the respondents argued that most students have already set the target that they want to achieve, such that the desire within them acts as a drive to work hard for success or an achievement. Thus, great performance in the subject will be achieved if students' ambitions are linked to it. For example, students opting to pursue the medical profession will be more interested in studying Biology than those opting for the engineering field and thus, influencing performance of the subject. One respondent said; "*mimi napenda bio sana kwa sababu ningependa kuwa daktari maishani ilinisaidi e wagonjwa.*" Meaning that, I love Biology so much because I want to be a doctor so that I may help those who are sick. The findings also showed that 28 student and three teacher respondents indicated that students' ambition could influence performance in Biology because according to them, it was still early for students to decide what they wanted to be in life, this could be done at college level thus, to them, ambition was not the issue as far as performance in the discipline was concerned. It emerged from the study that ambition contributes to performance; it cultivates independence, building the desire to study thus posting good results. The researcher noted the dream of learners influences their output.
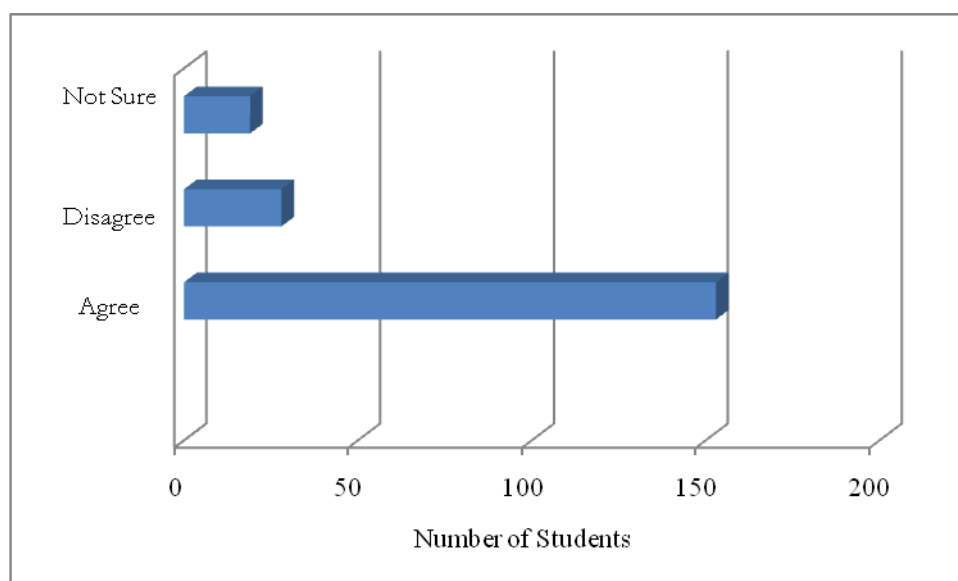
Figure 2. Does Student Ambition Influence Performance?

Does Students Attitude towards Biology Influence Performance?

Positive attitudes in students help to improve performance. It was found that majority of the respondents (89.5%) agreed that attitude influences performance. On the other hand, negative attitude contributed to lack of motivation in learners hence hindered them from performing well. Positive attitude cultivated students' ambitions and morale of what they wanted to be in future hence, worked hard under minimum supervision. The problem the researcher noted lied in the attitude; if the attitude was positive there was good performance and if negative, there was poor performance.
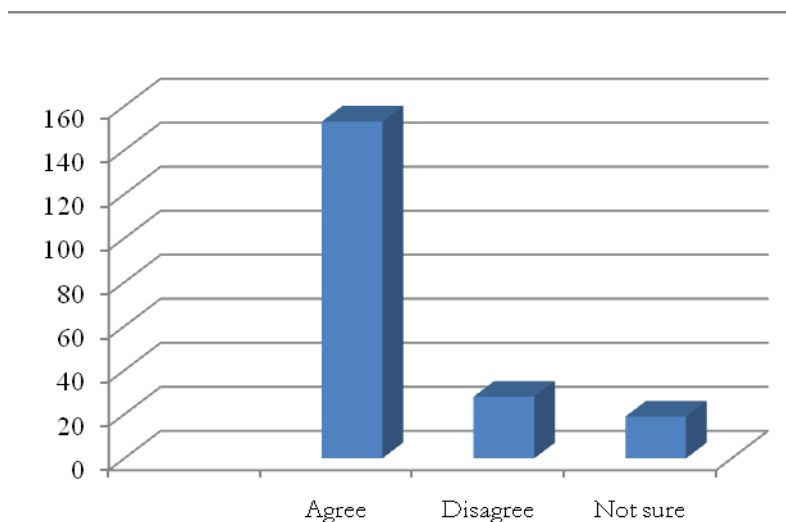
Figure 3. Does Students Attitudes Influence Performance?

Does Students Ability to do Practicals Influences Performance in Biology?

Biology practical forms paper three of the Biology KCSE exam. Bakke (2005) notes that having a personal experience in the learning process accounts for 80% of knowledge retention. It was found that 75.5% of the respondents agreed that ability to do practicals had an influence in performance in Biology.
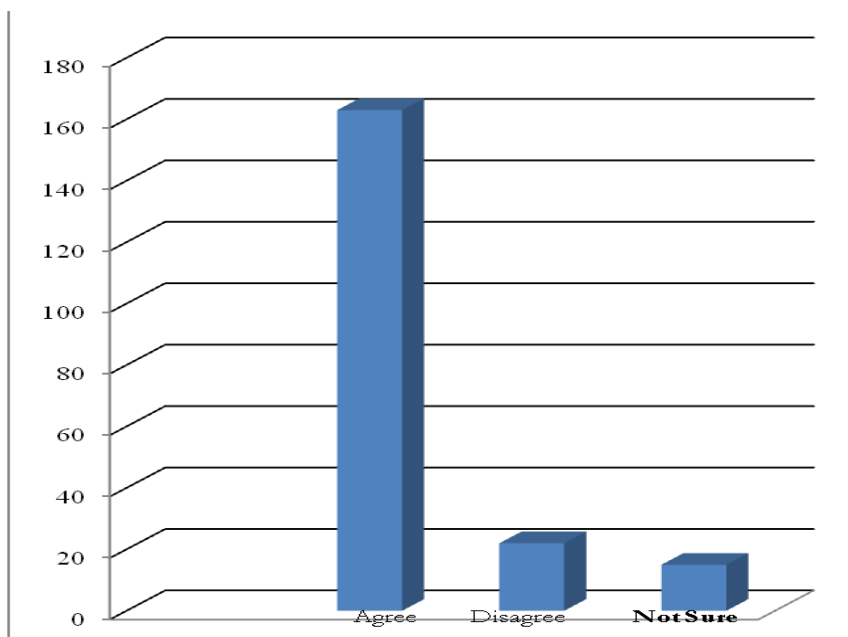
Conclusion

Basing on the data collected and analyzed in this study, the study findings revealed that, the student related factors affecting performance of Biology in Eldoret Municipality were; interest in Biology (theory and practical) provided a force within learners to participate in the learning process, their ability to carry out the practical effectively promoted good performance in addition to ambition and attitude which contributed to students output as it cultivated independence among students influencing performance positively.

Recommendations

1. Students should be encouraged to do co-operate learning to sharpen their understanding in the subject matter, thus building their interest hence improving performance.

2. Students to be encouraged to develop interest in practical so as to improve their performance. Practical contribute 40% of the overall score.

3. Ambitions should be high so as to perform highly allowing them to enter into careers that fulfill the vision 2030 that will solve global issues on food shortage, climate change and better healthcare.

4. Positive attitude should be cultivated to enhance students' ambition thus better performance.

5. Students should be encouraged to develop personal experiences in the learning process through practical because they are able to retain a great percentage (80%) of the knowledge learnt hence better performance.

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Knowledge Management as a Strategy for Achieving High Entrepreneurial Performance and Competitiveness

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Abstract

Enterprises operate in a dynamic environment and to remain relevant and competitive, there is need for adequate knowledge of their environment and effective management of resources for the achievement of high entrepreneurial performance. This paper focused on knowledge management as a strategy for achieving high entrepreneurial performance and competitiveness. It sought to find out if there is significant relationship between variables used in measuring knowledge management (independent variable), and entrepreneurial performance and competitiveness (dependent variables). Survey research was used in a cross sectional design method through the use of self-administered questionnaires to some selected enterprises in Ota, Ogun State. The data collected were subjected to simple regression analysis to measure the various effects of the independent variables on the dependent variables. The results of the analysis showed that the entrepreneur's ability to evaluate and utilize knowledge has positive relationship with the enterprise competitive position. The result also showed that the enterprise learning, knowledge and skills have positive relationship with the organizational product development. Based on these findings, the study among others recommends that entrepreneurs should not only embrace knowledge management but must continue to improve on their ability to evaluate and utilize knowledge in order to enhance their performance and competitiveness in their business environment.

Keywords*: Knowledge Management, Enterprise, Entrepreneurial Performance, Competitiveness*

Introduction

The concept of knowledge management is becoming more prominent in the business world due to its importance on issues such as creation, management and sustainability of organizational resources (Drucker, 1993; Grant, 1996;Teece, 2000). Quite a number of organizations are embracing knowledge management as a key strategic initiative by introducing knowledge management techniques (to improve the flow of knowledge around their organization, make it accessible when and where needed, and use it to add value) for the attainment of increased productivity, better customer service, improved business processes, product leadership, operational excellence and innovation in products and services (Teece, 2000). Despite the fact that interest in the source, nature, and quality of knowledge has been expressed since the times of Socrates, Plato, and Aristotle (Nonaka and Takeuchi, 1995), the idea of knowledge management (KM) is very recent (Davenport & Prusak, 1998; Alvesson & Karreman, 2001).

Several researchers recognized the impact of knowledge management on business as a system (Beer, 1994; Nonaka & Takeuchi, 1995; Alavi & Leidner, 2001; Becerra-Fernandez, Gonzalez, & Sabherwal, 2004) but few of these research works have been carried out on the impact of knowledge management initiatives on entrepreneurial performance and competiveness especially in the Nigerian business environment. The objective of this paper is to examine the relationships among knowledge management practices, performance and competitiveness of enterprises, using selected enterprises in Ota, Ogun State, Nigeria as a case study.

Literature Review
The Concept of Knowledge

According to Webster dictionary (1998) knowledge is the fact or condition of knowing something with the familiarity gained through experience or association. It is the understanding of a science or a technique and circumstance of apprehending truth of fact through reasoning and cognition. Knowledge includes commitments, reasoning/judgment, familiarity, awareness, understanding, learning, information, context, truth, and personal beliefs gained through experience or study, and results from making comparisons, identifying consequences, and making connections (Nonaka, 1995; Webster, 1998; Davenports, 1998). Knowledge is a fluid mix of framed experience, values, contextual information,

expert insight and wisdom that provides a framework for evaluating and incorporating new experiences and information (Bower, 1981; Polanyi, 1983).

Knowledge is the way to provide a framework for evaluating and incorporating new experiences and information to reach personal truth (perceive, apprehend with clarity or certainty; perceive beyond doubt) (Trautmann, 2010). It is based on personal experience, learning (empiricism), beliefs, commitments, judgment, understanding (rationalism) with the help of a flow of messages (information) (Trautmann, 2010). Polanyi (1974) Birchall and Tovstiga (1998), Muzumdar (1997), Nonaka and Takeuchi (1995), and Provost (1998) identified three dimensions of knowledge as tacit, explicit and implicit.

Tacit knowledge is personal, context-specific, and hard to communicate and is deeply rooted in action, involvement and commitment within a specific context (Polanyi, 1966; Nonaka, 1994; Nonaka & Takeuchi, 1995; Provost, 1998). Explicit knowledge is knowledge that can be easily expressed in words or numbers, and can be shared through discussion or by writing it down and putting it into documents, manuals or databases. It is transmittable in formal and systematic language to individuals, group of people and organization (Polanyi, 1974; Nonaka, 1994; Nonaka & Takeuchi, 1995; Trautmann, 2010). Implicit knowledge is contained implicitly in oral or written language, actions, trained neural networks, embedded in technology, culture, practices, and it can be expressed (Nonaka, 1994; Nonaka & Takeuchi, 1995; Trautmann, 2010). Gray (1999) and Holsapple (2003) identified extraordinary leverage, increasing returns, dynamism, transmittable, growth and increase in value as the characteristics of knowledge that differentiates it from other organization's assets. Relating knowledge to organization is generally the thought of 'know how', 'applied information', 'information with judgment' or 'the capacity for effective action' which is often embedded, uncultured and encoded in organizational documents, repositories, routines, processes, practices and norms (Davenport & Prusak, 1998; Darwin Magazine, 2001). Knowledge as an organization's most strategic resource requires effective management for achievement of the enterprise set objectives.

Knowledge Management

Knowledge management is concerned with the exploitation and development of the knowledge as an assets of an enterprise with the view of furthering the enterprise objectives (Davenport & Prusak,1998). Wiig (1999) viewed knowledge management as the systematic, explicit, and deliberate building, renewal, and application of knowledge to maximize an enterprise's knowledge-related effectiveness and returns from its knowledge assets. Alvesson and Karreman (2001) looked at knowledge management from the business point of view and stated that the purpose of knowledge management is to enhance organizational performance by explicitly designing and implementing tools, processes, systems, structures and cultures to improve the creation, sharing and use of different types of knowledge (human, social, structural) that are critical for decision-making. Alavi and Leidner (1999) examined knowledge management as a process of acquiring, organizing, and communicating knowledge about the resources of an organization to the employees for effective performance. Knowledge management is essentially about facilitating the processes by which knowledge is created, structured, shared, transferred and applied in organizations to enhance performance and competitiveness (Alvesson & Karreman, 2001; O'Leary 2002; Argote *et al.,* 2003; Hazlett *et al.,* 2005).

Factors that can enhance knowledge management in an organization are creativity, sharing and transferring of knowledge, (through identification, capture, acquisition, mobility of people across firms) rotation of personnel in organizations, grouping them in clusters due to the similarity in their characteristics and features that encourage informal linkages and networks (Hanson, 1982; Lincoln, 1982; Rogers & Larsen, 1984; Saxenian, 1990; Inkpen & Dinur, 1998; Nonaka, 1994; Maholtra, 2002; Reagans & McEvily, 2003; Rao, 2004). Knowledge management is therefore the systematic, explicit, and deliberate building, renewal, and application of knowledge to maximize an enterprise's knowledge-related effectiveness and returns from its knowledge assets (Wiig, 1999).

Knowledge Management Activities as Management Strategies

Knowledge management requires the execution of several knowledge-related activities geared towards retaining, analyzing, and organizing employees' expertise, with the primary goal of making knowledge available to the right person at the right time. In executing these activities, organizations acquire resources and capabilities for attainment of high performance and competitive advantage. Developing and acquiring these capabilities depends on the knowledge management strategies adopted in an organization. For effective management of organizational resources, a configuration of knowledge management activities-knowledge management building blocks (which include setting knowledge goals,

identification, acquisition, development, distribution, usage, conservation and assessment of knowledge) have been recommended to serve as an effective strategy (an action a company takes to attain set goals) (Hill & Jones, 2004).

Strategy formulation and implementation must be based on knowledge, understanding, and management of appropriate information. This can be achieved through adequate evaluation of the enterprise projects on customer orientations, market opportunity, portfolio, management styles and methods, organizational behaviors and initiatives. This is important for an enterprise to relate its competitive advantage and intellectual properties to organizational resources and capabilities. Achieving this will help an organization to provide answers to the following questions: where are we now, where do we want to be, and how do we get there? what kinds of knowledge do we need for effective management of our resources? what outputs have we created? how do we currently manage our knowledge? How do our organization's culture and systems either help or hinder sound knowledge management practices?

Knowledge Management and Entrepreneurial Performance

The relationship between knowledge management and entrepreneurial performance is implicit. The assumption that KM is needed for knowledge accumulation in high entrepreneurial performance has received different views of researchers (Appleyard, 1996; Decarolis & Deeds, 1999; Yeoh & Roth, 1999; McEvily & Chakravarthy, 2002; Vera & Crossan, 2003). Recent empirical studies such as Appleyard (1996); Decarolis and Deeds (1999); Yeoh and Roth (1999) have supportably argued for the direct impact of knowledge management practices on business performance. According to Chakravarthy et al. (2003) the process of knowledge management (knowledge accumulation, protection and leverage) must work in cohesion for positive impact on organizational performance. While each process is important, tensions among these KM processes may result to distortion in the flow and negative impact on entrepreneurial performance.

For instance, aggressive attempts at leveraging knowledge can inhibit knowledge accumulation because the latter may typically not offer financial returns in the short run whereas the former often does. Similarly, to encourage effective knowledge accumulation, organizations need to shake up existing patterns of behaviour, values, and tacit mindsets. Alvesson and Karreman, (2001) emphasized that knowledge management practices enhance intermediate organizational financial performance. In support of this assertion, Zack, Mckeen and Singh (2009) concluded that knowledge management practices are directly related to various intermediate measures of strategic organizational performance (namely customer intimacy, product leadership, and operational excellence) and these measures are in turn associated with financial performance.

Knowledge Utilization and Competitive Position of an Enterprise

McFayden and Canella (2004) suggest that knowledge is the most important variable for the determinant of organizational competitiveness in the 21st century. Thurow (2003) adds that knowledge-based technologies, such as microelectronics, computers, telecommunications, manmade materials, robotics, and biotechnology developed during the late 20th and early 21st century is sending the economy in never-before-witnessed directions and producing a knowledge-based economy that is systematically changing economic and social lives through invention and innovation of new products and services. Enterprises compete in complex and challenging business environments and are essentially affected by factors such as generation, use, and management of new knowledge cumulating to introduction of new products in the market place (Hitt, Bierman, Shimizu, & ochhar, 2001).

This is in line with Deed and Hill's (1996) view who posit, that firms that are effective in acquiring and utilizing knowledge will be able to create and sustain their competitive advantage better than those that are not really interested in the knowledge-based economy. In reaction to this, Thurow (2003) argued that sources of wealth which can be physical and tangible (land, oil, metals, etc.) through knowledge management processes can help firms to attain high competitive advantage. According to him, personal experience, employees', organizational resources, core values and competencies are the main sources of organizational knowledge and if effectively managed will result to a firm's uniqueness in the marketplace. As Zack, Mckeen and Singh (2009) rightly argued, while performance itself is a useful metric, the ultimate measure of value is the ability to support an organization's competitive strategy. New knowledge must therefore be used and managed effectively to gain competitive advantage, thus allowing the enterprise to be positioned differently from similar organizations in the same market.

Thus, Porter (1985) classified generic competition into four: cost leadership, focused cost leadership, differentiation, and focused differentiation. To implement any of these or a combination of the four generic competitive strategies, an enterprise would possibly require (a) strategic knowledge

(knowledge of the market conditions, customer needs, customer and competitors' behaviour); and (b) operational knowledge to implement managerial and operational processes associated with logistics issues such as procurement of raw materials, production facilities, marketing activities, and distribution of goods. Hence, the first hypothesis of this paper is;

H_1: organizational ability to evaluate and utilize knowledge affects its competitive position.

Firm's knowledge, Skill and Product Development

Product development is an evidence of information/knowledge intensive work (Clark & Fujimoto, 1991). Developing highly successful products is possible through the integration of the abilities of both product design and manufacturing engineers. Customer preference, competition, the environment and technology are all dynamic variables that can affect the development of a new product. An enterprise's new product development innovativeness and capabilities are derived from their ability to create, distribute, share and utilize knowledge (knowledge integration). The integration of knowledge in product development takes increasingly complex forms to capture the synergy of intra-company and inter-company integration and relationships, such as team integration (forming a team with employees from all the appropriate functions), intra-process integration (managing the entire development project from its concept formulation through market introduction), resource integration (giving the team the authority and resources to carry out the project), and chain integration (involvement of customers and the supply chain for product development) (Lambert & Cooper, 2000).

The efficiency of this team is based on their ability to fundamentally, identify the main reason for an enterprise existence (customers' satisfaction) through products / services development. New-product planning and development are vital to an organization's success and particularly possible via rapid technological changes (Cooper, 1994; Veryzer, 2003; Saaksvuori & Immonen, 2004). Product development as an interdisciplinary activity is the set of activities beginning with the perception of a market opportunity and ending with production, sale and delivery of a product that requires contributions of all the organization's functions (marketing, design and manufacturing) (Ulrich & Eppinger, 1995). The second hypothesis is;

H_2: firm's learning, knowledge and skills have positive relationship with its product development

Theoretical Framework

The theoretical framework that underpins this paper is the work of Stankosky and Baldanza (2001) who developed a knowledge management framework which suggests that the factors that enhance knowledge include learning, culture, leadership, organization structure and technology. These factors form the basis for organizational achievement of their set objectives and to remain relevance in the market place. The framework buttressed that knowledge management encompasses a wide range of disciplines such as cognitive science, communication, individual and organizational behavior, psychology, finance, economics, human resource, management, strategic planning, system thinking, process reengineering, system engineering, computer technologies and library science. This framework has been popularized through its usage in research works such as Vera and Crossan (2003); McKeen, Zack,and Singh (2006); Satyendra, Yolande and McKeen (2006); Anantatmula and Stankosky (2008); and Ajmal, Helo, and Keka, (2010).

Materials and Methods

The methodology adopted for carrying out this research was the survey method through the instrument of questionnaire which helped the researcher to collect the opinions, views and perspectives of the respondents as regards the research interest. The population of this study comprised all enterprises in Ogun state, Nigeria. Since the researcher could not cover all the enterprises in Ogun State, a sample size which is a small fraction of the population that adequately represented and reflected the target population under a study was adopted (Asika, 2008). Survey research method was used in a cross sectional design method through the use of self-administered questionnaires to one hundred (100) enterprises in Ota, Ogun State, Nigeria. Convenience sampling technique was used in choosing Ota as the area of study because of its proximity to the University while a simple random method was used in selecting the enterprises used as the sample size for the study. This procedure was adopted so as to guarantee randomness and fair representation by giving the respondents an equal chance of being selected (Oshodi, Asikhia & Asikhia, 2007). Both primary and secondary sources of data were used to obtain the data for this study. The data generated through the questionnaire was analyzed with simple regression model through the aid of a computer system and the application of SPSS (Statistical Packages For Social Sciences).

Data Analysis

The data for this study was generated and analyzed using the Statistical Package for Social Sciences (SPSS) software programme (version 16.0). To achieve the objective of this study (to examine the relationship between knowledge management and entrepreneurial performance and competitiveness), two hypotheses were formulated and the study used the model of simple regression to test the hypotheses. However, a descriptive analysis on the demographic and business profile of the respondents was first conducted before statistical inference drawn to ascertain the relationship between the independent and dependent variables.

Results

Table 1. Respondents' Demographic Characteristics

Variable	Items	Frequency	Percentage
Total Respondents		82	82.0
Gender	Male	49	49.0
	Female	33	33.0
Age of the Respondents	25-35	17	17.0
	36-45	40	40.0
	46-above	25	25.0
Marital Status	Married	43	43.0
	Single	26	26.0
	Divorced	13	13.0
Education Attainment	OND	33	18.0
	HND/BSc	49	49.0
	MBA	10	10.0
Number of Years in Organization	1-5	19	19.0
	6 –11	26	26.0
	12-17	20	20.0
	18-Aboved	17	17.0

Source: Field Survey (2013)

Table 1 shows the demographic profile of the respondents from the field survey. The Table revealed that out of the eighty two percent (82%) of the questionnaire returned, forty nine percent (49%) of the respondents were male while thirty three percent (33%) were female. Most of the respondents were between the age 36 and 45 years old representing forty percent (40%), followed by those who were in the age bracket 46 and above (twenty percent) and the rest were between 25 and 35 age bracket (seventeen percent). Forty three percent (43%) of the respondents were married, twenty six percent (26%) of them were single, while thirteen percent (13%) of them were divorced. Looking at their educational attainment, majority of them forty nine percent (49%) had Higher National Diploma/ Bachelor Degree on Science (HND/BSc.) certificate followed by those that had Ordinary National Diploma (OND) certificate thirty three percent (33%), while ten percent (10%) of them had MBA.

Table 2. Respondents' Perception on Knowledge Management

Issues on Knowledge Management	Freq. Dist in. (percent)
Effective knowledge management and attainment of organizational goals.	87.0
Organization has effective and efficient feedback system on	81.6
Knowledge management and organizational growth and survival	85.0
Knowledge management increases employee's performance and productivity	75.7
Firm's learning, knowledge &skills and product development	96.4
Knowledge created and improvement of quality.	93.0
Organization's resources and creation of knowledge within the organization .	85.3
Shared knowledge and achieving organization objectives.	97.0
Organization ability to evaluate and utilize knowledge affects its competitive position.	93.9

Source: Field Survey (2013)

In terms of the respondent's view on the relationship between knowledge management, entrepreneurial performance and competitiveness, Table 2 shows that six (6) items had the highest figure on the frequency distribution table. These are; the effect of shared knowledge on achieving organization objectives which had ninety seven (97%), followed by firm's learning, knowledge &skills and product development with ninety six percent (96%), followed by the organization ability to evaluate and utilize knowledge affects its competitive position with approximately ninety four (94%), followed by knowledge created and improvement of product quality which had ninety three (93%), effective knowledge management and attainment of organizational goals had eighty seven percent (87%), and Organization's resources and creation of knowledge within the organization had eighty five (85%). A close look on the data on Table 2, shows that the variables that relate to the research hypotheses were among the highest scored items.

Hypothesis One

H$_0$: Organizational ability to evaluate and utilize knowledge does not affect its competitive position

Table 3(a). Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.376(a)	.141	.114	.543

Source: Field Survey, (2013)

Table 3(b). ANOVA (b)

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	4.650	3	1.550	5.256	.002(a)
	Residual	28.310	96	.295		
	Total	32.960	99			

Source: Field Survey, (2013)

A Predictors: (Constant), ability to evaluate and utilize available knowledge; b Dependent Variable: the organizational competiveness.

From Table 3, the explanatory variable (ability to evaluate and utilize available knowledge) had a significant effect on the firm's competitive position. The P-value was significant at 0.002. This means that the research hypothesis (H$_1$) was statistically significant and the null hypothesis which stated that the firms ability to evaluate and utilize available knowledge does not affect its competitive position was rejected. By this, the study implies that the organisational ability to evaluate and utilize available knowledge significantly explained only fourteen percent (14%) of the firm's competitive position. Meaning that about fourteen percent (14%) of the firm's competitive position resulted from their ability to evaluate and utilize knowledge. Although the result on R^2 (independent variables) of fourteen percent (14%) was weak in explaining the change in the dependent variable, it still revealed that the independent variables (ability to evaluate and utilize available knowledge) had a positive effect on the dependent variable (the organizational competiveness).

Hypothesis Two

H$_0$: The enterprise learning, knowledge and skills do not have relationship with its product development

Table 4(a). Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.570(a)	.325	.296	.684

Source: Field Survey, (2013)

Table 4(b). ANOVA (b)

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	21.390	4	5.348	11.429	.000(a)
	Residual	44.450	95	.468		
	Total	65.840	99			

Source: Field Survey, (2013)

a Predictors: (Constant), the firm's learning, knowledge & skills; b Dependent Variable: the firm's new product development

From Table 4, the explanatory variable (the firm's learning, knowledge and skills) had a significant effect on the firm's new product development. The p-value was significant at 0.000. This means that the model hypothesis (H_1) was statistically significant and the null hypothesis which states that the enterprise's learning, knowledge and skills does not affect its product development was rejected. By this, the study implied that the enterprise learning, knowledge and skills did not affect its product development significantly explained only thirty three percent (33%) of the firm's new product development. Meaning that about thirty three percent (33%) of the firm's new product development resulted from their learning, knowledge and skills. Although, the result on R^2 (independent variables) of thirty three percent (33%) was weak in explaining the change in the dependent variable, it still revealed that the independent variables (firm's learning, knowledge and skills) had a positive effect on the dependent variable (the firm's new product development).

Discussion

The results of this study reveals that the independent variables used in measuring knowledge management were related with entrepreneurial performance and competitiveness. This was evident in the findings of the data analysis from the testing hypothesis One which showed that fourteen percent (14%) of the variance in a firm's competitive position can be predicted from the firm's ability to evaluate and utilize knowledge. This is in line with Toffler (1999) who pointed out that knowledge as a resource positively affects a firm's ingenuity and competitiveness. New knowledge when shared results in creativity, innovation and high competitive advantage which is inexhaustible, renewable, inclusive, and grows phenomenally (Toffler, 1999). From the perspective of knowledge based view theory, it is expected that a particular category of knowledge that relates to the resources of an enterprise (that is valuable, specific, inimitable and non-substitutable), if properly managed will definitely lead to high entrepreneurial performance and organizational competitiveness (Barney, 1991). Supporting this assertion, Sveiby (1997) believes that employees with adequate support from their organization have the ability to create new knowledge that is capable of enhancing organizational competitiveness. However, Drucker (1998) argues that in spite of the importance of knowledge to an organizational performance, some employees still delight in hoarding knowledge that may be useful to their organization. The use of new knowledge and knowledge management as a source of power for high competitive advantage therefore depends on the intelligence with which it is freely shared, disseminated and used in an organization (Leonard 1992; Drucker, 1998; Vera & Crossan, 2003; Buckman, 2004). Technologically, advanced and complex products require more than ordinary organizational learning, knowledge and skills to be developed and so as to reduce the time frame for product development without sacrificing quality or eliminating the steps involved (Gupta & Wileman, 1990; Ward *et al.,* 1995; Karlsson & Ahlstrom, 1999; Sobek *et al.,* 1999).

Conclusion

To remain competitive in the industry, organizations need to create and foster a knowledge-sharing culture. A culture of knowledge acquisition, utilization, and management via capturing, recycling, and deploying new and existing information for enhancement of entrepreneurial performance and achieving competitiveness. To achieve high entrepreneurial performance and attain competitive advantage, organizations also need to locate, acquire, share, transfer, utilize and transform information about their consumers and competitors and convert such information into new knowledge that is practicable, realistic and eventually lead to introduction of new products and services in the market place.

Recommendations

Based on the findings of this study, the following recommendations are made. Organizations should; (i) provide new technology that can help them to improve their learning, acquire skills and implement

knowledge management strategies. (ii) improve on their tacit knowledge in order to ensure smooth flow of knowledge among employees. This will help to acquaint the employees with the right information required for the achievement of the organizational goals and objectives in terms of global competitiveness. (iii) train and motivate their employees to be knowledge conscious in order to make knowledge management activities more effective. (iv) channel more finances to knowledge management technologies and other facilities that can enhance their innovativeness and new product development. (v) continue to improve on its ability to evaluate and utilize knowledge in order to improve its competitive position and achieve high entrepreneurial performance.

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Livestock Waste Management in Kenya: A Futuristic Perspective

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Abstract

Livestock waste management remains a major global concern because of nitrogen and phosphorus pollution, environmental safety and quality of crop and animal products. Livestock production is the largest source of atmospheric ammonia, accounting for over 40 % of the global inventory. Sources of wastes are production farms and slaughter/processing/packing plants. Objective of livestock waste management is to make best use of nutrients in manure while protecting natural resources from pollution for improved environmental quality and sustainability. When managed properly, manure can be a valuable resource for farmers especially in rural areas; providing nutrients for crops, generating income, improving nutrient use efficiency, among other benefits. However, if land is insufficient to use generated manure or if mismanaged, then pollution risks to water supplies and other ecosystem resources could result. Unmanaged waste could be breeding grounds for disease causing pathogens and vectors, generate odour, ruin aesthetic values, increase production costs and reduce farm product quality, among other dangers. Best management practices to reduce negative impacts include feed manipulation & feeding strategies, breeding for improved feed intake, as well as diligent management and use of improved technologies on handling, processing and disposal. Three main forms of manure are solid, liquid and slurry, each of which has its way of handling, management and disposal. Options for managing waste include composting, processing for sale, aerobic & anaerobic lagoon treatment, vegetative waterways, soakaway ponds, biogas production or direct land application. All these methods are practised with varying degrees of success in Kenya. Considering rapid population increase and subsequent land fragmentation, many farmers are constrained when it comes to available options. Determinant factors on choice include financial constraints, production systems in place, size of farm operations, compliance with local and international laws/regulations and standards, land availability, awareness of existing technologies, among others. This paper review and shares best practices and global trends for manure management in general, with Kenya's future in mind, to ensure improved environmental quality and economical usage. This will have both short and long term economic and environmental impact that benefits production system in the country and beyond.

Keywords: *Environmental Pollution, Environmental Conservation, Manure Treatment, Nutrient Cycling, Sustainable Development, Waste Management*

Introduction

With high population densities in Kenya, in some areas more than 800 persons/km2, there is high demand for the limited resources, especially food and land. Soils are now subject to continuous and intensive cultivation and fertility status is on the decline in a number of areas, thus presenting a serious threat to food security (Lekasi *et al.*, 2001b). Ownership of livestock is widespread amongst households in most parts of the country, especially within the high potential areas ranging between 77 and 85% of households keeping dairy cattle (EPZA, 2005). Decreasing land size holdings has led to a shift from extensive to more intensive mixed crop/livestock farming systems including acquisition of external inputs to feed livestock and replenish soil nutrients. Key areas of concern across the world include the underlying public concern with manure management and its potential pollution risks associated with air, water, habitat and soil resources; large quantities of manure generation and application to limited land area, often without considering potential hazards; and most emphasis appears to be on water pollution (Rachuonyo, 2002; Safley, 1994). Challenges associated with manure management are similar in many

locations; only practices to deal with these challenges may be varied. Review of legislation, regulation and policy elsewhere should be considered valuable as the various governmental approaches to livestock waste management are extremely dynamic at this time, especially in Europe and USA (Agriculture Canada, 1994). While we cannot extrapolate from experiences of other jurisdiction directly, combinations of such are helpful in providing various policy approaches that may be successful for sustainable environmental quality and improvement on general livelihoods. In summary, nutrient management plans should be required for not only concentrated animal operations but also any sizable livestock production farm (Rachuonyo *et al.,* 2002). The broad objectives of this paper were to evaluate the production, challenges, management, use and policy guidelines of livestock waste from various nations and utilize this information in projecting future strategies and direction for improving manure nutrient management in Kenya; consistent with vision 2030.

Manure Production and Concerns

Livestock farming has undergone a significant transformation in the past few decades. Production has shifted from smaller, family-owned farms to large farms that often have corporate contracts. Most meat and dairy products now are produced on large farms with single species buildings or open-air pens, resulting in large quantities of waste (MacDonald & McBride, 2009). "Livestock waste" means livestock excreta and associated losses, animal remains, slaughterhouse refuse, bedding, wash waters, sprinkling waters from livestock cooling, precipitation polluted by falling on or flowing onto an animal feeding operation, and other materials polluted by livestock (Illinois Administrative Code 506). People often believe that animal manure is harmless, but in truth it can be quite hazardous. Factory livestock facilities pollute the air and release over 400 separate gasses, mostly due to the large amounts of manure they produce. The principal gases released are hydrogen sulfide, methane, ammonia, and carbon dioxide. Gasses can be dangerous air pollutants that threaten both the environment and human health. Nitric oxides are also released in large quantities from farms through manure application, and are among the leading causes of acid rain

Main Concerns with Manure

No matter what part of United States, Europe, Canada or elsewhere in the world that one might choose to examine, the underlying public concern associated with manure and manure management is pollution and potential pollution. Recent patterns of concentrated intensive livestock operations, profitability of large scale livestock production and agricultural policies have all contributed to the increased production of manures. As a result, large quantities of manure have been applied to a limited land area often without considering the potential hazards, especially in developed countries (Rachuonyo, 2013). The threat of pollution in all its forms, effects and potential effects is prevalent where these large quantities of livestock waste are produced. Estimates indicate that the amount of livestock waste is 13 times greater than the amount of human sanitary waste generated in the United States (EPA, 2001). Livestock and poultry waste can be introduced to the environment through direct discharges, through land application of manure, and from open feedlots, barns and housing, and pastures. Concerns with potential pollution of air, water, habitat and soil resources resulting from livestock manure management are key public policy concerns in many countries, Kenya among them. Most emphasis appears to be on water pollution and a focus of concern is on the decreasing quality of drinking water. In agriculture, concerns with manure are centred on improving nutrient use efficiency in crop and animal production as well as increasing the fertilizer equivalence value of animal manure (Sutton *et al.,* 2013).

Pollution

Pollution can be defined as an unwelcome concentration of substances that are beyond the environment's capacity to handle. Animal waste from farms and related practices can severely impact an ecosystem, especially water quality, if not managed properly. Livestock waste has the potential to contribute excess nutrients, pathogens, organic matter, solids and odorous compounds to the environment. These substances can cause eutrophication of surface waters, degradation of ground waters and be detrimental to people and other living things.

Nutrient Loss

Nutrient loss is a basic focal point being given consideration in all jurisdictions, especially in the agricultural sector. That is, nitrate (NO_3) and phosphorus (P) leaching along with surface runoff are seen to be the primary factors in potential water and soil pollution. Timing of application of manure is an important issue in preventing leaching and surface runoff. Ideally, applications should be made when crop

uptake is at its maximum and weather conditions are optimal. When livestock manures are applied to correspond with the needs of the crop, the potential of damage to the environment is lowered. If manure is applied in excess of crop needs or when the crop is not growing then there is a potential of polluting soil, water, habitat and air (Watson *et al*., 1994). In a study by Lekasi *et al.,* (2001a) steers fed a basal diet of napier grass and dairy meal concentrate resulted in significantly higher N, both in faeces and urine, than the low concentrate levels. Urinary N can be conserved when wheat straw is applied at relatively high amount of 1.8 kg liveweight/yr, about 720 kg/400 kg cow liveweight/yr. On average, 28 and 18% of the N input as feed was recovered in faeces and urine, respectively. Of the total N excreted, faecal N contributed between 47 and 76% (mean 61%) while urinary N ranged between 24 and 53% (mean 39%). Greatest loss of N during the accumulation phase was observed in heaps with high moisture contents from the addition of urine. During the composting phase, manures with maize stover refusals manually added had the greatest N losses. Overall, N losses ranged between 34 and 63%.

Water Pollution

Disposal of excess manure from intensive livestock production is seen to be one of the sources of pollution to groundwater and in some cases drinking water supplies (Sutton, 1990). Water pollution, whether it is surface or groundwater, is the most obvious concern related to livestock waste management and the initial reason many governments have been forced to deal with livestock waste policy development (SWMR, 2013). Over the last decade, levels of groundwater contamination by nitrogen have become apparent (Kerns & Broomhall, 1992; Weinberg, 1994). When people perceive that their drinking water may be polluted with livestock wastes, they become intensely concerned. Almost every country has some type of water protection legislation which is often the basis for starting to deal with manure management as a problem. In several countries, public health or other like bodies has certain powers where safety or public health is at risk (Watson *et al.,* 1994).

Air Pollution

Livestock wastes produce ammonia, methane, fine particulate and volatile organic compounds (CDMMG, 1989). Livestock production is the largest source of atmospheric ammonia, accounting for over 50 % and 40 % of the national and global inventories, respectively (Moore *et al.,* 1995). Air pollution begins from the time manure leaves the animal. The smell of manure gases gets the public's attention. The complaints regarding smell against operations are an added pressure on farmers in dealing with manure management. Minimizing ammonia losses to the atmosphere has become a major policy target. Air pollution is also controlled through manure storage and application policies. For example, in the Netherlands all storage structures must have covers and manure must be incorporated into the soil within 24 hours after spreading. Sweden manure must be incorporated within 4-12 hours after spreading depending on location (Abler & Shortle, 1992; Bertrand, 1988). Thus, it is not surprising that livestock ammonia is an area of growing public concern and regulatory debate.

Soil Pollution

Very few countries appear to have legislation that specifically relates to soil contamination. The Netherlands have a Soil Protection Act (1987) which covers a number of the problems related to pollution from manure by indirectly enforcing N, P, and NH_3 standards as well as reducing the acidifying effects of ammonia on the soil (Francis, 1992). The Law of Soil Protection in the Netherlands restricts application of manure, regulates spreading of manure and suggests working the manure into the soil (Brussard & Grossman, 1990).

Habitat Degradation

Water pollution is not just limited to the human use issues, but plays a major role as it impacts on habitat for fish and wildlife. Aquatic habitat contamination and oxygen depletion is a major consideration as well as toxicity of ammonia and nitrite from manure sources. In Canada, the Federal Fisheries Act pertains to the unauthorized discharge of any substance harmful to fish (Patni, 1994). The European Communities 1991 Directive concerning the protection of waters against pollution caused by nitrate from agricultural sources states that members must designate areas where the total nitrogen concentration in water exceeds 50mg/Lor where eutrophication occurs (Milne, 2005). Denmark has also developed an action plan for the aquatic environment to control pollution of aquatic habitats (Sunderland, 1991). In France, the Civil Code may require ecological damage to be 'made good', that is, restoration to its original condition (Rolfe, 1993). A unique program in the U.S.A. resulted from a conglomerate of several states

(Maryland, Pennsylvania, Delaware & Virginia) developing the Chesapeake Bay Agreement to improve water quality and habitat by reducing nutrients entering the bay (Perkinson, 1994).

Management and Practice Problems

Pollution caused or perceived to be caused by spreading manure in excess has given rise to specific problems related to manure management. Individual countries, states, provinces, counties and so on are being forced to deal with what appears to be inadequate manure storage, inappropriate manure application, increased livestock densities and a lack of efficient manure disposal methods. Each jurisdiction handles these direct and often diverse manure management problems in a variety of ways and will be discussed.

Manure Storage

Concentration and intensification in livestock production has resulted in a need for storage of solid manure and slurry. Because the application of manure in many countries has been limited to certain times of the year related to crop and soil condition, storage during low demand periods is necessary (i.e., fall/winter). Manure storage capacities are often based on livestock units. Adequate storage capacity is related to the size of facility, livestock units, length of storage and consideration of high rainfall and flood conditions. Many jurisdictions require storage capacity for a certain length of time (i.e. 5 months) and enough to withstand a 24 hour 10 to 25 year rainfall. Permanent manure storage permits are required in the Netherlands (Bertrand, 1988). Specific design details such as cover and ventilation are a large part of current manure storage requirements set out within government regulations. Besides the design of storage facilities, location and type (earthen, concrete) of facility poses yet another dilemma. Distances from waterways, wells, farmhouses are all factors of consideration when determining where to locate manure storage structures. Designing, constructing and maintaining manure storage facilities is a large expense to the farmer. Many jurisdictions offer funding and cost-share programs to help off-set the farmer's monetary output. In Kenya, it was observed that most farmers preferred to store their manure in a heap or pit (67%) rather than by deep littering (33%), and 90% did not cover the manure. Forty-six percent of farmers kept the manure under some sort of shade (Lekasi *et al.,* 2001a).

Manure Application

The details of the application requirements for manure appear in many of the regulations and policies (Abler & Shortle, 1992; Batie & Diebel, 1990; Conrad & Teherani-Kronner, 1989). In several countries, manure application has strict technical limits imposed with respect to timing, soil nutrient requirement, rate of application and water protection. Timing is dependent on season, soil condition (frozen, unfrozen), soil moisture, cover crop and so on. Placing restrictions on when manure can be applied helps to prevent excessive runoff. The method and equipment used to apply manure is sometimes restricted as well. Many countries require manure to be injected directly into the soil or spread and integrated within a short period of time (i.e. 6 -24 hours). In Denmark, specific timing and application regulations exist under the Environmental Protection Act (Kofoed *et al.,* 1986). Quantity and rate of manure application is often limited to the type of crop being grown and its nutrient requirements. Several European countries totally restrict any manure application in designated areas called water protection zones (Beier *et al.,* 1994; Swedish Board of Agriculture, 1994). Along similar lines, manure application is usually only permitted within a certain distance of a stream, open ditch or other water body.

Livestock Density

Livestock density is yet another issue related to quantity of manure and pollution extent and risk. Restricting livestock numbers based on calculations of area of land associated with a farm unit has been used in some instances and is being considered in others. This poses an economic problem for the farmer who, with improved technology, has intensified activities on a relatively small area to remain a viable business. Existing operations must either maintain/reduce their livestock numbers or find more land to spread manure. New livestock operations may only be permitted to start with a certain number of animals, which cannot be expanded upon. For example, in Sweden, animal density requirements apply to the whole country (Swedish Board of Agriculture, 1994). These regulations apply to all farms with at least 10 animal units. A balance must exist between the number of animals on the farm and the amount of land available for spreading livestock waste. Under the Law of Management, the maximum number of animals has been accurately calculated with consideration given to the amount of phosphorus in manure and a crop's normal requirements of phosphorus. Dairy cows cannot be more than 1.6 animals per

hectare, fattening pigs 10.5 animals per hectare, laying hens 100 birds per hectare (Brussard & Grossman, 1990; Colorado Department of Public Health and Environment, 2013).

Waste Disposal

Disposal of manure remains the number one dilemma for both the individual farmer and the industry as a whole. In many cases, using manures has become less related to fertilizing and more accurately labelled waste disposal. As we move from farm-scale to industrial-scale production, disposing of manure in a safe, economical, efficient and non-polluting manner has been a leading research agenda item in many countries (Hanley, 1991; Safley, 1994). Some countries have evolved strict and specific policy and practices while others approach the issue through education and voluntary actions. To quote from an article indicative of how severe the problem of manure surpluses can become, "For the time being, the Dutch may have won their constant battle against water, now they are in imminent danger of drowning in manure" (Brussard & Grossman, 1990). Excess manure production is prevalent in countries that have increased intensive livestock production as population and thus demands have increased. Disposal of manure involves many factors including availability of land associated with the farm unit, manure contracts with other land owners, and maximum quantities of manure allowed for a farm unit per hectare (Safley, 1994). The Netherlands has specific legislation related to disposal known as the Fertilizer Act of 1984, which regulates trade in fertilizing products, removal of surplus manure and its financing as well as the production of animal manure (Francis, 1992). The Act restricts the transfer of manure production to another business or to another location and establishes regulations regarding surplus manure. The Manure Law of 1987 took over many of the Fertilizer Act regulations and created the Manure Bank which is unique to the Netherlands and was formed to aid in efficient transfer of excess manure. Membership is not mandatory and it is run as a non-profit operation. Some of the banks funding relies upon a levy paid on manure surpluses and is used to create facilities for efficient transport, supervision and processing of surpluses. Contractual agreements for surplus manure to be applied elsewhere also exist in Switzerland (Swedish Board of Agriculture, 1994). These supply contracts for surplus manure must be entered into by owners with inadequate land base. Nutrient Management Plans, Best Management Practices and Codes of Practice have been adopted as general requirements by many jurisdictions (Madison *et al.,* 1986; Watson *et al.,* 1994). In some cases, they are part of detailed legislation and regulation, in others they are strictly voluntary. These plans cover a variety of purposes including reducing pollution, guidelines for use and management of manure, storage, application, water protection and standards for new livestock facilities. Financial assistance is often offered to encourage adoption of these plans and practices.

Legislation, Regulation and Policy

One of the most important outputs of the Earth Summit (United Nations Conference on Environment and Development) in 1992 was Agenda 21: an action plan for the 1990s and well into the twenty-first century, elaborating strategies and integrated programme measures to halt and reverse the effects of environmental degradation and to promote environmentally sound and sustainable development in all countries (UNCED, 1992). This shows how important environmental conservation and protection as well as the sustainable use of resources is recognized. The legislative, regulatory and policy frameworks with respect to livestock waste management are extremely dynamic at this time in Europe and in the U.S.A and is becoming the trend in many parts of the world (Beegle & Lanyon, 1994). Extrapolation of these from elsewhere may not be directly; however, the combination of experiences may be helpful in that they provide various policy approaches with varying degrees of success. The general idea is to incorporate livestock waste within wider scope of environmental protection. For example, the European Community legislation based on 1980 Drinking Water Directive which requires all members to observe standards established within a five year period (Batie & Diebel, 1990). The nitrate standard established was a maximum of 50mg NO_3 per litre of drinking water with a recommendation for 25mg/L. Denmark's 1987 Environmental Protection Act sets a strictly regulated national framework for manure storage, application, designation of environmentally sensitive areas, and livestock density control through a production unit geographic location and size regulation (Brussard & Grossman, 1990). Netherlands' legislation includes the 1987 Soil Protection Act and Manure Law which provide national standards for manure application, timing, storage, local enforcement, animal density, levies on manure surpluses and creation of a national manure bank (Abler & Shortle, 1992). The Nuisance Act provides opportunity for the development of ammonia emissions standards related to manure storage. Sweden's 1988 Law of Management and Environmental Protection Law provide for regulations regarding animal density requirements, manure application, storage, cover cropping and mechanisms to avoid ammonia loss

(Swedish Board of Agriculture, 1994). The United States federal legislation that has implications for livestock waste management includes the Clean Water Act, Safe Drinking Water Act, Food Security Act, Environmental Protection Act and Water Quality Act (Rolfe, 1993). Within a federal legislation framework, more specific legislation/ordinances associated with livestock waste management activities are regulated and include liquid manure directives, animal density, timing of manure application, length of storage and relationship with urban and rural land use planning and public health. Requirements are in place for all commercial operations to have nutrient management plans that follow best management practices. In the United States, The Water Quality Act 1987 requires each state to develop programs to control nonpoint sources of pollution of both surface and ground waters (Perkinson, 1994). In most of the States including Colorado, Delaware, Illinois, Indiana, Maryland, among others, the Confined Animal Feeding Operations Control Law is designed to protect waters of the state from potential impact due to confined animal feeding operations; and includes development of manure management plans and permit process, provisions for conditions of manure storage, application rates, flood plain locations, discharge permit system and submission of manure and process waste water management plans to the State Department of Health; livestock waste quantity application criteria with focus on water and odour pollution concerns (EPA, 2009; Spellman & Whiting, 2007).

Regulations and Enforcement

Livestock waste management regulation and enforcement for the jurisdictions reviewed are a complex mixture of activity at various levels of government. In some instances a specific level of government is responsible, but more often a shared responsibility of two or three levels of government is utilized for integrated approaches. The direct involvement of livestock producers or their organizations in regulation and enforcement appears to be becoming more common.

Key regulations which are described as being strictly enforced include (Abler & Shortle, 1992; Patni, 1994; Sunderland, 19991):

1. All farmers must develop and submit annual manure application plans
2. Properties with greater than 31 livestock units must have not less than 9 months manure storage capacity
3. Manure application rates are determined, for example, by the quantity of manure from cow rearing which must not exceed 2.3 livestock units/hectare/year
4. Manure must be incorporated into bare soil less than 12 hours after application
5. Location of livestock production facilities and manure storage facilities is regulated
6. Establishment of manure storage capacities based on livestock units is required
7. Environmentally sensitive areas are designated (4% of arable land)
8. Livestock number control
9. Timing of manure application
10. Length of storage prior to spreading
11. In some states a liquid manure directive restricts manure application quantities and time periods.
12. National standards for quantity of manure, timing and method of application
13. Detailed commodity specific manure storage regulations
14. Manure storage permits required
15. Restrictions on emissions of ammonia
16. Efficient transport and transfer of surplus manure
17. Indirectly enforce N, P, and NH3 standards (reviewed every 2 - 5 years)
18. Surry application by land injection methods
19. Restrict farm practices in designated water protection zones
20. Prohibition of expansion and starting new livestock enterprises
21. Detailed winter spreading, snow and frozen soils specifications
22. Manure must be incorporated within 24 hours
23. Limitations of chemical fertilizer usage
24. Obligated to keep farm records of slurry and manure production

Enforcement involves a peer group review by local livestock producer co-ops and in cases of non-compliance, legal action is taken through the Ministry of Environment. Penalties include fines for infringement and detention or imprisonment up to 1 year for acts of gross negligence.

Policy

Policy is generally linked and integrated with the legislation, regulations and enforcement provisions. In European Community, all member countries must impose general pollution and nuisance control with limits to nitrate as per the Drinking Water Directive (Agriculture Canada, 1994). Farmers must develop annual manure application plans to control pollution of the aquatic environment with N and P. Civil and rural codes apply which may require rehabilitation and restoration of ecological damage to original conditions. Water protection zones may be designated with restrictions on farming practices to reduce the leaching of nitrates. Farmers are compensated by annual payments per hectare affected (Rolfe, 1993). New enterprises must seek approval from land use planning authorities. A nitrate reduction scheme establishes nitrate sensitive areas with compensation for extra costs incurred in restricting agricultural practices (Patni, 1994). Codes of good agriculture practice are the focus of livestock waste management policy. Policy emphasis is on education, awareness and financial incentive, rather than legislation and regulation. Most federal and state policies are based on extension education, guidelines, best management and nutrient management plans associated with financial incentives for livestock waste management (Safley, 1994).

Applied Livestock waste Management Practices

Three key components in waste management consideration include livestock facility site selection, waste storage and land application. Facility site selection emphasizes natural land characteristics (slopes, surficial geology, soils, vegetation and surface drainage), and includes visual impact, microclimate, health and safety considerations. Generally, accepted agricultural and management practices for manure management and utilization provides livestock facility runoff control, wastewater management and odour management (reduction of frequency, intensity, duration and offensiveness of odour) specifications (Safley, 1994). All European Community countries require building permits for new sites. The permit is only issued if it can be determined that the operation will not cause pollution. Dairy housing mainly pasture during spring/summer/fall and barn during winter months; ventilation required for scrubbing of ammonia emissions from barns (Smith & Chambers, 1993).

On-Farm Storage Facilities

The need for storage facilities to match application rates and timing to crop demand is almost universally recognized and most have developed relevant regulations and financial incentives (Abler & Shortle, 1992; Bertrand, 1988; Weinberg, 1994). For beef operations, storage of manure is needed for a minimum of 4-6 months. Slurry is held in concrete lined lagoons while solid waste is confined to concrete slabs. Dairy slurry is washed from parlour into concrete lined lagoons for 5-6 months storage. Swine operations use concrete walled tanks, steel tanks and plastic lined lagoons. Specific rules with regard to installations include siting at least 100 m. from third-party dwellings, camping and sports facilities and premises of professional use, 35 m. away from watercourses, 200 m. away from bathing resorts and beaches and 500 m. from fish farms. Poultry slurry must be stored 500 m. from any dwelling. In the Netherlands, reception pits from swine manure must be covered due to odour and NH_3 (Bertrand, 1988). Delaware's manure storage guidelines suggest the following essential features for on-farm storage facilities: sufficient capacity to store manure until proper disposal application on cropland; proper location to avoid runoff to surface water or percolation to groundwater; and. measures that ensure effective odour and fly control (CDMMG, 1989).

Land Application of Livestock Waste

European Community manure and slurry application is limited to 210 kg N/ha with reductions by the year 2000 to 170 kg N/ha (Bertrand, 1988). Danish farmers are required to develop application plans at the beginning of each year for their manure disposal. These plans are reviewed and enforced by the local co-op. Punishment for not managing manure disposal effectively could be a reduction in stocking level. Applying slurry during the growing season makes it necessary for special machinery to be used in order to directly incorporate manure in the soil between the row crops or dribble it through flexible pipes at the foot of broadly sown plants in close rows. In Denmark, it has been stated by farmers that new methods and machinery for more accurate application of livestock manures are expensive and demand high investment (Sunderland, 1991). French farmers in Brittany are restricted by rules for slurry spreading. For pig slurry a distance of 200 m. is required from dwellings and business premises, unless slurry has been deodorized, then 50 m is accepted (Kofoed *et al.,* 1986). Animal density for all of Sweden is regulated so that the supply of phosphorus by manure corresponds to the needs of the crop (approx. 20

kg/ha/yr). Farms wishing to expand or change their animal units must show that they have enough associated land for spreading (Francis, 1992).

General guidelines of industry framework for land applications of manure include (CDMMG, 1989; Hanley, 1991; Madison et al., 1986):

1. Manures should be uniformly applied to soils. The amount of manure applied per acre (gallon/acre or tons/acre) should be known, so manure nutrients can be effectively managed
2. Manures should not be applied to soils within 150 feet of surface waters or to areas subject to flooding unless:
3. Manure is injected or surface-applied with immediate incorporation (i.e. within 48 hours after application) and/or conservation practices are used to protect against runoff and erosion losses to surface waters
4. Liquid manures should be applied in a manner that will not result in ponding or runoff to adjacent property, drainage ditches, or surface water
5. As land slopes increase from zero percent, the risk of runoff and erosion also increases, particularly for liquid manure. Adequate soil and water conservation practices should be used which will control runoff and erosion for a particular site, taking into consideration such factors as type of manure, surface residue or vegetative conditions, soil type, slope, etc.
6. Whenever possible, manure should be injected or surface-spread and incorporated within 72 hours of application
7. Not more than 25 tons per acre (63,000 kg./ha.) of solid dairy manure (or its equivalent on a P-content basis) should be applied annually unless it is incorporated
8. Where incorporation is not possible, limit applications to 25 tons per acre (63,000 kg./ha.) of solid dairy manure (or its equivalent on P-content basis) over a five-year period
9. Manure may be applied up to the rate that will provide the N needs of the crops to be grown. This will often result in over-application of P and/or K
10. When soil-test P levels reach 150 pounds per acre (168 kg./ha.), plant P-demanding crops such as alfalfa. Reduce manure application rates
11. If soil-test P levels reach 300 pounds per acre (336 kg./ha.), discontinue manure application until soil P levels drop
12. Do not apply manure to frozen soils within 200 feet (61 m) of lakes and streams. Never apply it in grassed waterways, terrace channels, open surface drains or other areas where water flow may concentrate
13. Do not apply manure within the 10 year floodplain or within 200 feet (61 m) of lakes and streams unless it is incorporated within 72 hours.
14. Manure can be safely applied to frozen soils on slopes of 6 percent or less. Protect these areas from upslope runoff
15. If you apply manure to frozen soils on slopes between 6 and 12 percent, contour strips, terraces or other conservation measures must be in place
16. Do not apply manure to frozen soils on slopes greater than 12 percent
17. Do not apply manure where there is less than 10 inches (25 cm) of soil over bedrock
18. Where the soil cover is 10 inches to 20 inches thick, incorporate manure within 72 hours. Do not apply manure to these soils when they are frozen
19. On coarse-textured soils, such as sands or loamy sands, limit fall manure applications to areas where crops are growing, or delay applications until soil temperatures are less than 50 degrees F (10°C).

Composting

Composting is not a new waste treatment technology. It has been widely practiced by gardeners and farmers all over the world as a sustainable means of returning nutrients to the soil. The process of composting transforms organic waste such as livestock waste into useful soil conditioner or fertilizer. As compost is stable and readily assimilated by soil, it can enhance soil structure, texture, water-holding capacity and infiltration, colour, biodiversity and help prevent soil erosion, among other benefits. Composting also enables production of a more consistent quality product, reduced use of bulking agent, better odour control as potentially odorous air from the process can be easily collected for treatment.

Peters (1998) assessed the success of composting projects by several community groups in Nairobi's low-income areas as means of improving community environmental conditions and generating income through the sale of the compost. A complementary purpose of the study was to add to the limited amount of research on waste in East Africa. The study found that composting can be an effective strategy

for alleviating the problems of unmanaged waste in Nairobi's informal settlements. Composting managed to achieve a number of beneficial environmental effects such as improved health, improved physical environment, and initiation of urban agriculture, among others. However, the biggest constraint faced by most composting groups in generating income is finding a market for the compost. The expense of transportation prevents the groups from bringing the compost to an accessible point of sale. Most of the groups have nowhere to store the compost, so it deteriorates rapidly in harsh sunlight (UNCHS, 1989).

Manure Processing

Many systems of manure processing have been researched, only few are used on any larger scale. Manure processing aims at converting surplus manure in products of higher value and/or products which are easier to transport. As well, it helps to reduce local manure surpluses. Feasibility of large scale manure processing depends on the local circumstances (local legislation, fertilizer prices) and processing cost. The techniques available include livestock manure excrement solid-liquid separator, screw press swine manure separating machine and cow dung dewater processing equipment. The liquid mixture (manure, urine and water with a dry matter content of 5 – 12 %) can be used for biogas production. This will not essentially change the composition of the manure from the environmental point of view. It is an energy production process. The dry matter content of the manure is increased a little bit, the smell is reduced but all the minerals (N.P and K are still in the manure mixture. Without or after biogas fermentation this mixture could be directly applied as fertilizer to agriculture land (crop land or pasture).

Further drying of the solid fraction is an expensive process, very often requiring fossil fuel. However, the dried manure could be pelletized and used as fertilizer for special crops or in the hobby gardening, normally only a small marketing niche for this type of product. The dried fraction could also be used for burning. This is frequently not cost efficient, the drying will require more energy than the effective energy gained from burning the product. Manure from broilers could be an exception because the original product is mixed with wood shavings and has a high DM content. The residual ash of the burning process contains P and K and can be used in the fertilizer industry. Again the fertilizer industry will only be interested in this product if it is available in large quantities of a confirmed constant quality. The residual ash could contain residues of heavy metals which make it unsuitable for further processing by the fertilizer industry. Benefits of processing include reduced volume of manure and the emissions to the environment, production of biogas reduces the need for fossil fuel, composted manure has a higher value as organic fertilizer and the transport cost are reduced to bring manure from surplus areas to deficit areas. However; most processes require large quantities of manure and are generally not techniques suitable for farm implementation. Some of the end-products have to be produced in very large quantities and of a very reliable quality before acceptance by the industry. Most processes are expensive and cost between US$ 10 to 20 per ton of liquid manure. These techniques are applicable to the industrial livestock production systems and to the mixed cut and carry system and external feed resources, where manure is stored in the form of a liquid mixture and cannot be directly applied to the land.

Kenya's Future Livestock Waste Management Options

Historically, manure generated by livestock has been returned to soil for benefits mentioned above. Land application is the best method of utilizing manure; however, recent trends in livestock production and processing raise concerns over environmental degradation and water quality impairment. Like any developing country, Kenya has its own shares of challenges in several areas, waste management being one of them. Some of these challenges include political interference, corruption, shortage of enforcement resources, complacence/complaisance, limited awareness, contempt for authority, poor collaboration/co-ordination of stakeholders, cultural attitude/perception, ambivalent commitment by administration, poverty/ignorance, poor governance, discriminative application of the law and limited infrastructural support. Waste management choices mentioned above are used in various places, especially composting, lagoons and direct land application. National Environmental Management Authority is requiring nutrient management plans, imposing tougher regulations and demanding more accountability in waste handling. However, voluntary control measures are less costly and more productive than government control and regulations. Growing concern about waste handling coincides with the public concern about environmental quality. Following best management practices can improve the environment and reduce liability to farmers.

Conclusions and Recommendations

Governments, agencies and farmers are struggling with manure management issues, but with so many areas of concern and such a complicated system, absolute solutions remain to be found. Approaches

to livestock waste management practices, legislation, regulation and policy are extremely dynamic at the present time. In areas of intensive livestock production in Europe, U.S.A. and Canada waste management and associated environmental considerations are becoming increasingly key public policy issues and this needs to be promoted locally since production standards already determine access to international markets. Actions taken to date haven't necessarily remedied the problems, but have rather attempted to abate the problems while searching for solutions. Recommendations therefore include:

1. *Regulation and accountability*. Factory farms are industrial facilities and should be regulated accordingly. They must obtain permits, monitor water quality and pay for cleaning up and disposing their wastes

2. *Increased transparency*. The public should know where CAFOs are located, how CAFOs in their neighbourhoods dispose of their waste, and what water-bodies or drinking water sources may be at risk. There is not currently a comprehensive database of this critical information, which should be collected and made publicly available.

3. *Public awareness and participation*. Local governments and residents must have a say in whether to allow factory farms in their communities. The public is also entitled to review and comment on the contents of pollution reduction plans and to enforce the terms, where a factory farm is in violation.

4. *New technology*. Factory-farm technology standards must be strengthened. The National Environmental Management Authority must consider recent technology advances that significantly reduce pathogens.

5. *Alternative farming practices*. National and county governments should promote methods of raising livestock that reduce the concentration of animals and use manure safely. Many alternative methods exist; they rely on keeping animal waste drier, which limits problems with spills, runoff and air pollution.

6. *Pollution-reduction programs for small feedlots*. Voluntary programs must be expanded to encourage smaller factory farms, which fall outside of the regulations for industrial facilities, to improve their management practices and take advantage of available technical assistance and other resources.

7. *Consumer pressure*. Individuals can help stop factory farm pollution by supporting livestock farms that use sustainable practices. In the grocery store, this means checking meat labels for "organic," "free range," "antibiotic-free," or similar wording, which indicates meat raised in a more sustainable manner. Many sustainable livestock farms also sell directly to consumers or through local farmers' markets

Changes result from new research findings, applied experience, industry economics and integration with other environmental and land use planning policy. There is no one model elsewhere that can be considered as a prototype for addressing livestock waste management issues; however, experience elsewhere can assist with developing a livestock waste management planning system. Priority must be given to educate the producer, government resource manager and the public.

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Logistics Leverage for a Sustainable Competitive Advantage in Savings and Credit Cooperative Societies (SACCOs): Case of Wakenya Pamoja SACCO Society Ltd., Gusii Region, Kenya

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Abstract

The paper focuses on Logistics Leverage for a Sustainable Competitive Advantage (SCA) in SACCOs, a survey of Wakenya Pamoja SACCO Society Ltd. (WPS). SACCO membership is on a declining trend, attributed to the stiff competition faced from mainstream commercial banks and MFIs who are perceived by clients to be more efficient and as having better operational and governance systems. SACCOs are now being prompted to rethink their overall strategies especially marketing, given the ever-shortening technology cycle as product, promotion or price strategies are quickly met with countermoves from the competition. The general objective of the study was to determine how strategic logistics/marketing linkages can be utilized by WPS to achieve SCA. The specific objectives were to: establish the logistics capabilities that can create SCA for WPS; evaluate the key structural issues that need to be resolved to achieve strategic logistics/marketing integration and; assess the inherent benefits of logistics leverage for the organization. The survey research design was used, and the target population included 482 members. Stratified sampling procedure was employed to obtain a sample size of 220. Data was collected using questionnaires and the weighted mean, frequencies and percentages were used to analyze it. The study established that: strategic corporate relationships and alliances, and technology were resources that could be developed into logistical capabilities resulting in SCA; key infrastructural issues to be addressed included the development of a competitive philosophy, the introduction of an agent to manage the connection among the functions, and getting support of the high level managers; and that increased market share and profitability are the inherent benefits of logistics leverage. In view of these findings, the study concluded that logistics leverage is a viable strategy and that there are other ways of obtaining competitive advantage that do not primarily involve product, promotion or price based strategies.

Keywords: *Logistics Leverage, Sustainable Competitive Advantage, Marketing Strategy*

Introduction

One of the biggest challenges companies face is meeting rising customer expectations in a competitive marketplace. Customers today, expect to get more for less; and if they don't get it, they'll move on to a company that can give it to them. Because of this, executives struggle to find the balance between lowering operational costs and meeting customer demands. Given factors such as homogenization of products, shortening product-to-shelf cycles and the ever shortening technology cycle, the way to sustainable competitive advantage may not lie in changes in the product, promotion, or pricing strategies, but rather in improving ancillary services. Such service improvements are most likely to yield a sustainable positional advantage in the market when implemented through changes in the corporate infrastructure - people, technology, facilities and/or strategic corporate relationships. Porter (1985), Bowersox, Mentzer, and Speh (1995), Bourlakis and Bourlakis (2006), and Markley and Davis (2007) give some insight into this with each referring to logistics as instrumental and central to providing Sustainable Competitive Advantage (SCA).

The Council of Logistics Management (1991) defined logistics as the process of planning, implementing, and controlling the efficient, effective flow and storage of goods, services, and related information from point of origin to point of consumption for the purpose. It is the process of anticipating customer needs and wants; acquiring the capital, materials, people, technologies, and information necessary to meet those needs and wants; optimising the goods- or service-producing network to fulfil customer requests; and utilizing the network to fulfil customer requests in a timely way (Tilanus, 1997). Simply put, logistics is customer-oriented operation management. Unlike a product change or enhancement, achieving logistics superiority is a capability difficult to imitate because it involves changes in the people, technology, facilities and/or strategic corporate relationships infrastructure of the company. The efficiency and effectiveness of the logistics operation has a considerable influence not only on the business performance but also on the customer's perception of the quality of the products and services provided by the plant. Accordingly, logistics is strategically important in many industries as it is central to achieving competitive advantage (Bowersox, Closs, & Cooper, 2010).

The Savings and Credit Cooperative Organization (SACCO) movement in Kenya is billed as the largest in Africa and among the top ten globally (Wanyama, 2009). With over KES 230 Billion in assets and a savings portfolio estimated at KES 190 Billion, the SACCO movement in Kenya constitutes a significant proportion of about 20% of the country's savings. SACCOs have thus become vital components of Kenyan's economy and social development. One of the major challenges facing SACCOs today is the considerable competition from banks and microfinance institutions (MFIs), which are perceived by clients to be more transparent, and as having better governance and operational systems. Banks and MFIs generally have much smaller Boards and management which allows them to make quick operational decisions to adapt to market changes. Banks have better strategic direction, better operational systems and transparent decision making processes. They are also quicker in developing new products and providing clients with quick access to funds as they are more liquid compared to SACCOs.

Founded in 1976, as a union banking section of Kisii Farmers Co-operative Union (KFCU), Wakenya Pamoja Sacco Society Ltd. (WPS) became autonomous in 1992, under the name Gusii Rural Farmers SACCO Society Limited (GFRS). Over the years, WPS has undergone major governance reforms, in its bid to remain competitive and has gone as far as opening up the common bond and modifying the by-laws to be more accommodative of the members' needs. These changes have, however, done very little to improve WPS productivity, as like most SACCOs, it continues to face the challenges of competition, together with weak governance and operational systems. A particular challenge, however, for WPS, is determining how to remain competitive and relevant given the stiff competition from other financial service providers. Any change in the product features, promotion, or price strategies has only a temporary impact in the financial market, as they are quickly met by countermoves from the competitors. A key marketing strategy that can potentially create and maintain SCA is termed as logistics leverage (Fugate *et al.,* 2008), which is defined here as the achievement of superior, infrastructure-based logistics performance, which - when implemented through a successful marketing strategy - creates recognizable value for members. Achieving SCA through leveraging logistics is likely to achieve and maintain competitive superiority. The study sought to establish the relationship between logistics leverage and the achievement of SCA for WPS.

Study Objectives

The general objective of the study was to determine how strategic logistics/marketing linkages can be utilized by WPS to achieve and maintain SCA. The specific objectives of the study were to: establish logistical capabilities that can create SCA for WPS; evaluate key infrastructural issues that need to be resolved to achieve strategic logistics/marketing integration; and assess the inherent benefits of Logistics Leverage for WPS.

Literature Review

Businesses find ways to remain competitive by implementing strategies that assure a sustained competitive advantage. A firm experiences competitive advantages when its actions in an industry or market create economic value and when few competing firms are engaging in similar actions (Barney, 2002). Barney goes on to tie competitive advantage to performance, arguing that a firm obtains above-normal performance when it generates greater-than-expected value from the resources it employs. How to maintain such an advantage given factors such as the homogenization of products and shortening product-to-shelf cycles is a question that most organizations ask. A careful review of the work by Porter (1985), Bowersox *et al.* (1995), Bourlakis *et al.* (2006), and Markley *et al.* (2007), reveal some insights. Each refers to logistics as instrumental and central to providing SCA. Unlike a product change or enhancement, achieving logistics superiority (because it involves changes in the people, technology, facilities and/or strategic corporate relationships infrastructures of the company) is a capability difficult to imitate.

The capability of the logistics system is a critical part of the firm's success in times of time – and quality – based competition (Mentzer *et al.,* 2004). Logistics capabilities are demonstrated to be a source of competitive advantage (Lynch *et al.,* 2000; Zhao *et al.,* 2001). Thus, a superior logistics channel structure can lead to competitive advantage (Markley, 2007), and the infrastructure nature of this superiority makes it difficult to imitate. Therefore, the competitive advantage is sustainable. If logistics is to help a firm enhance competitive position, then it must be properly positioned within the firm's competitive philosophy or, to use Drucker's (1994) terminology, within the firm's theory of the business. Drucker (1994) notes that a firm's long-term success depends on the relevance of its business theory and the resulting stream of strategic decisions that lead to the development of appropriate core competencies.

In the 1990s, having realized that traditional sources of competitive advantage, such as natural resources, access to financial resources, technology, protected or regulated markets and economies of

scale had become increasingly easier to imitate and thus lost their strategic power, strategy researchers and practitioners started searching for new strategic possibilities. As a result a resource-based view (RBV) of the firm was developed, in which the focus of strategy specialists shifted from the external environment to the internal context of the organization, and the greatest emphasis was laid on the crucial role of organizational resources and capabilities, which were viewed as a strategic foundation of the organization and the primary source of competitive advantage (Barney, 1991; Grant, 1991; 1998). Proponents of this view argued that organizations should focus on acquiring, deploying, developing, and retaining their resources rather than the competitive position in the market (Colbert, 2004).

Bourlakis *et al.* (2006) discussed the importance of logistics to firm strategy, emphasizing that integrating logistics activities is critical to competitive effect. In summary, today's competitive environment is one in which logistics activities are well positioned to help firms obtain a competitive advantage. A comprehensive approach to planning combined with a high level of information availability can help the firm allocate and develop its resources into such a distinctive value-added logistics capability (Sandberg *et al.,* 2011). In spite of marketing and logistics holding a strong and mutual interdependence, it is common to find barriers in the relationship between them in the practical field, as well as in the academic field (Svensson, 2002). In relation to the perception each function has of the other, Ballou (2006) highlights the fact that marketing and manufacturing professionals ignore the importance of logistics. Organizations that maintain collaborative relationships between marketing and logistics work easily with the mutual understanding of responsibilities, shared ideas and information, as well as dedicating themselves to joint problem solving (Ellinger, 2000). On the other hand, the lack of integration between these functions may affect cooperation, resulting in poor organizational performance.
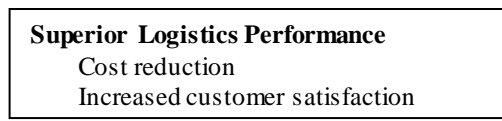
As to the ways to reach integration, Murphy *et al.* (1996) found in the interfunctional integration literature, 14 managerial techniques that may be utilized to improve the marketing and logistics' cooperation. These include: support of the high level managers; common goals and performance indicators; jointly made work projects; agent that manages the connections among the functions; information sharing; coordination committees to discussing issues of interest of the two functions; logistics training for marketing's people and the inverse; mutual negotiation for problem solving; incentive systems evolving sharing of earns and risks; unify the marketing and logistics' departments; job rotation among professional of the two functions; promotion of informal interaction among two function professionals; to use a neutral interceptor (third party or from another area) to solve problems from the two functions; and the implementation of a cooperation philosophy. The support of the high level managers, the information sharing and a cooperation philosophy implementation, are the more widely utilized techniques (Murphy *et al.,* 1996). The implementation of these techniques demands more changes in the corporate culture, than formal changes, or substantial expenses. The foundation of future marketing and logistics integration is strategic. The focus of logistics has been and will primarily continue to be upon cost drivers, i.e. skills and resources that generate efficiency.

The integration of marketing and logistics is necessary to bring the logistics sources of advantage into the realm of effectiveness, or drivers of differentiation. This will only occur and result in positional advantages if the leverage logistics can bring to marketing is realized. Where this integration is accomplished, strategic positioning of the marketing/logistics integrated firm as cost efficient and customer effective will result (Daugherty *et al.,* 2009). By focusing on logistics competency, the leading logistics performers are providing tangible and significant benefits to customers (Bowersox *et al.,* 2010). The net result is the creation of a meaningful competitive advantage. The exploitation of logistics competence offers a meaningful way to create value-added services not achievable in other ways.

A major premise of this work is that logistics competency can be created, but unless the firm is positioned to exploit it, little strategic significance will result. Logistics leverage has to be consciously created through the actions of marketing and logistics managers within the firm. Key issues to be resolved include the creation of value-added services, top management vision, strategic alliances and partnerships, interfunctional teams, the orientation of marketing, organization structure, marketing intelligence, channel member programs, and the nurturing of sole-source relationships. Once these issues are resolved, the firm will be positioned to effectively integrate logistics competence into marketing strategy to create sustainable differential advantage. The most popular indicators of marketing effectiveness and competitive advantage are market share and profitability. Leveraging logistics success can reduce costs and increase customer satisfaction and, therefore, positively influence the firm's profitability. Profitability is a desirable outcome because it creates shareholder value. When consistently and substantially maintained, it ensures the firm's longevity (Bourlakis *et al.,* 2006; Markley *et al.,* 2007).
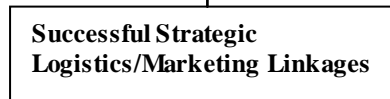
Conceptual Framework

Independent Variable   Dependent Variable


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┌─────────────────────────────┐              ┌─────────────────────────────┐
│ Superior Logistics Performance│            │ Sustainable Competitive Advantage│
│    Cost reduction            │ ────────▶    │    Increased Market share   │
│    Increased customer satisfaction│         │    Increased profitability  │
└─────────────────────────────┘              └─────────────────────────────┘
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Moderating Variable

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┌─────────────────────────────┐
│    Successful Strategic      │
│  Logistics/Marketing Linkages│
└─────────────────────────────┘
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Figure 1. Conceptual Framework

Source: Researcher's Own Conceptualization (2012)

Methodology

The study was conducted through the survey research design. The study area was within the Wakenya Pamoja SACCO Society Ltd (WPS) headquarters, located in Kisii County. The SACCO had a membership of approximately 102,000 members both dormant and active including delegates (directors and non-directors), and members of staff (Managers and other employees). The study targeted a population of 482 WPS members, staff and delegates. The members only included those with savings amounting to KES 300,000 and above, based on the December 2011, WPS Statement of Deposit Return. Stratified sampling was used to select the sample size and respondents for the study, as this technique ensured that subgroups were proportionately represented and accounts for differences in characteristics therein (Onen & Oso, 2008). Yamane (1965) simplified sample size calculation formula was used to arrive at the sample size of the study. A questionnaire comprising both the closed and open ended questions was used as the main data collection tool, as the study was primarily concerned with the views and opinions of the respondents. Data was collected within the duration of two weeks. The weighted mean, percentages and frequency counts were used to analyze the data. The weighted mean was used to analyze responses on likert items. Percentages were used to show the particular frequency of respondents preferring a particular alternative, while data from open-ended questionnaire items was grouped into broad themes that were converted into frequency counts. Results were summarized in tables, charts and graphs, giving implications of logistics leverage on sustainable competitive advantage for WPS.

Results and Discussion

All the 220 questionnaires were completed and returned to the researcher, representing a 100% response rate, which very good for use in the research (Mugenda & Mugenda, 2003). The first objective was to establish logistical capabilities that can create SCA for WPS. The results indicated that respondents were of the opinion that strategic corporate relationships and technology with a mean of 4.14 and 4.00 respectively, were factors that if improved/changed/enhanced would result in SCA for WPS. They ranked facilities and people at 3.73 and 3.50 implying that while these were logistical capabilities that would be utilized, the final outcome would not have a greater impact like the former. The key to winning and keeping customers is to understand their needs better than competitors. A company gains competitive advantage by the extent to which it can position itself as providing superior value to selected target markets as compared to competitors. If a company positions its products as offering the best quality and service, it must deliver on the promised quality and service. Thus, positioning begins with actually differentiating the company's marketing offer so that it will give consumers more value than competitors do.

The second objective was to evaluate key infrastructural issues that need to be addressed to achieve strategic marketing/logistics integration. The study established that WPS did not have a competitive philosophy in place. It also established that only 60% of the directors and employees clearly understood the specific duties, roles and responsibilities of the logistics and marketing departments. While it was agreed that there was a collaborative relationship between the two departments, introducing an agent that manages the connections among the functions, the support of high level managers and setting of common goals and performance indicators were indicated as the most effective techniques that

would be used to improve the relationship with a mean of 2.76, 2.65 and 2.59 respectively. Drucker (1994) notes that a firm's long term success depends on the relevance of its business theory and the resulting stream of strategic decisions that lead to the development of appropriate core competencies. The study revealed that the management of WPS did not clearly understand the firm's business theory that is, what to do and how to do it better than anyone else, as they were rated average on their understanding of the five key issues raised by Drucker (1994) that are critical to determining the relevance and effect of the firm's theory of business.

The third objective was to assess the inherent benefits of logistics leverage for the organization. The study indicated that WPS has the ability to build logistics competence, with the ability to change its marketing intelligence being ranked the highest with a mean of 4.44. If logistics, however, is to help a firm enhance competitive position, then it must be properly positioned within the firm's competitive philosophy. It is only after this is addressed that WPS will be able to accrue the inherent benefits of logistics leverage that the study revealed to include creation of value for members, increase of the market share and profitability, together with facilitating for the overall reduction of the organizational costs. Logistics leverage can help a firm achieve and maintain positional advantage through both types of competitive advantage conceptualized by porter (1985). For WPS, it provides a way to control costs, achieve differentiation and as such come up with strategies that are all inclusive and cannot be copied by competitors as they are infrastructure based.

Conclusion

The study established that: the strategic corporate relationships and alliances, and technology were corporate resources that could be developed into logistical capabilities resulting in SCA for SACCOs, given their limited resources. This complex bundling of resources is to be considered as valuable, rare and difficult to imitate for competitors (Barney & Clark, 2007). Key infrastructural issues to be addressed to achieve strategic logistics/marketing linkages include the development of a competitive philosophy, and using the techniques of introducing an agent that manages the connection among the functions and support of the high level managers; and that increased market share and profitability are the inherent benefits of logistics leverage. In view of these findings, the study concluded that logistics leverage is a viable aspect of marketing strategy.

The study also concluded that changes in corporate infrastructure are the keys to the sustainability of logistics leverage. For example, strategic corporate relationships can lead to an alliance that the competition cannot match. A logistics alliance is an extension of the superior skills of each partner to do value-added activities within the supply chain. Such an alliance can also lead to innovative new products and processes that become valuable resources in the marketing strategy. The challenge to managers is to identify such infrastructure sources of competitive advantage in their logistics systems.

Finally, no success can be achieved without strong coordination and collaboration between marketing and logistics. Much of the logistics leverage plans are driven by insightful market research and the superior logistics performance will not have an impact upon the customer without effective marketing communication. Managers striving to achieve positional advantage through logistics leverage must recognize the role logistics can play in marketing strategy and realize that this role involves inextricably intertwining the two functions to achieve successful marketing strategy, one that has been demonstrated to result in more efficient operations, more satisfied customers, increased market share, and high profitability.

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Metallurgical Research, Development and Raw Materials Sourcing for the Development of Steel Industries in Nigeria

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Abstract

It has been said that no meaningful industrialisation can take place in a nation without Iron and Steel. In fact, Iron and Steel are the bedrock of Nigeria's industrialisation and ultimate factor in the realisation of our industrialisation efforts. Most of the Steel industries have been constructed and erected and they have to go into full operation in view of the huge money already sunk into these projects and the relative irreversibility of investment. Metallurgical Research and Development is needed to further discover the use of locally sourced raw materials for the operation of these industries. Apparently, most of the imported raw materials are expensive and some time difficult to import due to bureaucratic process and challenges faced at the present stage of steel development in Nigeria. The need for sustained availability of the raw materials for these steel industries calls for drastic reduction in the imported raw materials. This paper will therefore focus on various Metallurgical Research, Development and Raw materials sourcing for use in metallurgical industries. The paper further highlights the raw materials needs for steel production; processes for metallurgical coke and of refractory clay were reviewed. Local deposits of these materials were mentioned. The future of metallurgical research and development were brought to the fore and finally some suggestions and recommendations were given which will assist Government, stakeholders and those that are involved in the practice of metallurgical engineering with emphasis on the steel industries.

Keywords*: Research, Development, Raw Materials Sourcing and Steel Industries*

Introduction

There can be no national industrial and technological advancement without functional steel sector. It is very strategic for effective technology acquisition. However, steel industries cannot grow sustainably without drawing the bulk of its materials need locally. Thus, import substitution in terms of raw materials and spare parts is an indispensable strategy in developing steel industries. Metallurgical research and development therefore is a necessity in achieving import substitution as the example of steel development in most of the developed countries. The development of raw materials required for most of the metal-based industries, for iron and steel making in actual fact begin with exploration as shown below.

Exploration

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Evaluation

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Mining → Processing → Smelting → Marketing
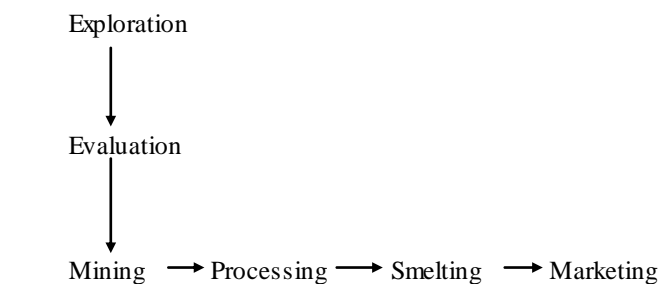
Figure: 1 Activities of the Mineral Industry

Research and development programs of Metallurgical interest have been executed in some institution of higher learning, research centres and industries, especially since independence in Nigeria. The most significant of these projects on record have recounted – the contributions of metallurgical research and development to national economy. It is conclusively advocated that an increased research and development activities in the metallurgical industry is the self – reliant industrialization and economic development of Nigeria as it faces global economy meltdown.

Various mineral resources known to occur in Nigeria (including iron ore, coal, gypsum, clay, salt etc.) could be described as relatively low grade, but they are considered so only in the context of currently commercialized production processes and technologies. With more intensive research and development, it should be possible to develop processing techniques that are peculiarly appropriate to the local resource. A case in point relates to the local iron and steel industry for which iron ore and metallurgical coals are essential but currently import raw materials.

Unfortunately, Nigeria's largest iron ore reserve on the Agbaja' largest plateau in Kogi State (with over one billion ton of ore) is known to contain unacceptably high levels of phosphorus, an element that is difficult to eliminate in convectional ore beneficiation and iron and steel furnace processes, in addition to being deleterious to the properties of the unfinished steel product. Similarly, the coal resources of Anambra, Beune and Plateau States are new non –coking and therefore unsuitable for direct use in the blast furnaces.

In both of these cases, local research and development efforts geared to the characteristic of these local resources could result in their economical utilization by the local steel industry, thus saving larger sums in foreign exchange that could have been spent on importation, while enhancing Nigeria's security of supplies of critical raw materials (Adigwe, 1983).

Despite the growing competitions from some non – ferrous metal like Aluminum with its alloys, and non- metallic materials, notably plastics, in the country, the supremacy of steel is rather secure. Consequently, the buck of metallurgical research relevant to the current global economic meltdown will provide the necessary impetus to develop the metallurgical industries in Nigeria in the areas of iron and steel making and heat treatment processes with a view of overcoming the present global economic meltdown (Afonja, 1983).

Raw Materials for Steel Production

During the short period of production at the Ajaokuta Steel Company Limited and Iron ore mining Corporation at Itakpe both in Kogi State, the Delta Steel Company Limited (DSC) Aladja produced steel which were made into billets (ranging from low to medium carbon steel) for use at Ajaokuta Steel Company Limited, without necessarily depending on imported ores because the vast proven local ore reserves that are largely available have be improved upon and the qualities upgraded. Consequently, the beneficiation of these local ores has attracted a lot of metallurgical research. In the past, the Metallurgical Research and Test Division of the National Steel council had been able to upgrade samples of huge reserve of sedimentary magnetite – hematite ore deposit at Itakpe from 38-40 % as mined to 65 % Fe by the gravity method (Anagbo & Udevi) (Bello, 1986)

This concentrated quality would satisfy the 63% Fe requirement for the production of iron in Ajaokuta Steel company Limited through the use of the blast furnace. Whenever the furnace is operational, it is also determined that the silicon content could further be minimized. A super concentrate of 68% Fe was produced by a second stage flotation process, providing a possible raw material even for the direct – reduction steel plant (as being practiced at DSC), especially with the intrinsic low sulphur and phosphorus contents of the deposit. The research got to a stage where a pilot plant scale was developed for the beneficiation flow sheet involving Reichert Cone, the Humphrey Spiral and the Magnetic Separator (Bello, 1993)

The Tuto –Buro fine –grained hematite ores have similarly be upgraded from 32% also by the gravity method while the Ajabanoko ores (Kogi State) was improved by magnetite separation from 39 % Fe to 63% Fe –Anagbo (Igwe, 1986). From the research carried out, it implies that the ore from these two deposits could also be processed for the blast furnace feed. The vast deposit of over a billion tonnes of Oolific sedimentary ore at Agbaja is unfortunately associated with very high phosphorus content (John). It has only been possible to upgrade the ores from 52-56% Fe to 60% Fe. In this state it could be blended with richer ores to feed the blast furnace at the Ajaokuta Steel Company Limited, provided the phosphorus content could be attenuated.

It was estimated that at full capacity, the Delta Steel Company Limited will require 1.55 million tonnes of iron ore while the first phase of Ajaokuta Steel Company Limited would gulp up to 2 million tonnes per year (Pwajoh, 1989). In the early 80s, the cost of ore per tonne was put at $45, a whooping sum of $159.75 million per year would have been needed for investment in iron ore alone when both industries became fully operational. A substantial part of this sum could be saved if the momentum of local ore beneficiation was maintained to curb importations.

Research and Development work carried out on Itakpe iron ore by NMDC Jos, established that the supply of the required specifications of concentrates to Ajaokuta Steel works is never in doubt. In the research work NMDC Jos collaborated with NIOMP and DSC Warri to prove through research that the handling problems associated with abundant fines in the super- concentrates transported from NIOMP to DSC can be solved.

It is on record that the Itakpe super – concentrates produced by Froth Flotation using feeds of sizes 0- 180µm (> 80% < 90µm) and 0-90µm (> 705 < 63µm) meet the requirements of DSC in terms of physical and chemical characteristics in Fe > 66%, gauge of < 3.5% and sieve size of - 45µm < 30 % (Usman, 2002)

Review of Metallurgical Coke

In the production of steel, the next but important raw material is the metallurgical coking coal. The use of these coking coals is via the blast furnace route. In the 80s, it was established that about 401 million tonnes of coals in Nigeria were intrinsically deficient for the direct application to steel making. The issue of coke-able coals has therefore also attracted considerable metallurgical research, Adigwe discovered that it is possible to reduce the objection of the medium – rank Lafia – Obi (coking coal) high sulphur content, moisture content and ash content from 44 % to only 10% (Tiajopromexport, 1993)

Further work was set in motion to control the sulphur content as being investigated by Afonja; He further showed that Enugu coal estimated at 64.3 million tonnes reserves, characteristically of the low ash content can be upgraded to 30% in convection modern preparation with imported high rank coal. The drive would be to blend the imported coals with upgraded Lafia coal.

Since its inception in 1979, the Research Centre of NMDC Jos has been conducting applied research to ensure the inclusion of an appreciable percentage of locally available coals in metallurgical coke making at the Ajaokuta Steel Plant. Samples from Enugu, Okaba and Lafia coal deposits were extensively investigated and their results documented.

Table 1. Coal Reserves and Resources in Nigeria

State	Location	Indicated in Site Reserve Million T	Inferred Resources Million T	Overall Resources Million T
Benue	Orukpa	57	73	
	Okaba	73	250	
	Ogboyoga	107	320	
Delta	Asaba (lignite)	250	Unknown	
Enugu	Enugu Area Ezimo	54	200	
		56	60	
Plateau	Inyi Lafia – Obi	20	Unknown	
	(Coking Coal)	15	Unknown	

Source: Selection of coals for making High Quality Metallurgical Coke at Ajaokuta

Table 2. Results of Proximate Analysis and Coking Properties Determination of Nigerian Coals

S/N	Origin of the Coal Sample	Proximate Analysis				Sulphur slot a.d	Crusible Swelling Numble (CSN)	Gray King Coke type
		Mad	Aad	Vad	Vdat			
1	Enugu (washed)	8.2	12.54	34.5	42.5	0.7	0	A
2	Onyeama	3.4	13.80	40.40	48.9	0.5	0	A
3	Okaba	9.4	11.60	35.30	44.70	0.50	0	A
4	Akpunuje	8.5	7.0	26.90	31.90	0.60	0	A
5	Lafia (original)	1.5	25.60	22.60	32.20	2.30	6	G
6	Lafia after beneficiation H.M.S. of 1.4g/CM^3	1.6	11.30	22.10	30.0	Sulphur intact	8	G3

Note: ad – as determined, daf – dried ash free, tot – total

Source: The Development of Steel Industry from Nigerian Raw Materials

Table 3. Petrographic Composition of Nigerian Coals

Coal Sample	Maceral Analysis					Maceral Composition
	V	E	M	F	MS	
Enugu	58.6	18.1	1.0	16	5.7	Vitrinite: Collinite Exinite: Spores and cuticles Fascinate: 50% F + 50 % SF Pyrite in mineral substance
Okaba	55.5	19.5	1.5	18.5	5.0	Vitrinite: Collinite and telinite Exinite: Spores and cuticles Fusinite: Fusinite and semi-Fusinite, Scleronite
Lafia	47.5	25.0	1.0	7.5	19	Vitrinite: Collinite Exinite: Spores, cuticles, Low-eflectance. Fusinite: Fusinite (60%) and Semi-fusinitie (40%) Pyrite in mineral sub-Stance

(V – Vitrinite, E – Exinite, M – Micrinite, F – Fusinite, MS – Mineral Substance)

Note: The Leitz photometer then used is now broken down and obsolete.

Source: The Development of Steel Industry from Nigerian Raw Materials

Coal Chemical Composition (Coal Grade)

Coals are selected by grade, which takes cognizance of the chemical quality in respect of ash, sulphur, phosphorus, alkali and chloride contents. If any chemical parameter of a particular coal exceeds limits specified at a coke plant, the coal may still be satisfactory for specific use if is possible to formulate a blend with other coals or materials such that the final charge lies with the limits specified. It should be noted that alkalis cause coke breakdown, scabs and other operating problems in the blast furnace. Consequently, the alkali content in a coal charge for coke making is always kept as low as possible. It is restricted to a maximum of 1.95% in the case of Ajaokuta Steel Company Limited (Adigwe, 1983). Also chlorides pass into by –product section and require considerable water to remove from the tar recovered in the By-product plant. Because of its corrosive nature, chlorides also cause maintenance problems in the coal handling and coke oven plant

In April 1993, at Vukhim pilot plant Russia, a number of coals were used to compose coking coal blend for the operation of Ajaokuta Coke Oven Plant. Six coals from Australia, United State of America and Great Britain were subjected to a series of tests after which eight-charge variants were shot listed. In 1993, direct blending test of imported and Enugu coal was carried out on a 250 Kg pilot Oven at NMDC, Jos.

Coal Blend Studies

Lafia and Enugu coals have been co-carbonized and also co-carbonized with a prime coking foreign coal – Ogmore coal from U.K. The effects of coking modifiers such as pitch have also been determined for the carbonization of Lafia and Enugu coals. Ashland A240 petroleum pitch was used. The resulting coke products were subjected to optical microscopy, micro strength tests and reactivity tests.

As present research conducted by NMDC, Jos, the state of test, research and development of relevant local materials and their preparedness for use in the steel industry was brought to the limelight. Apart from the fact that Lafia / Obi coals would be blended with other imported coals, the Atito Akpuneje coal (Nasarawa state) shows promising characteristics (Ash 14.9, Fixed carbon 53.5) (Bello, 1986)

Improved quality of coke was produced at a pilot scale from blend of Okaba and an imported coal (Agro- allied, supplied by ASP 1993), employing the pre-heating coking improvement technique. The pre- heated blend between Agro-allied coal (medium coking) an 5% Okaba coal almost satisfy ASP's M10 (≤9% as against obtained value of 9.5%) and M40 (≥ 78% as against obtained value of 76.2%) requirements despite that Agro- allied low Free Swelling Index (FSI) of only 2.5 Consequently, primer coking coal with an FSI of 6, blended with Okaba coal and an additive of bitumen, would no doubt result in a far more than 5% Okaba blend in the imported coal.

The execution of these would bring savings for the country to about $632 million per years as estimated for use in the first phase of Ajaokuta Steel Company Limited. Other basic raw materials that is important to steel making which has drawn the attention of researchers in the metallurgical / metal based industries is clay.

Review of Refractory Clay and Deposits

A research was carried out, where a pilot plant was designed to upgrade the products of a Nigeria industry based in Ukpor / Ozubulu belt (Anambra) and offshore, to determine and find out the requirements of refractory as needed in making iron and steel in terms of plasticity.

Among the clay, vast deposits of identified Kaolinite exist in Oza- Nogogo, Ukwuazu, Okhuo and Iguoriaski (Edo state). Refractory clays have also been reported in abundance In onibode and Oshiele

(Ogun) , Ogbete and Ekulu (Enugu) as well as Giru (Sokoto), Nsu (Imo) and Barkin Ladi (Plateau). High quality bricks clays occurs in many parts of the country including Umuahia (Imo), Abeokuta (Ogun) and Abakaliki (Ebonyi).

A good number of studies were carried out on local clay deposit in Nigeria, the result oriented showed that they satisfy the chemical and physical requirements for manufacture of refractory brick. Critical parameter with alumina (Al_2O_3) that ranges between 31.24 % and 38.50 % and their refractoriness are from 1660ºC to 1750ºC. However, initial investigation into Oza- Nogogo clay deposit show that it is plastic with Alumina content of 31.08% and a refractoriness of over 1600ºC

A laboratory test was carried on Jakura limestone and the result indicated that it has pure chemical composition of about 55% CaO and low silica value of 0.80%. The Osara dolomite which is about the best so far studied gave a 54 .80% CaO, 42.82 MgO (Calcined) and a refractoriness of 1710ºC. Table 4: shows clay deposit in Nigeria.

Table 4. Data Bank of Some Clay Deposits in Nigeria

S/N	DEPOSIT	CHEMICAL COMPOSITION (%)								PHYSICAL PROPERTIES	
		Al_2O_3	S_iO_2	Fe_2O_3	CaO	MgO	K_2O	Na_2O	L.O.I	Plasticity Index	Refractoriness
1	GIRU (Kebbi State)	38.50	43.63	0.67	0.02	0.10	0.03	0.04	14.16	0.42	1750
2	KANKARA (Katsina State)	36.40	46.48	1.09	0.79	0.87	0.08	0.10	14.31	3.19	1700
3	NSU (Imo State)	31.24	49.57	1.72	0.61	0.43	0.06	0.09	11.79	6.03	1710
4	KWI (Plateau State)	31.69	37.63	14.48	0.025	0.12	0.06	0.12	12.40	0.68	1660
5	ONIBODE (Ogun State)	35.00	48.00	1.70	0.2	0.3	0.12	0.05	13.1	6.5	1730
6	OZUBULU (Anambra State)	34.10	47.21	1.85	0.61	0.48	0.07	0.12	11.03	5.71	1727

Source: The Development of Steel Industry from Nigerian Raw Materials

The Future of Metallurgical Research and Development

Two distinct patterns are readily identified from the few metallurgical research and development projects enumerated above. Firstly, we notice that the bulk of result –oriented research and development projects are associated with the premier steel industry. It is clearly indicative of an urge, perhaps borne out of necessity, to indigenize what is essentially an imported technology. It is for this reason that some of us have contended that no transfer of technology is possible which side tracks the 'Philosophical approach'. In ensuring that any imported technology process is adequately matched with 'indigenizing' research, development and raw materials sourcing, in this present time a fundamental pattern, must be adopted which will drive the desired technology and development.

Secondly it must be admitted that most of the local result – oriented metallurgical research have been unduly restricted by infrastructure and definitely funds. Yet it has been demonstrated that a reasonable investment in research investment and development can bring rewarding returns and is in any case mandatory for speedy technological and economic empowerment and development. The often quoted rapid technological growth of Japan since World War II is a case in point. For instance, in 1973, Japan invested an equivalent of N1Billion (by first tier rate of N1= Y180.272) in technological research and development and 200 out of every 10000 Japanese were involved in research work, spending at an average rate of 40 % per annum to sustain what was observed from a far as the Japanese feat.

The point being made here is that Nigeria should plan for accelerated economic empowerment and development program by deliberatively encouraging research and development, since the steel industry is a spring determinant of our economic stability by way of producing the essential industrial raw materials, the funding of Metallurgical Research and Development must receive priority consideration.

From the National Metallurgical Development Centre (NMDC) Jos, Nigerian's point of view and experience, it is very obvious that a lot of result –oriented metallurgical research would be necessary to all metallurgical industries, like the Ajaokuta Steel Company Limited, Delta Steel company Limited and other related industries. This will also assist to indigenize the imported technology as much as possible and therefore improve the chance of these metal-based industries for surviving.

Conclusion

The economic impact of Research and Development (R&D) on local raw materials to develop the steel industry and later for expansion and improvement cannot be over-emphasized. As a security in case of international supply problems in the future, R&D on all types of relevant deposits has to be conducted continuously ahead of production.

Consequently, all the Metallurgical base industries requires adequate funding to provide consumables, replace obsolete equipment and other specialized equipment to facilitate aggressive research. Material Society of Nigerian and other material / Metallurgical Societies should join in this crusade; they should therefore work in conjunction with the steel industries, so that they could jointly proffer solutions to importation problem of raw materials, expatriates skill and technology by substituting them with locally sourced raw materials.

Finally, Today's neglect of Research and Development is tomorrow's regret of technological breakthrough for Nigeria Government to meet up with the vision 20, 2020 and realize the aims and objectives of the of steel and materials development. We must therefore join hands to develop R&D and show concern to developing the steel and material industries. The only way out of this quagmire is to have effective policy and legislative laws that will enforce the principle and practice associated to Research and Development there by overcoming the effect of materials and steel development at the epileptic status in Nigeria.

Recommendations

Finally, as a way of funding research in Nigeria, it is suggested that metallurgical industries and government should do the followings:

(a)That now declare huge profits by selling scarce and essential commodities at inflated prices, should be made to contribute 15- 20% compulsorily to a Research and Development Fund (RDF).

(b) The Research and Development Fund should be organized along the lines of the Industrial Training Fund (ITF). This would help in the development of raw materials sourcing for the industries to increase their productivities.

(c) Proper utilization of resources by research centres should be enforced by the Government, in order to achieve optimal performance.

(d) The Government should consider establishing Research and Development centres in each Geo –political Zones in Nigeria, where newly graduated Nigerians could be involved in research and developmental works rather than roaming the street in search of employment.

(e) Government should encourage the participation of private investors in building centres and funding research works / programs.

(f) Most of the metallurgical -based industries should make it as a point of duty to develop a research centre in their industries, where research work could be carried out.

(g) The Management of Ajaokuta Steel Company Limited and Delta Steel Company Limited should update and upgrade their equipment and pay more attention in funding their researches for effective and optimal utilization of the centres.

(h) The concept and ideology of an industrialized nation like Nigeria, which has been based on the policy of import substitutions, needs must be reversed. Researches in the steel industry with the use of these locally sourced raw materials should be the major focus.

(i) An industrialized nation should not be structured in such a way that it has to depend on foreign raw materials, imported components, spare parts and expatriate skill for sustained development.

(j) To achieve the desirable object of substituting imported raw materials with locally sourced ones, a lot of funds will be spent on research and development.

(k) The Metallurgical Training Institute in Onitsha should be encouraged to develop a research centre, where findings from these works are documented and use same as aiding teaching tool for students.

(l) A Nation that wants to be self – reliant, self sufficient and strong economically should not build on mass importation of raw materials but rather source for these raw materials locally.

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Women Education for Social, Economic and Political Development in Kenya

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Abstract

Various national regional and international conventions and documentation have emphasized that enabling the population regardless of gender to actively participate in social and economic well being is critical for long term and sustainable social, political and economic development of any society. One way of empowering the population is through education. Education is the process by which people acquire knowledge, skills, values and attitudes by which they develop an appreciation of their cultural values, through which all these are passed from one generation to the other. Education is the true bedrock of the society's culture, civilization and a powerful tool for perpetuating social, political and economic development. As such, education is pivotal to overall development of humankind. According to the human capital theory, "The greater the investment in education, the greater the collective benefits to the society and the greater the benefit the participants are likely to get." Further, the collective benefits for the society increase with higher participation of women in education. For over a decade now, educating girls/women has been identified to have both direct and indirect benefits. Improved maternal health, lower incidences of HIV/AIDS, poverty reduction and environmental protection are but some of the positive outcomes when girls/women are educated. The impact of educating women actually goes beyond them and their family to enrich the entire nation. It is in the light of this that this paper seeks to discuss the diverse social, political and economic benefits that accrue from educating women. Based on the discussions, recommendations will be made that will go a long way to enhance women education in general and particularly in Kenya.

Keywords: *Social, Economic, Political, Education, Development*

Introduction

Various national, regional and international conventions and documentation have emphasized that enabling the population regardless of gender to actively participate in social and economic well being is critical for long term and sustainable social, economic and political development of any society (Cochrain, 1979). One way of empowering the population is through education. Education is the process by which people acquire knowledge, skills, values and attitudes by which they develop an appreciation of their cultural values, by which they make necessary rules, laws and obligations that, ensure the survival of the society and by which all these are passed from one generation to the other. Education therefore is the true bedrock of the society's culture, civilization and a powerful tool for perpetuating social, economic and political development. As such, education is pivotal to overall development of human kind (Christiana, 2002).

According to the human capital theory, "The greater the investment in education, the greater the collective benefits to society and the greater the benefits the participants are likely to get." Further, the collective benefits for the society increase with increased participation of women in education (Coleman, 2004). In this perspective, education is a cornerstone of economic growth and social development and a principle means of improving the welfare of individuals (Mason & Andrew, 2001).

Scholars contend that there is no question that educating citizenry pays off in benefits to the nation as a whole. One Orodho (2002) especially concurs with the above statement but counsels that, although direct evidence of the causal relationship between formal education and development in developing countries is rather blamed as less extensive than for the more industrialized countries, enough signals are in place which indicate that appropriate education and training, especially for girls/women would have a more positive impact on the socio-economic and political development of developing countries like Kenya(Kane, 2004).

Additionally, education may be viewed as the key to women's future as it enables them to widen their horizon beyond child bearing and household drudgery. Women constitute more than 50% of the population in Africa and more than 51% of the total population in Kenya(Summers & Lawrence, 1994). With the knowledge and skills acquired through education, women are able to efficiently and effectively

undertake their roles in the society. The impact of educating girls/women actually goes beyond themselves and their family to enrich an entire nation. This paper therefore seeks to discuss the diverse social, economic and political benefits that accrue from educating women. In view of this, recommendations will be made that will go a long way to enhance women education in general and particularly in Kenya.

Social Benefits

The social benefits that accrue from education are quite evident and when more educational opportunities are opened to girls/women, such benefits are even greater (Kane, 2004). Available evidence suggest that, if a mother is more educated she may play a greater role in family decision making, makes her aware of proper medical care which reduces infant and child mortality, makes her break away from traditions which promote gender discrimination in the society and may greatly enable her access higher status occupations which lead to improved income and social status (Dollar & Gatti, 1999).

In this context therefore, education enhances the woman's decision making autonomy at home, their exposure to the outside world, their conjugal family orientations and their control over the family resources. Studies have shown that there is a strong positive correlation between parental education particularly the level of a mother's education and a child's health. Educated women are able to provide better nutrition and general health care for their children compared to the illiterate mothers. In fact, educated women are much likelier to have significantly less malnutrition in the family (Dollar, 1999).

Strong positive relationship has also been observed between women's education and fertility rate. In terms of arresting population growth, the fastest and the most effective and cheapest method is the schooling of girls. This is because education affects the demand for children for example, by changing the perceived costs and benefits of having children and the ability to afford children and by altering preferences as reflected in the ideal family size. Additionally, education affects the supply of children by affecting the age of marriage and the relationship between husband and wife by increasing knowledge of contraceptives and possibly, though not always, by changing attitudes towards contraception.

Women with higher levels of education normally delay their first birth thus; maturity at the time of their first birth might lead to improved child care hence reducing the mortality rate of children born to the educated women. Further, child mortality is reduced by as much as 10% for children less than five years with each additional year of schooling for their mothers after primary education. Educated women are able to secure earlier and longer schooling for their children and are also knowledgeable about school opportunities for them. They are even more involved with the psychological development of their children than the uneducated mothers (Mason & Andrew, 2001).

One of the reasons so many experts and economists believe educating girls is one of the most important investments in the world is how much they give back to their families. Most of the social benefits that accompany increased education are attributable to girls who use their schooling more productively than boys. Women in the developing world who have had some education share their earnings with the family members while majority of men keep a third to a half of their earnings to themselves (Kane, 2004).

To be born a girl in a rural area in some African communities means being doomed to a life without education and clean water, with early marriage and babies coming too early, too many births, babies who die of preventable diseases, backbreaking work in the fields, emotional subordination to her husband and family and an early death. Social exploitation of girls and women is another route open for male domination of the female deprived of education. The uneducated woman therefore transmits to her children the same doomed life. However, educating women enables them to overcome such traditional obstacles and to obtain increased control over their lives and that of their children.

Women with some education are less likely to subject their daughters to the practice of female genital mutilation and early marriages. This is mainly due to the fact that they are aware of the negative consequences of such practices compared to the uneducated women. Studies have also demonstrated that an increase in the education of women is significantly related to the decreases in HIV/AIDS infection rate. In fact, education is often referred to as the social vaccine for HIV/AIDS. This is attributed to the fact that educated women have a lot of information on the scourge and how it can be transmitted compared to the uneducated women. Finally, education gives girls and women access to employment opportunities as well as enabling them to act as role models in the society. From the foregoing discussion, it's evident that girls/women education is an important social tenet to national development and therefore should be supported by all.

Economic Benefits

The Universal Primary Education (U.P.E) and the Gender Equality and the Empowerment of Women are both central to the 2000 United Nations Millennium Development Goals (M.D.G's) (Mason & Andrew, 2001). This demonstrates the international communities' recognition that investing in women education could be one investment with the highest returns in the developing world. The substantial gains that increased schooling for females have on economic outcomes have indeed made economists to conclude that investment in women education may well be the highest return investment available in the developing countries including Kenya (Dollar, 1999). The World Bank therefore advises that since investing in primary education yields higher returns than investing in higher levels in low income nations, and because girls are more concentrated at lower educational levels, closing the gender gap in primary education is the most beneficial economic strategy for developing countries (Karani, 2004).

Women usually manage food, water, fuel, intensive agriculture and birth spacing. It therefore implies that a woman with at least six years of education will be a critical actor in farm productivity, livelihood diversity, resource conservation and population control. Women economic contribution on a global basis ranges from 10%-58% of full household income, cash income, income in kind and the value of labour devoted to unpaid activities carried out by its members. In fact, women engage in more total productive time than men. Although the amount of time spent in paid activities is less for women than for men, they spend a larger amount of time in some production relative to men. For instance, in Africa, 70% of the food is grown by women, in Asia; the figure is 50%-60% while in Latin America it is 30%. In Kenya, 60% of the rural households are headed by women who do most of the farm work. With many women being the main farmers, education offers them a chance to develop more efficient farming practices improve output and raise awareness of the ecological needs of the land. Studies have indicated that educating girls in areas with little schooling substantially increases agricultural productivity and that one extra year of primary education increases farm yields more than increased access to land or fertilizer usage (Sperling, 2005).

Another economic benefit of educating girls is that when girls are provided with one year of education beyond the average (primary education), it increases eventual wages by 10%-20%. This improves their economic status in the society. Further, increasing the portion of females with a secondary education by 1% increases a nation's annual per capital income growth by 0.3 percent (Eshiwani, 1993). Generally, from a technical perspective, education leads to the acquisition of technical skills and positive attitude that are likely to increase economic productivity of an individual. In this regard, education helps to reduce poverty by increasing the value and efficiency of the labour force. In fact, as economics world wide are transformed by the technological advances, particularly with the advent of information technology (IT) and the emergence of globalization and new production methods that depend on the well-trained and intellectually flexible labour force, education becomes even more significant. It is therefore apparent that equipping girls/women with the technical skills is likely to increase their economic productivity.

The economic development of a country is greatly dependent on the safety of its environment. Women have a vital role to play in ensuring environmental safety, management and development and therefore, their full participation in ensuring this is essential to achieve sustainable economic development (Mason & Andrew, 2001). As managers of the environment, women are key agents in the balance between population and environment, as they greatly contribute to the control of population growth. Through their knowledge on family planning methods, women can make a contribution to a reduction in the rate of population growth and as population pressure is a key factor in environmental degradation, it is to be assumed that a reduction in population would benefit the environment. Fewer births especially among educated women will benefit them because this enables them to be more efficient in their roles of environmental management. Educated women are also more efficient in educating their children on environmental issues than the uneducated. World Bank asserts that if developing countries like Kenya improve their economies but maintain current rates of population growth, the consequences of increased environmental degradation will be enormous. In fact, World Bank concludes that improved participation of women in education leads to one of the highest returns in environmental protection (Summers & Lawrence, 1994).

In conclusion, the World Bank knows it and every development economist knows that Education of girls is the surest way in the world of reducing poverty. For over a decade now, education for girls has been identified as one of the best solutions to reversing the relentless trade of poverty and diseases devastating large portions of sub-Saharan Africa. Access to education for girls therefore directly improves the feasibility of not only the second and the third U.N. Millennium Development Goals (U.P.E and Gender Equality and Empowerment of Women respectively), but also it will go a long way to ensuring

the achievement of the first, fifth and the sixth Millennium Development Goals that is reduction of rural poverty, improved maternal health and lower incidences of HIV/AIDS, respectively (Eshiwani, 1993).

Political Benefits

On the political arena, education is perceived to have a positive impact on making informed decision and choices, and contributes to the formulation of sound political policies by strengthening good governance and the evaluation of a civil society through community and national capacity building. Women education facilitates their participation in governance. Governance implies the process of decision making and the process by which decisions once implemented at the different levels at which public affairs and resources are managed. Such decisions have impacts on the ability of people especially women to access control, utilize and enjoy the resources. The concept of governance therefore implies the power to make decisions that affect the capacity of individuals and groups to develop and achieve their full potential in social, economic and political life (Dollar, 1999).

Men and women are an equal resource of a community and a nation. Educating women is the key strategy used to build and enhance women's capacities, capabilities and increase their choices so that they can actively and equally participate in decision making processes for enabling their own well- being, as well as that of their families and the community. It also increases their opportunity to participate in decision making or endorse decisions affecting their lives. This is because empowerment builds and reinforces positive self confidence and self esteem. Through this process, women develop analytical skills to take appropriate and timely decisions which are a crucial requirement for active participation in governance. Additionally, education and awareness through information is an indispensable input in the process of empowerment to facilitate women's decision making capacities and capabilities to participate in governance and develop need based policies and implementing relevant programs (Sperling, 2005).

Traditionally, women are usually viewed as home makers and their managerial and co-ordination roles are seldom recognized. Educating girls is therefore important in that it enables them to challenge existing unequal power relations and in the process they gain greater self confidence and enhance their own personal skills and capabilities to dialogue and negotiate for others while gaining greater control over the external factors that influence their participation in governance.

Educating women therefore enables them to contribute to emergency of policies and programmes that put their needs and concerns into consideration. If women are involved at decision making levels in political and administration issues, focus on women's concerns for example gender violence, early marriages and Female Genital Mutilation (FGM) among other issues would be alleviated to a great extent. Women concerns which are usually taken casually, ignored or marginalized would move centre stage to demanding attention in policies and solutions. They would also succeed in transforming them into social issues rather than being dismissed as peripheral issues which concern women only. Indeed, women participation in governance is not a luxury or fashion, it is absolutely necessary for the development of women, community organization and the nation at large. There is therefore an urgent need for women to have greater access to education and this will increase their access to decision making structures and to acquire the skills needed to participate in the formulation of policy and legislation.

Recommendations

From the foregoing discussion, the social, economic and political benefits that result from educating girls/women are evident. It is in the light of this that the following recommendations are made:

Awareness campaigns on the importance of education and more so that of girls should be intensified. This will help to change the prevailing negative attitude towards girls' education by parents and the society at large. Parents will therefore be motivated to invest in the education of their children indiscriminately.

Since girls/women education was identified as one of the key social-economic factors that influence fertility rate by changing attitudes towards contraception, influencing demand for children by changing the perceived costs and benefits of having children and the ability to afford children and by altering preferences as reflected in the ideal family size, the Kenyan society should be given adequate information on how education can be used as an important tool to arrest rapid population growth. Awareness campaigns also should be intensified in order to sensitize the Kenyan society regarding the negative effects of some of the retrogressive socio-cultural practices on girls/women education.

Guidance and counseling in schools by teachers and role models should be intensified in order to change the prevailing negative attitude towards education that is still held by some girls. This will increase girls' participation in education hence improve their contribution in the social, economic and political development of the country.

Secondary schools education should be highly subsidized through bursary scheme and school fee waivers especially for girls from poor and vulnerable families. It should also be automatic that the bright girl's from poor families should be provided free secondary school education; this will increase their participation in education and improve their contribution to national development.

To promote girls education for increased national development, the Government of Kenya should put up more boarding schools for girls' especially in arid and semi arid lands (ASALs) and low agricultural potential areas and equip them adequately with appropriate learning facilities. This move will encourage more girls from poor families in these areas to enroll in boarding schools instead of having to traverse bandit-infested distances through the bush to school.

Awareness raising activities to increase the participation of women in education and subsequently at decision making levels within the family, community, political and government spheres should be encouraged.

Conclusion

Among the socio-economic forces that will determine the future progress of developing countries especially in sub-Saharan Africa, education, particularly that of girls/women is at centre stage. Women play an important role in the development of the smallest social institution, the family as well as at national and global levels. Governments should therefore focus their efforts on improving girls' access to education thereby increasing their enrolment rate and educational benefits.

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Phosphorus Efficiency among Selected Sorghum (*Sorghum Bicolor L. Moench*) Lines and Segregating Families

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Abstract

Sorghum (Sorghum bicolor (L.) Moench) is an important food security crop in Kenya but its production is limited by low available soil phosphorus (P) amongst other factors. This is because its cultivation is mainly carried out by resource limited peasant farmers in marginal agricultural areas that are characterized by soils with very low P levels. This study was carried out to evaluate Kenyan sorghums that are tolerant to low P levels. A P efficient sorghum line, MCSR L6 was crossed with a P inefficient but P responsive line, MCSR N64. The resultant F_1 seed was selfed to produce F_2 seed that was used in the current study. Six F_2 segregating families were characterized for P efficiency in the field with low available P (3 mg of P/kg of soil). MCSR L6 yielded better than MCSR N64, under low available P, but showed poor response to P application in the field. The F_2 sorghum families segregated in terms of days to 50 % flowering, plant height, leaf number per plant, tiller number and grain yield. Based on grain yield, the six sorghum families were classified into four groups; efficient and responsive to P, inefficient and responsive to P, efficient and non-responsive to P, and inefficient and non-responsive to P. The results indicate that the F_2 progeny show genetic variability for P efficiency and responsiveness to additional P, implying that these two traits were successfully transferred from the parents to the progenies.

Keywords: *Sorghum Bicolour, Phosphorus Efficiency, Segregating Families*

Introduction

Sorghum (*Sorghum bicolor* (L.) Moench) is the second most important cereal crop after maize in sub-Saharan Africa (Zidenga, 2004). In Kenya, sorghum is an important food security crop which is grown principally in the often drought-prone, marginal agricultural areas of Eastern, Nyanza and Coastal provinces (EPZA, 2005).

The soils where sorghum is cultivated, especially in Western Kenya, have very low available phosphorus (P) (Okalebo *et al.*, 2004). Available P levels in these soils range from 2 -5 mg/kg soil; which is far below the 10-15 mg/kg required for optimal crop production. Therefore low P availability in the soil is among the primary factors limiting sorghum production in most regions of Kenya.

Application of inorganic phosphate fertilizers is the traditional way of increasing crop production in soils with low P (Zhul *et al.*, 2001). Phosphorus is a macronutrient whose availability has profound consequences for plant growth and physiology (Abel *et al.*, 2002) and is required by plants in large doses. The use of large doses of P fertilizers is normally too expensive for the small scale-farmers who dominate the sorghum cultivation. Moreover, utilization of P fertilizers by crops is often very low, ranging from 10 to 30 % in the year applied, due to the high P fixing capacity of acid soils (Zhul *et al.*, 2001). There is need to reduce sorghum production costs by deployment and adoption of low input technology. One of the approaches is the deployment and adoption of P-efficient sorghum varieties.

Genetic potential for P efficiency has been reported in several crops including wheat (Zhul *et al.*, 2001), rice (Ahmad *et al.*, 2000), cowpeas (Krasilnikoff *et al.*, 2003), maize (Corrales *et al.*, 2007) and sorghum (Schaffert *et al.*, 2001). The Moi University Sorghum Research Team screened a large collection of local Kenyan accessions for P efficiency and identified highly P efficient accessions. The accessions were selfed and further tested to develop stable inbred lines, and MCSR L6, which is P efficient, was among the lines that were developed. MCSR L6 was then crossed with a P inefficient but locally adapted

farmer preferred line, MCSR N64. In this study F_2 sorghum families from the cross were screened for P efficiency at Sega in Siaya district where soil P level is about 3 mg/kg of soil.

The objective of the study was to evaluate the F_2 segregating sorghum families in the field under low P to determine whether P efficiency was successfully transferred from parent MCSR L6 to the progenies.

Materials and Methods

The field experiment was carried out at Sega in Siaya district of Nyanza province, which is located 34° 15' E, 0° 15' N, at an altitude of 1300 meters. It has a mean annual rainfall of 800 to 1200 mm and the mean temperature is about 24°C (National Geographic Society, 1996-2010). The soil is acidic (pH 5.1); with low available soil P of 3 mg/kg of soil.

Sorghum Seed

The sorghum seed from inbred lines, MCSR N64 and MCSR L6 that contrast in tolerance to low available P in the soil and F_2 seed were used. The sorghum lines were developed from local Kenyan accessions through 6 cycles of selfing and selection, and were provided for the study by the Moi University Sorghum Research Team. MCSR N64, which is P inefficient, received pollen from the P efficient line MCSR L6. The F_1 seeds were sowed and plants selfed during the 2007 short rains season to obtain F_2 seed. The F_2 seed was grouped into six families; seed from each F_1 plant formed a family. The F_2 seeds were planted out and selfed in the field to obtain $F_{2:3}$ seed. The $F_{2:3}$ seed from each family was further grouped as either P efficient or inefficient based on grain yield of individual plants planted under low P.

Field Evaluation

The experiment was carried out under a P-deficient soil (3 mg/kg) and was laid out in a split plot design with four replications; phosphorus levels comprised the main plots and sorghum accessions being the sub-plots. The phosphorus levels were low P (no P application) and adequate P (90 kg P_2O_5 ha^{-1}). The F_2 seed and the parentals were sowed in sub-plots of 2 m rows with a spacing of 60 cm between rows and 20 cm within rows and seedlings were thinned to a single plant per hill when they reached six-leaf stage. All the sub-plots were supplied with nitrogen in form of calcium ammonium nitrate fertilizer at planting and as side dressing 6 weeks after planting to a total of 39 kg of N /ha. Recommended insecticides and fungicides were used to control pests and diseases.

Scoring of phenotypic characters was done on the middle rows with outer rows being considered guard rows. Ten plants per row in the middle rows were randomly selected for evaluation and tagged just before flowering. A total of 40 plants per sorghum family under each P level were evaluated. The morphological characters evaluated included days to 50 % flowering; leaf number, tiller number, panicle length, panicle width and total plant height at maturity; and seed weight after threshing.
Classification of the F_2 sorghum families in terms of P efficiency and responsiveness to P was done. Sorghum families with grain yields above the trial mean under low P level were classified as P efficient and those with relative response to P above mean relative response were classified as P responsive (Schaffert et al., 2001). The sorghum families were classified into four groups; efficient and responsive to P (ER), inefficient and responsive to P (IR), efficient and non-responsive to P (EN), and inefficient and non-responsive to P (IN).

Data Analysis

The data was subjected to analysis of variance (ANOVA) and mean separation was done using Duncan's multiple range test using SPSS$^®$ software (SPSS Inc. Chicago, USA). A probability equal to or less than 0.05 (P≤ 0.05) was considered to be statistically significant.

Results

The F_2 segregating sorghum families and the parents showed significant variations the morphological traits in the field (Table 1). There were significant differences (P < 0.05) among the sorghum accessions and between P treatments in days to 50 % flowering, but the interaction of P level x genotype was non-significant. Both parents MCSR N64 and MCSR L6 showed no significant differences in 50 % flowering under low P. However, under adequate P, MCSR N64 flowered earlier than parent MSCR L6. Most of the F_2 sorghum families flowered later than either parent both under low P and adequate P. Among the F_2 sorghum families, family 6 flowered early (86 d and 82 d) under both low P

and adequate P respectively. Within each sorghum family and parental line, plants grown under low available soil P tended to flowered later than those supplied with adequate P.

There were significant differences (P < 0.05) among the F_2 sorghum families and the parents, and between P treatments in total plant height. Parent MCSR N64 was shorter than parent MCSR L6 under both low P and adequate P. In comparison with the parents, the F_2 sorghum families were taller both under low P and adequate P. However, families 4 and 5 were shorter than parent MCSR L6 under adequate P. Within each sorghum family and parental line, plants grown under low available soil P were shorter than those supplied with adequate P.

Table 1. Effect of P Treatment on 4 Quantitative Traits of F_2 Sorghum Families and the Parents

	Days to 50% flowering		*Plant height, cm*		*Leaf No.*		*Tiller No.*	
	Low P	Adequate P	low P	adequate P	Low P	adequate P	low P	adequate P
MCSRN64	85[ab]*	77[c]	124.2[d]	128.0[cd]	8[d]	8[d]	0[c]	1[b]
MCSR L6	83[ab]	82[b]	157.3[b-d]	179.0[a-c]	8[d]	9[c]	0[c]	1[b]
Family 1	87[a]	85[ab]	202.4[ab]	193.0[ab]	10[bc]	11[b]	0[c]	2[a]
Family 2	87[a]	86[ab]	172.2[a-d]	198.5[ab]	10[bc]	11[b]	0[c]	1[b]
Family 3	87[a]	82[b]	182.1[a-c]	217.0[a]	10[bc]	12[a]	0[c]	2[a]
Family 4	87[a]	86[ab]	200.1[ab]	176.4[a-d]	10[bc]	12[a]	0[c]	1[b]
Family 5	88[a]	86[ab]	183.6[ab]	175.6[a-d]	10[bc]	11[b]	0[c]	1[b]
Family 6	86[ab]	82[b]	179.2[a-c]	200.3[ab]	10[bc]	12[a]	0[c]	2[a]

* Means of each trait followed by the same later are not significantly different at $p \leq 0.05$.

The number of leaves per plant differed significantly (P < 0.05) among the F_2 sorghum families and their parents, and between P treatments. The F_2 sorghum families had more leaves per plant compared to the parents under both low P and adequate P. Sorghum plants within each family and parental line that were supplied with P had slightly more leaves than those plants under low P. Tillering differed significantly (P < 0.05) among the F_2 sorghum families, and was also influenced by P treatment. With adequate P application families 1, 3 and 6 produced more tillers. Also, sorghums grown under adequate P tillered more than those grown under low P.

Table 2: Effect of P Treatment on Grain Yield of F_2 Sorghum Families and the Parents

Accession	*Seed weight/plant, g*		*% P response (B/A*100)*	*Class***
	Low P (A)	**Adequate P (B)**		
MCSR L6	25.65[d-f]*	28.00[c-f]	109	E N
MCSR N64	20.26[f]	33.18[b-f]	164	I R
Family-1	21.88[ef]	38.53[a-d]	176	I R
Family-2	30.13[c-f]	51.70[a]	171	E R
Family-3	24.81[d-f]	36.82[b-e]	128	I N
Family-4	28.38[cf]	46.82[a-c]	165	E R
Family-5	25.46[d-f]	25.90[d-f]	102	E N
Family-6	25.02[d-f]	50.03[a-b]	200	I R
Trial mean	25.39	38.11	152	

* Means followed by the same later are not significantly different at $p \leq 0.05$.
** I- P inefficient, E- P efficient, R- P responsive, N- P non-responsive.

The grain yields differed significantly (P < 0.05) among the F_2 sorghum families and the parents, and between the P treatments (Table 2). MCSR L6 yielded better than MCSR N64 under low P but in contrast, MCSR N64 yielded better than MCSR L6 under adequate P supply. The F_2 sorghum families showed segregation in grain yield under both low P and adequate P supply. Most F2 sorghum families yielded better than the P inefficient parent MCSR N64 under low P, with families 2 and 4 yielding even better than the P efficient parent MCSR L6.

When supplied with adequate P, the F_2 sorghum families yielded better than either parent, except for family 5. The yield for all the entries was better when P was applied. MCSR N64 responded better to

P application than MCSR L6. Among the F_2 sorghum families, family 6 showed the highest (200 %) relative response to P supply while family 5 (102 %) showed the lowest relative response to P supply.

The F_2 segregating sorghum families and parents were also grouped in terms of P efficiency under low P and responsiveness to P supply based on their grain yield in the field (Table 2). MCSR L6 and family 5 were grouped as P efficient but non-responsive to P application. Parent MCSR N64 and families 1 and 6 were grouped as P inefficient and responsive to P supply. Families 2 and 4 were P efficient and responsive to P supply, indicating that these families inherited both the P efficiency of MCSR L6 and P responsiveness of MCSR N64. In contrast, Family 3 was grouped as P inefficient and non-responsive to P supply.

Discussion

Parental sorghum lines, MCSR L6 and MCSR N64, and the F_2 sorghum families showed significant morphological differences when grown in the field with or without P application. The F_2 sorghum families showed segregation in days to 50 % flowering, total plant height, leaf number and tillering when compared with the parents. Most of the F_2 sorghum families flowered later, were taller, had more leaves and tillered more than the parental lines. The high yields of the F_2 sorghum families than the parents can be attributed to heterosis; a phenomenon where when inbred lines are crossed, the progeny show an increase in character means for traits that previously suffered a reduction due to inbreeding depression (Falconer, 1989). Regardless of the sorghum family or parental line, sorghum plants grown under low P tended to flower later, were shorter, had fewer leaves and tillered less compared with plants supplied with P fertilizer. According to Camacho et al. (2002), morphological variables have been used to express the influence of mineral nutrients on plant growth patterns since vegetative growth responds positively to fertilizer application. Plant height, leaf number (Camacho et al., 2002), tillering and grain yield (Castillon, 2001) are reduced by low available P. However, plant maturation is delayed by low P availability.

The P efficient parent, MCSR L6 had a higher grain yield than the P inefficient parent, MCSR N64 under low P. In contrast, MCSR N64 had a higher grain yield than MCSR L6 with adequate P application. This implies that although MCSR L6 is P efficient, it responds poorly to additional P compared to MCSR N64. Schaffert et al. (2001) attributed the poor response of some sorghum genotypes to P application to yield ceiling effect. MCSR N64 seems to be a useful sorghum line in breeding because although it is P inefficient, it responds well to additional P application and can transmit this to the progenies.

Some of the F_2 sorghum families performed even better than the P efficient parent under low P, and better than the P responsive parent when supplied with P. The higher performance in some of the F_2 sorghum families compared to the parents can also be attributed to heterosis of the sorghum families.

The F_2 sorghum families were grouped in terms of P efficiency and response to P supply. Some of the families segregated towards parents MCSR L6 and MCSR N64 by being P efficient and non-responsive to P, and P inefficient and responsive to P respectively. The presence of some F_2 families with characteristics of the parents indicates that the genes for P efficiency and responsiveness to P were successfully transferred from the parents to the progenies.

There were other sorghum families that were P inefficient and non-responsive to P, and P efficient and responsive to P. These sorghum families possessed a recombination of the parental attributes. This indicates that independent assortment for P efficiency and responsiveness to P occurred. The occurrence of recombinants which were both P efficient and responsive to P application is important in development of superior sorghum varieties. Such plants will be able to yield well at low P and even better when supplied with P. According to Corrales et al. (2007), high responsive by plants to P fertilizer application is an important characteristic for achieving high crop productivity.

The F_2 sorghum families segregated in both directions in P efficiency and response to P application. Weidong et al. (2001) reported that P use efficiency showed continuous variation with segregation in both directions, suggesting polygenic inheritance pattern in wheat. Therefore results of this study suggests that P efficiency and responsive to P application are under polygenic inheritance. Therefore, further research should be done to have a better understanding of genetic control of both P efficiency and responsiveness to P. This information will be useful in guiding breeding aimed at development of low P tolerant sorghum varieties.

Conclusions

There was genetic variability for P-efficiency and responsiveness to P fertilizer application among the F_2 sorghum families which implied that P-efficiency and responsiveness to P application was successfully transferred from the parents MCSR L6 and MCSR N64 respectively, to the progenies. The occurrence of recombinants with combined attributes of the two parents indicates that P efficiency and responsiveness to P are independently inherited.

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Predictive Modelling of Human - Elephant Conflicts in Shimba Hills Ecosystem

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Abstract

Human-elephant conflict (HEC) is a key example of the growing competition between people and wildlife for space and resources in Kenya. To effectively implement mitigation measures, understanding of the underlying factors that determine HEC is required. This study mapped the conflict prone areas in Shimba Hills (SH) Ecosystem. The study used questionnaires, group discussions and available Shimba Hills National Reserve (SHNR) conflict records to gather information on the nature, type and conflict locations (presence data). GIS-based stepwise logistic regression were used to analyze the relationship between the conflict areas and the selected habitat factors including distance to roads, distances to fenced and unfenced areas, distance to water, distance to settlements, slope, elevation and the land cover types. Binary logistic regression was used to determine the presence data of conflict sites and absence data (non-conflict sites). Random points were generated in the study area to represent absence data of conflicts. Results showed that distances to water (β= -0.0012, P=0.000), fence (β= -0.0006, P=0.000), roads (β=0.0005, P=0.016) and settlements (β=0.0002, P=0.037) were significant determinants of HEC. Areas near water, near fence, away from road and settlements were prone to conflicts. The four significant variables were used to generate conflict prone area map. The study successfully identified and mapped prone areas for elephant. Such maps are of practical and strategic use to wildlife managers in the SHNR. The study recommended community awareness programs. The programs will educate and involve the community on early detection of HEC and the necessary mitigation measure required.

Keywords*: Human-Elephant Conflict, Predictive Modelling, Shimba Hills Ecosystem*

Introduction

The competition for resources increasingly evokes conflicts wherever humans and wildlife coexist. According to Riley *et al.* (2003), human-elephant interaction becomes a conflict when people experience, perceive and interpret them as producing negative impact. Whereas the conditions for each Human-elephant Conflict (HEC) may be unique, the key driver of such a conflict is competition for space and resources (Balmford *et al.*, 2001). Effective mitigation of human-elephant conflicts require a complete understanding of the problem, its local-specific causes and attempts to solve it, in order to develop effective management strategies for local communities (Sitati *et al.*, 2003). The Shimba Hills (SH) ecosystem in Coastal Kenya, is a site of great concern due to its high biological richness and status as an indigenous homeland. It is a prime example of a location where well-intended management and conservation initiatives have led to even greater conservation dilemmas. Similar to other protected areas in Africa, the limited size of SH cannot adequately sustain its rapidly growing resident elephant population as the extensive browsing behavior is destroying the existing ecosystem and extirpating endemic plant species such as the Cyanometra trees (Kiiru 1995; Kahumbu, 2002). Additionally, elephants have learned to search for food outside of the reserve boundary leading to severe conflict between elephants within the protected area and farmers living near the Reserve boundary (Kahumbu, 2002; Knickerbocker &Waithaka, 2005). The present situation illustrates the immense challenge of reconciling global biodiversity goals with local residents' concerns for economic development and security. Shimba Hills National Reserve (SHNR) is a typical model of how HEC and subsequent mitigation strategies employed by park managers and conservationists have continued to experience emerging concerns. Local concerns about increases in conflicts with elephants and the haphazard

measures adopted when attacks occur in the SH-ecosystem led to this study. The objective was to identify types of conflicts in SH-ecosystem, to identify and map the conflict prone areas.

Materials and Methods
Study Area

The study was carried out in SH ecosystem which comprises of Shimba Hills National Reserve (192 km²), Mwaluganje Elephant Sanctuary (MES) (36 km²), Mkongani North (11 km²) and Mkongani West (14 km²) Forest Reserves making up a total of 253 km². It is situated in coastal province, Kwale district. The ecosystem is a remnant coastal rainforest located 35 kilometers south of Mombasa, Kenya between $4°05'-4°21'S$ and $39°15'-39°30'E$. It is composed of a low range of hills which rise to just over 400 meters along the coast of the Indian Ocean. The SH ecosystem is jointly managed by the Kenya Wildlife Service (KWS), Kenya Forest Department (KFD), and the Mwaluganje Elephant Sanctuary Committee (Conservation International, 2007).

The area experiences a humid semi-equatorial climate of an average monthly temperature ranging from $24°C$ to $28°C$ and an annual precipitation of 1200mm with long rains between March to June. The vegetation in and around SHNR creates an intricate montage of open grasslands, bushlands, woodlands, and forests. The mosaic of high-canopy forest, grass, deciduous forest and thicket provides ideal habitat for a diverse range of species (Kiiru, 1996). The remnant humid tropical ecosystem contains endemic, threatened, and endangered flora with a total of 1,396 plant species that are endemic to SH and that the forest habitat holds more than half of Kenya's rare tree species. It also habours the endangered Sable antelope (*Hippotragusnigerharris*).

Soil composition of the area is classified as Shimba Grit and Mazeras Sandstone from the Upper Triassic Age (200 million years ago) (Shimba Support Group, 2007). The soil in Kwale has very poor fertility due to excessive leaching, high sand content, and low organic content.

Small-scale agriculture is the most significant source of income in Kwale district, although 92% of the District is categorized as having low agricultural potential (Kahumbu, 2002). The Crops grown here are mainly cassava, maize, sweet potato and pigeon peas and tree crops such as cashew nut and coconut. The Digo and Duruma, two of the nine subtribes of the Mijikenda group compose the largest populations in Kwale District (Kenyaweb, 2001). Other livelihood activities in the area include; charcoal production and small businesses.

Data Collection

Data collection was done for a period of five months from November 2012 to March 2013. To achieve the objectives, a combination of primary and secondary data collection methods was utilized. The primary data collection method used questionnaires, focused group discussions and observations. Secondary data and GIS techniques were used to gather information on rainfall, landcover, elevation, slopes and conflicts records.

Questionnaires

A total of 11 locations were purposely selected on the bases of (1) a long documented history of human-elephant conflicts (2) villages within the range of 0 to 10 km from the reserve boundary. The 11 locations were stratified into blocks of four regions: North West comprising of Mbuguni and Ngomeni locations; South West having Mkongani, Mwaluphamba and Mwaluvanga; South East having Lukore,Majimboni, and Magawani; and the North East having the Tsimba, Tiwi and Golini (Figure 1). The South East and North East regions were characterized by high populations, nearby social facilities that contributed to the settlements being clumped together. The North West and South West regions comprised majorly of rural areas where population was small and scattered.

Respondents to the questionnaire were the general community in proximity of the Reserve and the staff of KWS and KFS. These groups of respondents were targeted because they were deemed to treasure a wealth of knowledge on the type and nature of conflicts occurring around them. The questionnaire was pre-tested among some group of a population which was not included in the main sample group then necessary corrections were done on the questionnaires. The questionnaires were administered systematically by skipping one or two households depending on the settlement pattern of the area. A total of 106 questionnaires were administered.

Focus Group Discussions (FGDs)

Focus Group Discussions (FGDs were used to obtain the conflict sites in the study area as well as complement the information provided on the questionnaires. The FGDs used pre-defined questions to

gather information on the human wildlife conflicts around SH-Ecosystem, elephant problem and locating the conflict areas on a baseline map derived from the topographic reference map of the area. Using these conflict areas the actual coordinates of conflict locations were recorded using a handheld Global Positioning System (GPS). The discussions also sought to get the consensus view of group on what can be done to reduce the elephant problem. Selection of participants was based on those who have lived in the area for a minimum period of ten years. The discussions were done by combining two neighbouring locations into one forum; these comprised of Mbuguni-Ngomeni locations, Mkongani-Lukore locations, Mwaluphamba-Mwaluvanga locations, Majimboni-Magawani locations, and Golini-Tsimba-Tiwi locations. The number of participants per discussion group was 10 members. Among them were the officials that were appointed by the community to report on Human wildlife conflict, elderly men and women. Five sessions of group discussions were done. Data collected were collated and integrated in the discussion in a narrative form (Shemweta & Kidegesho, 2000).

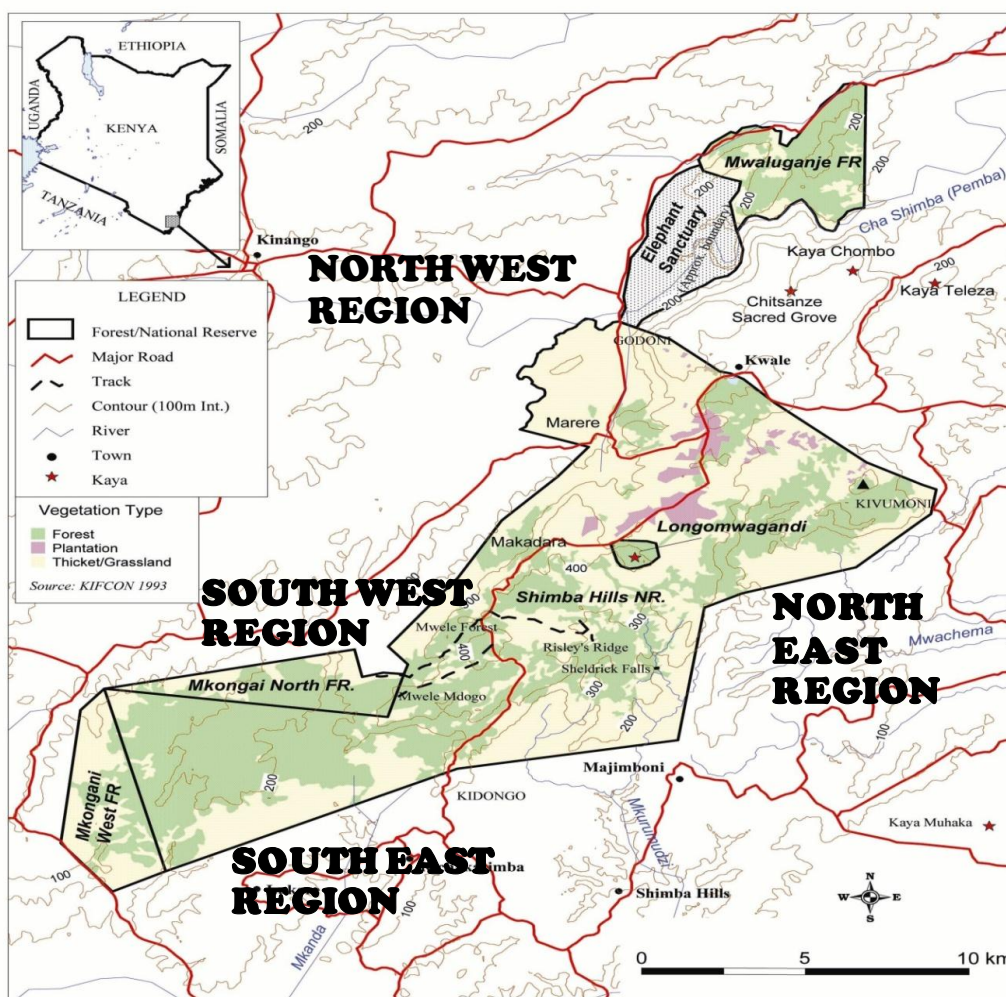**Figure 1. Map of Shimba Hills Ecosystem Showing the Regions Where Data was Collected**
Map Source: Reuling 2007

GIS Techniques

GIS techniques coupled with secondary data were used to gather data on geographical and environmental variables: elevation, slopes, water, fenced areas, unfenced areas, roads, settlements, landcover, and rainfall. Data for elevation was obtained from Digital Elevation Model (DEM), which was

downloaded from the Shuttle Radar Topographic Mission website (USGS, 2012). Using ILWIS Academic software (ILWIS, 2009) and the DEM, slope map was prepared in degrees and percentages. Data for water comprised of supplemented water points and the rivers. Data for supplemented water points was obtained by recording their coordinates using a handheld GPS to record their coordinates. Data for rivers were obtained by digitizing them from the scanned topographic map of SHNR.

Shimba Hills National Reserve (SHNR) and Mwaluganje Sanctuary boundaries are fenced with electric fence except in Lukore and Mwaluganje areas. The data for the fenced part of the boundaries were obtained by digitizing scanned maps of Kwale and Msambweni Districts. The coordinates of the two unfenced areas were obtained by recording the two end points in the field using the handheld GPS.

The road network of kwale- Msambweni district consist of tarmacked and murram roads. Both minor and major roads were considered for this study. They were obtained from the roads department in kwale as shape files. Data for settlements was obtained from the Kwale Youth development database that included the commercial buildings, residential buildings and institutions. The land cover of Kwale district prepared by Reuling (2007) was scanned and digitized to obtain the required land cover types: bush land, forest, woodland, agriculture and town. Rainfall data for the period January 2008 to November 2011 was obtained from the KWS Kwale research records.

A total of 89 conflict locations were recorded in the SH-ecosystem using the handheld GPS to represent the presence points. Absence data when combined with presence data are used in regression based models to predict the relative likelihood of occurrence of conflicts (Pearce & Boyce, 2006). Therefore, an equal number of random points (89 absence points) were randomly generated using the ILWIS 3.3 to represent the absence data points. Apart from the 89 conflict presence points recorded using the GPS, other historical records of 1176 conflicts were obtained from the SHNR records from January 2008 to November 2011. These were useful in relating the frequency of conflict with rainfall and the month of the year.

Data Analysis

The data collected from the questionnaires was entered and coded in excel spreadsheet and analyzed in Statistical Package for Social Sciences (SPSS) version 16. Descriptive statistics in form of percentages, frequencies of counts, tables, bar and pie charts were used for analysis.

In order to relate the habitat factors (independent variables) with conflict locations (response variable) data were analyzed using stepwise logistic regression. The logistic regression was used because it differs with other statistical methods as it is not affected by the assumptions of variance inequalities across groups and is applicable whenever the dependent variable is binary (Hosmer & Lemeshow, 2000). As recommended by Menard (2010), preliminary analysis of the data was performed to check the assumptions of logistic regression with respect to the selected predictors of the study. Multicollinearity, which is high correlation among predictors in logistic regression, affects the validity of the statistical tests of the regression coefficients by inflating their standard errors (Garson, 2010). Variance Inflation Factor (VIF) test was done to predict which factor caused multicollinearity problem. Since none of the variables had VIF greater than 10 (Mernard, 2010), all the variables were fit for the logistic regression analysis.

The final best model from stepwise logistic regression was used to prepare a conflict prone areas map in ILWIS package. The following the logistic regression equation (Sokol & Rohlf, 1995) was used:

P (X) = Exp $(\beta_0 + \beta_1 X_1 + \beta_n X_n)/1 + $Exp $((\beta_0 + \beta_1 X_1 + \beta_n X_n)$

Where $P(X)$ = probability of occurrence

β_0 = Constant

β_1 = variable 1 intercept

β_n = Variable n intercept.

X_1 = Rastermap of variable 1.

X_n = Raster map of variable n

Results
Types of Human Wildlife Conflicts

The survey showed that many communities around SH ecosystem were dependent on crop farming (38.23%) followed by the mixed farming (36.27%) and trade and professional work (20.59%) (Table1).

The natural resource use by the local communities showed that distance did not matter when obtaining resources (χ^2=0.583,df =2, P=0.11). Chi-square goodness of fit test showed that the utilization of different natural resources was significantly different (χ^2=71.467, df = 7, P=0.001df=7). Firewood

(32.95%) was highly utilized followed by water (18.75%), medicinal plants (17.05%) and charcoal (10.79%). All other uses comprised of only 20.44% (Table 2).

Table 1. Livelihood Activities of Local Community in Shimba Hills Ecosystem

Livelihood Activity	Frequency (n=106)	Percent
Crop Farming	39	36.79
Livestock Keeping	5	4.71
Crop Farming & Livestock keeping (mixed)	37	34.90
Trade	21	19.81

Forms of Conflict

Various forms of conflicts occurring in SH ecosystem ranged from destruction of food stores to human death. The frequency of the various conflicts was significantly different (χ^2 = 132.978, df = 5, P = 0.001). Crop raiding was the major type of conflict (34.8%) experienced in SH ecosystem followed by human threat (29%) (Table 3). A majority of respondents (90.7%) reported that most conflicts in the study area occurred at night. The conflicts that occurred during the day and at all times accounted for 3.7% and 3.6%, respectively. Analysis using the historical (2008-2011) conflicts showed that the highest number of incidents was recorded in July, with a mean of 42.3 incidents per month whereas the lowest recorded incident was in January with 20 incidents per month (Table 4). Human threat was high in March, May and July months whereas crop raiding was at its highest peak.

Table 2: Natural Resources that Communities Obtain from the SHNR

Resources	Frequency (n=106)	Percent
Firewood	58	54.72
Charcoal	19	17.92
Grass	14	13.21
Water	33	31.13
Timber products	14	13.20
Wild fruits	8	7.55

Table 3: Forms of conflict

Forms of Conflict	Frequency (n=106)	Percent
Crop damage	97	91.51
Disease Transmission	29	27.36
Human threat	81	76.42
Damage infrastructure	37	34.91

Table 4. Mean ±SE Monthly Number of HEC Incidents in SH ecosystem (January 2008 to December 2011)

Months	Jan	Feb	Mar*	Apr*	May*	Jun*	Jul	Aug	Sep	Oct*	Nov*	Dec
Mean conflict No.	20	22.67	31	26.25	36.25	26.5	42.25	25	22.25	23	22.75	21
Conflict season rate	Low	High	High	Low	High	Low	High	Low	Low	High	Low	low

*Shaded region are the rainny months of the year.The rate of conflict was determined by comparing the present month from the previous month.

Relationship of Conflict Sites with the Explanatory Variables
Selection of the Variables

The eight predictor variables tested for significance in explaining conflict sites of the elephants around SH ecosystem used stepwise logistic regression. The predictor variables were distance to roads, distance to unfenced areas, distance to fenced areas, distance to settlements, and distance to water, slope, land cover (i. e Bush land and forest, woodland, agriculture) and elevation. The final best model had four predictor variables that had significant effect on the conflict occurrence (Table 5). Fence (ß = -0.0006) and water (ß = -0.0012) had a negative effect while settlement (ß =0.0002) and road (ß =0.0005) had positive effect on the probability of conflict occurrence. For the fence, Shorter distances from the SH ecosystem fence experienced more conflicts.

Table 5. Predictor Variables having Significant Effect on the Probability of HEC Occurrence in SH Ecosystem

Variable	B	S.E	Wald	df	P value
roads	.0005	.000	5.790	1	.016
settlement	.0002	.000	4.343	1	.037
Fence	-.0006	.000	33.910	1	.000
Water	-.0012	.000	31.556	1	.000
Constant	4.241	.697	36.984	1	.000

Model Fitness

The final model with the four significant variables had a Nagelkerke R^2 = 65.3%, which indicates that the four predictor variables explains over 65% of the probability of conflict occurrence. The model was also tested using the Hosmer and Lemeshow (H-L) test whereby if the H-L goodness of fit test statistic is greater than 0.05 it implies that the model is fit (Hosmer & Lemeshow, 2000). According to this analysis, H-L was 0.376 implying that there were no difference between the observed and the model predicted values.

Mapping of Human-Elephant Conflict Prone Areas

Figure 3 show a map of potential areas of the probability of occurrence of elephant conflicts in Simba Hills Ecosystem. The map was prepared in ILWIS package using the final model from the logistic regression analysis. The map of the probability of conflict occurrence was divided into 4 classes: low (0 - 0.4); medium (0.4 - 0.7); high (0.7 - 0.9) and very high (0.9 – 1.0) probability. Most of the SH-ecosystem had a very high probability of conflicts (44.6%) followed by high class (30.6%) and medium class (17.2%) with the low class (7.6%) having the smallest percentage. The areas with high probability of conflict are located far away from the reserve boundary.
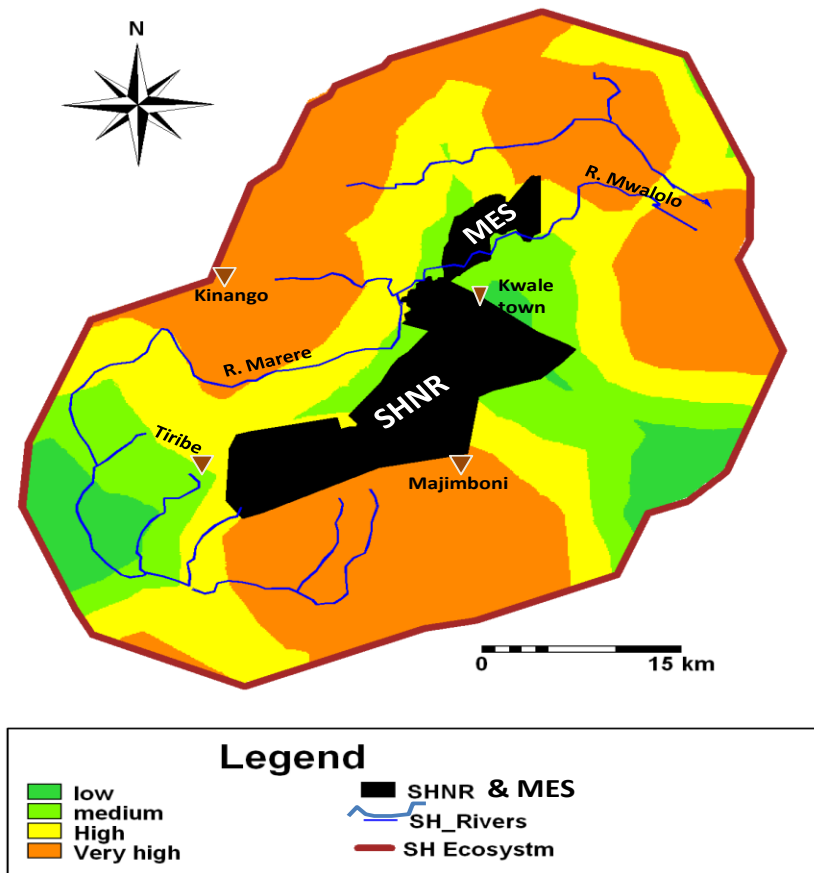
Figure 3. HEC Prone Areas in SH Ecosystem

Discussion

Types of Human Wildlife Conflicts

This study indicates that HEC takes place throughout the year with high conflicts experienced in the months of March, May and July. Crop raiding and human threat were the most common types of conflict experienced in SH ecosystem. The peak of crop raiding was in July, which was two months before the harvesting of maize. This may be due to two reasons. First, in many regions in Kenya, maize is harvested when the plant is dried on the field. At this stage the corn cob becomes difficult to chew which increases handling time. Additionally palatability may decrease compared to two months before harvesting when the liquid content of crops is still higher. Parker and Osborn (2001) found a similar trend of crop raiding in Zimbabwe which occurred in the month of March, two months to the harvest.

The highest human threat was experienced in the month of March. Generally, Kwale district experiences water shortage in the months of January, February and early March shortly before the beginning of the rainy season. During this period, the local people travel to obtain water from the waterholes provided by the KWS found at the reserve boundary and hence encounter elephants on their way.

The elephants are causing serious conflicts in SH ecosystem due to their high population of between 400-700 that surpasses their carrying capacity and high density of 1.9 elephants per kilometer (Litoro, 2002). With high elephant numbers, tendencies to search for food elsewhere particularly outside the ecosystem is likely, which would in turn be expected to lead to increased incidences of crop raiding and hence conflict with human beings. In addition, Smith and Kasiki (2000) found that high elephant numbers had the capacity to inflict catastrophic damage during one visit to a field.

Determinants of HEC in SH Ecosystem

Results of the logistic regression analysis revealed that distance to water, roads, settlements, and fence were the most important determinants of HEC in Shimba hills ecosystem. The probability of conflict occurrence was positively related to distance from water. Most conflicts were in areas near water

sources. Elephants require drinking water every one or two days (Douglas-Hamilton, 1973). Harris *et al.* (2008) found that the presence of water was a best predictor of elephant presence and if they were close enough to water an elephant seeks areas with high vegetation cover. More conflicts occurred within half a kilometer to about three kilometers away. Similar observations of Short distances to water points were found in Tsavo East national park (Leuthold & Sale, 1973), Serengeti National park in Tanzania (McNaughton, 1990) and Maputo elephant reserve in Mozambique (Boer *et al.,* 2000).

Whilst a vast majority of people living around the SH Reserve are small-scale farmers growing mainly cassava, maize, sweet potato and pigeon peas and tree crops such as cashew nut and coconut, the western side of the ecosystem comprising of Mbuguni and Ngomeni, Mkongani, Mwaluphamba and Mwaluvanga locations were drier than the Eastern side. Farmers in those regions are more vulnerable to crop failure and so, farmers near the water source cultivate crops near water sources where they are raided on by the elephants.

Conflicts occurrence was inversely related to distance from roads. In accordance to natural resource conservation, roads facilitate people movement to areas previously inaccessible. Whereas people move from areas with scarce resources to areas with resource abundance, elephants generally prefer areas away from the disturbing effects of roads such as the road kills and poaching (Mukeka, 2010). Elephants in SH ecosystem are driven away from the farms by the rangers using vehicles. Inaccessible road made it difficult for the access to the conflict sites especially at night, making the farms away from the road susceptible for frequent attacks. Sitati *et al.* (2003) found that farms that had been raided frequently were far away from the accessible roads. Barnes *et al.* (1991) found that elephants avoided zones within 7 km of roads because of human disturbance and poaching threat.

Probability of elephant attacks were negatively related to distance from settlements. Avoidance of settlements by the elephants was mainly due to avoidance of human presence and poaching threat (Kyale, 2006). In rural Kwale district, settlements were scattered whereas in the urban area they were clumped together. A study done by Harris *et al.* (2008) found that wherever settlements were found, female elephants with their young stayed 5 km or more away. The communities that had experienced attacks said they were attacked on the months of July while guarding their crops or in March while fetching water and/or firewood at the forest edge. The elephants that managed to go near the settlements were few habitual individuals, most probably the bulls.

Probability of conflict occurrence was positively related to distance from reserve fence. However, only the South East region out of the four regions analyzed experienced conflicts near the fence line. This was similar to other studies such as Sam *et al.* (2005) in Bia Conservation Area, Barnes *et al.* (2005) in Kakum Conservation Area, Ghana and Naughton-Treves (1998) in Kibale Forest National Park, Uganda who revealed greater conflicts near the protected areas. The three other regions: North East, North West, and South West found lower levels of human elephant conflicts along the fence. Three reasons could explain this finding. First, there was greater KWS involvement in elephant control along the SH ecosystem than further from the reserve. Secondly, farmers along the reserve border spent more time and effort defending their crops than those residing at a greater distance. Finally, probably farmers had abandoned their farms near the fence line. According to the farmers, too much time and expense was required to travel to the KWS main office in Kwale town whereas no tangible benefits were accrued for reporting the damage. A study in TaitaTaveta found significantly lower levels of human elephant conflict in areas bordering national parks (Smith & Kasiki, 2000).

The conflict prone map showed high probability of conflict in the North West and South West regions further away from the fence boundary, this is probably because of the presence of the problem elephants that were translocated to Tsavo East and West national parks. The behaviour of the translocated elephants from SH to Tsavo East (Pinter-Wolloman, 2009) showed that the initially translocated elephants in Tsavo national parks were homing back to SH and some to Malindi. Pinke-Wolloman (2009) found out that some elephants homed back immediately after release, while others waited until the rains before homing.

Conclusion and Recommendation
Conclusion

Four variables viz distance to road, distance to fence, distance to settlement and distance to water were significant predictors of potential conflict areas. It was concluded that the areas far from settlements and road were areas near the electric fence on the South Eastern side i.e Lukore, Majimboni and Magawani. In addition areas near water points were significant predictors of potential prone areas.

Recommendation

There is need to review the existing community awareness and education programmes. The Knowledge about effective local conflict mitigation methods utilized in other areas of high risk can be used to enlighten the local farmers around SH ecosystem. Farmers should be encouraged to work together utilizing various methods of conflict mitigation simultaneously.

The conversion of the solar power to electric power, or increasing the voltage of the solar power, fence repair, and establishing provisions for continued fence maintenance should be foremost on the conservation agenda, along with the replacement of the wooden poles with concrete posts.

A majority of farmers in Kwale district are dependent on rain fed agriculture. A suggestion on planting the chilli plant was put forward by the KWS management but most farmers were not for it. Other options include bee keeping and cultivation of medicinal plants. A bee keeping project done in Northern Kenya (King *et al.,* 2011) found that beehive fences improved crop production and enhance rural livelihoods through honey sales. Since many communities in Kwale district still depend on medicinal plants from SHNR, an alternative option of cultivating medicinal plants could be used by farmers as their livelihood.

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Pre-disposing Factors Contributing to the Prevalence of Intestinal Parasitic Infections among HIV/AIDS Patients in Bungoma County, Kenya

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Abstract

Intestinal parasitic infections are parasites that populate the gastro-intestinal tract of humans adding stress to both arms of the immune system already weakened by human immunodeficiency virus (HIV), worsening morbidity in the infected person. This study was conducted with an aim of determining some of the pre-disposing factors to the Prevalence of Intestinal parasitic infections among the HIV/AIDS patients in Bungoma County. A cross-sectional study of 240 HIV positive and 60 HIV negative individuals was done. Stool samples were observed for intestinal parasites. Statistical analysis was done using SPSS version 17.0. Data were summarized using descriptive statistics (frequencies, Means and standard deviation). Differences in proportion of prevalence were analyzed using Pearson Chi-square test while factors causing observed differences in the prevalence were analyzed using multiple Logistic regression to identify significant factors responsible for observed prevalence. Results were considered significant at p<0.05 α-level. Significantly higher ($\chi 2 = 23.764$, df = 1, P = 0.002) prevalence of intestinal parasitic infections was recorded among the HIV/AIDS patients (33.4%) compared to (19.3%) in HIV-ve patients. Protozoan and helminthic parasites were the parasites found where the prevalence of intestinal protozoans was higher than that of helminthes. Age, levels of education, income levels, smoking and drinking habits as well as dietary habits contributed significantly to increased prevalence of Intestinal parasitic infection (IPI) among the HIV/AIDS patients. The magnitude of parasitic infection was high in both HIV/AIDS and HIV -ve. It is recommended that routine examination of stool samples for parasites would significantly benefit HIV infected and uninfected individuals by contributing to reduce morbidity.

Keywords: *HIV, AIDS, Prevalence, Intestinal parasites, IPI*

Introduction

Man becomes infected with intestinal protozoa (*E. histolytica*) through the ingestion of food and water contaminated with faecal material containing the cystic stages of the organisms. Swallowed cysts pass through the stomach unchanged and hatch in the duodenum or upper jejunum, where they liberate trophozoites. The trophozoites then pass on with the contents of the bowel into the large intestine where they attach themselves onto the mucous membrane and secrete a powerful cytolytic enzyme which destroys the tissue cells. Cytolysed tissue cells together with red blood cells serve as their food (Neva *et al.,*, 1994). Apart from eroding the intestinal mucosal lining, they may invade the liver via the portal vein, the lungs, and occasionally the brain. The clinical manifestations can range from very mild or none to very gross such as rupture of an amoebic abscess into the pericardium and a multitude of others (Neva *et al.,* 1994). The public-health importance of amoebiasis, for instance, discussed in many works but its impact on urban and rural life needs more serious study and elucidation. Although most of the past work shows a small prevalence in some urban centres, the trend might have changed due to congestion in slums where toilets are inadequate and poorly constructed.

Material and Methods

This study was conducted at Bungoma District Hospital, in Bungoma County; Western region of Kenya. The Hospital is located in Bungoma town, a major transit town to Uganda. The area has maximum temperature that varies over the year between 18°C and 28°C with minimum temperature range of 8°C and 12°C. The mean temperature is 25°C with the lowest temperature of 8.4°C in September and the highest temperature of 28°C in March (Survey of Kenya, 2004; Bungoma District Development Plan, 2002-2008).

The study area experiences bimodal rainfall pattern with an annual rainfall of 1200- 1800mm. The long rain starts in March and continues to September while the short rain season starts in September and ends in October. It has a total population of 1,630,934 of which 835, 339 were female and 795, 595 male (Kenya National Bureau of Statistics, Kenya, 2009).

The study participants were people living with HIV/AIDS aged 18 to 65 years inclusive and not on ART; and were attending CCC for the first time, during the period of June 2010 to February 2011, who had been referred from: Outpatient department (OPD), Health Centres, Government of Kenya prison

and Dispensaries within the County. A convenience sampling technique was used to select HIV/AIDS patients and HIV negative individuals attending the CCC.

Questionnaires, interviews, observations and stool examination were used as main tools for data collection. Quantitative type of data was collected from 300 respondents at Bungoma District Hospital from June 2010 to February 2011. This study was conducted with the approval of the Institutional Research and Ethics Committee (IREC) of Moi University (Reference: IREC/2011/52). Participants, who consented to the study filled the questionnaire on the outlined pre-disposing factors contributing to intestinal parasites among HIV positive patients.

Intestinal parasites were examined in the stool samples using direct microscopy for preliminary screening and formal-ether concentration was employed to increase sensitivity. Modified Zeihl-Neelsen method was used to detect *Cryptosporidium* spp. All data was entered and analyzed using SPSS V.17. Data was summarized using frequency and differences in pre-disposing factors contributing to prevalence in intestinal parasites were analyzed using Pearson Chi-square. In all analysis, results were considered significant at P ≤ 0.05.

Results and Discussion

Majority of the HIV/AIDS were female 138 (57.5%) while the HIV negative 33 (55%). More than half of the HIV/AIDS 125 (56.2%) were aged between 36-50 years while 26 (43.3%) HIV negative were of similar age-group. In both HIV/AIDS and HIV negative respondents, majority had secondary level of education 142 (59.2%) and 23 (38.3%) respectively. Similarly, majority were married in both groups 187 (77.9%) and 44 (73.3%) for HIV/AIDS and HIV negative respondents respectively. With regard to occupation, 109 (45.4%) HIV/AIDS and 26 (43.3%) HIV negative were self employed. Pre-disposing factors contributing to the prevalence of intestinal parasitic infections were as tabulated below.

Table 1. Shows Factors Affecting the Prevalence of Intestinal Parasitic Infections among HIV/AIDS Patients at Bungoma District Hospital

Attributes Characteristics Characteristics Character	Frequency	Prevalence of IPI	χ^2	P-value
Age	<18	26	17.8		
	18-35	23	36.9	19.443	<0.001
	36-55	19	39.7		
	> 55	12	51.6		
Gender	Male	63	22.8	21.311	<0.001
	Female	17	44.4		
Marital status	Married	19	34.5		
	Single	21	35.1	0.811	0.623
	Divorced	21	32.3		
	Widowed	19	32.7		
Levels of education	None	31	49.3		
	Primary	18	45.4		
	Secondary	13	33.9	25.442	<0.001
	College	14	24.2		
	University	4	13.2		
Income levels	< 1500	27	51.1		
	1501-5000	18	35.4		
	5001-10000	15	32.5	31.222	<0.001
	10001-20000	13	24.9		
	> 20001	7	22.4		
Smoking habits	Smoker	34	45.2	22.133	0.001
	Non-smoker	46	21.3		
Dietary habits	Eat fatty food	25	44.2	9.442	0.022
	Vegetarian	8	23.2		
	Eat at home	49	34.3		
	Eat in hotels	11	35.4		
Drinking habits	Drinker	33	27.5	19.233	0.001
	Non-drinker	47	39.3		

A total of 8 factors were likely to affect the prevalence of intestinal parasites in HIV/AIDS patients and these were: Age, Gender, Marital status, Levels of education, Income levels, Smoking habits, Dietary habits and Drinking habits. Out of the 8 factors, it was established that marital status was an insignificant factor, while the other 7 factors were independently responsible for the prevalence of intestinal parasitic infections among the HIV/AIDS patients.

It was established that prevalence of IPI increased with age. According to the results, HIV/AIDS patients aged 18 to 35 years had significantly lower prevalence of intestinal parasitic infections than those aged over 55 years. This observation is similar with that of Sarfati *et al.* (2006). The overall high infection rate with intestinal parasites recorded in the elderly could be due to reduced immunity as senescent sets in (George-Morris, 2004). Meanwhile, significantly higher proportion of females had intestinal parasitic infections than their male counterparts. The higher prevalence of IPI among the females compared to males in these studies can be attributed to the fact that females in the study area engage in water and food preparation for the family, thus leaving them more exposed to infective agents of IPI than men. It is also possible that females received repeated high doses of the HIV in unprotected sex, leaving them with a more degraded immunity than males thus more vulnerable to various infections. Alternatively it is also possible that more females visited the hospital not only for medical treatment but also for other services such as antenatal services and family planning in the study area. This is contrary to (Awogun 2011) observation that reported opposing trend and attributed it to the fact that males have fewer restrictions than females.

The findings that parasite infections declined with increased level education of the study participants indicated the overall improvement of hygienic conditions and sanitation with knowledge of self deworming. Another study by Bern *et al.* (2000) had shown such a relation between increase in educational level and lower prevalence of intestinal parasite infection. Higher income levels was also found to result in reduced prevalence of IPI mainly because, people with high income have ability to afford drugs that will reduce the prevalence of IPI than those without any disposable income.

Smoking and poor dietary habits were all found to increase the prevalence of IPI among the HIV/AIDS patients. These are similar to findings by Zander (2004). Smoking, poor dietary habits and excess drinking have been associated with reduced immune response and increased pathogens in the body (Foudraine *et al.,* 1998) and can presumably explain the high prevalence of these pathogens among the patients who smoked, non-vegetarians or consumed less alcohol.

Table 2. Multiple Logistic Regression of Factors Influencing Prevalence of Intestinal Parasitic infections among the HIV/AIDS Patients

Factor	β	S.E	Wald	Sig	OR (95%CI)
Age (ref>18)					
<18	0.219	0.565	0.150	0.699	1.244(0.411-3.765)
18-35	0.879	0.595	2.184	0.139	2.409(0.751-7.730)
36-55	2.079	0.691	9.060	0.003	8.000(2.066-30.983)
Gender (Male)	0.203	0.534	0.159	0.169	0.808(0.625-1.078)
Education level (ref=none)					
Primary	0.327	0.378	0.751	0.386	8.904(0.191-12.262)
Secondary	1.235	0.632	3.823	0.051	3.438(0.997-11.859)
Tertiary	2.195	0.790	7.722	0.005	1.387(1.061-2.909)
Income level (ref<1500)					
Kshs 1500-5000	-0.177	0.466	0.144	0.704	0.838(0.336-2.089)
Kshs 5001-10000	-0.623	0.472	1.748	0.186	0.536(0.213-1.351)
Kshs 10001-20000	-1.329	0.501	7.036	0.008	0.265(0.099-0.707)
Kshs >20001	-0.910	0.764	1.419	0.234	0.403(0.090-1.798)
Smoking habits (smoker)	0.304	0.926	3.108	0.034	0.738(0.365-0.958)
Drinking habits (drinking)	-0.404	0.300	8.908	0.007	1.513(1.369-8.106)
Dietary habits (Vegetarian)	-0.112	0.263	0.601	0.002	0.894(0.300-0.998)
Constant	4.709	3.41	4.251	0.006	4.181(2.093-7.083)

Numerous studies have shown that multiple factors can each influence the proportion of parasites infections. Also habitat characteristics are known to greatly influence parasite and host distributions (Krist *et al.* 2000). This study supports the value of standard faecal examinations in HIV/AIDS individuals, since these examinations can be easily performed with low costs allowing

initiation of provision of the therapeutic approaches. It can be inferred that some attributes of man play an important role as host factors in the prevalence of IPI.

Conclusion and Recommendations

Factors that were responsible for the prevalence of intestinal parasitic infections were age, gender, levels of education, income levels, eating of meat and smoking. Concerted effort in Health education targeting females and males weather married or not, low income earners and smokers on the mode of transmission, personal hygiene and dangers of IPI in HIV/AIDS need to be emphasized.

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Vegetation Composition and Natural Regeneration in a Tropical Montane Forest Following Anthropogenic Disturbances

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Abstract

The Mau complex in Kenya is a range of highlands covered by natural forests known as South-West Mau, Eastern Mau, Ol'donyoPurro, Transmara, Maasai Mau, Southern Mau and Western Mau. The Western Mau Forest is located at an altitude between 2,000 and 2,600 m and between latitude $0^0 10' 46''$ S to $0^0 17' 42''$ S and longitude of $35^0 27' 05''$ E to $35^0 39' 42''$ E. The Mau complex is an important source of many rivers that flow into Lake Victoria basin, yet it has been under pressure for conversion into farmland. A study was carried out on the vegetation composition, regeneration and anthropogenic disturbances. The study was conducted using 500 m long and 2 m wide belt transects in forest zone, 30 m long, 5 m wide transects both in transition zone and grasslands. The forest zone transects were subdivided into 50 m by 2 m subplots, transition and grassland zone transects were subdivided into 5 m by 5 m subplots. In all subplots, a 1 m by 1 m quadrat was placed at the centre. Data were collected on occurrence of fern, liana, shrub, seedling (< 1 cm), sapling (DBH 1-9.9 cm) and tree (DBH ≥ 10 cm) species. The data were used to calculate abundance, diversity and regeneration. The data were analyzed using analysis of variance and chi-square statistic. Shannon-Weiner index was used to quantify species diversity. Two hundred and twenty three (223) vascular plant species belonging to eighty three (83) families were identified. The Asteraceae had the highest number of species (18) followed by Fabaceae (17). Forty (40) families had a single species each. There were more plant species in the transition zone than forest and grassland zone. The forest was dominated by seedlings and saplings (DBH ≤ 3 cm); the diameter size distribution was reverse J-shaped, indicating that the forest has a good regeneration potential. Species diversity was significantly higher in the forest (3.5 to 4.5) than transition zone (2.0 to 3.5) or grassland (1.5 to 3.0). There was a significant human disturbance, and this affected the species composition, diversity and forest regeneration.

Keywords*: Western Mau Forest, Vegetation Composition, Conservation, Natural Regeneration*

Introduction

Conservation of natural vegetation is currently one of the leading agenda for a number of world conservation organizations, authorities and interest groups (UNDESA, 2004). The concern over vegetation conservation generally stems from the anthropogenic activities that lead to depletion of forest resources (Ramirez *et al.*, 2001; Reyers, 2004). In the face of these problems, ecologists and conservation biologists have proposed the protection of forest vegetation using several strategies that range from strict protection in the national parks to suitable management and other integrated conservation and development programs (Borgerhoff & Coppolillo, 2005).

The Western Mau Forest, which is one of the blocks in Mau complex, provides critical ecological services to the country, in terms of water source; river flow regulation; flood mitigation; recharging groundwater; reduction of soil erosion and siltation; conservation of plant biodiversity and micro-climate regulation. Through these ecological services, the Western Mau Forest supports major economic sectors in Rift Valley, Western and Nyanza provinces of Kenya, including energy, tourism, agriculture and industries (DRSRS & KFWG, 2006). In spite of multiple uses, values and functions associated with the forest it has been a subject of encroachment and unregulated resource extraction. Similar destruction has been noted for other natural forests throughout the world, such that many of them might disappear before some of the species are properly studied, catalogued, used or domesticated (Hitimana, 2000). This could lead to instability of ecosystems and reduced availability of various forest products and services (Alemu & Bluffstone, 2007).

Materials and Methods

The research was carried out in Western Mau Forest block in the south Rift region in Kericho County (Figure 1). It is located at an altitude between 2000 and 2600 m; and between latitude 0^0 10' 46''S to 0^0 17' 42'' S and longitude of 35^0 27' 05'' E to 35^0 39' 42'' E. It is managed by Kenya Forest Service and covers about 22,712 hectares of indigenous forest.
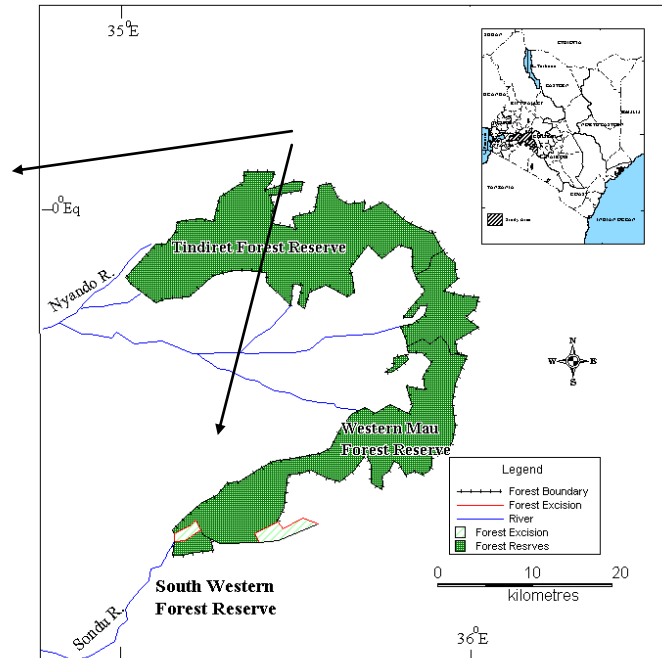
Figure 1. Map of Western Mau Forest, Kenya

The forest was divided into three study sites; Site 1 (Masaita and Mt. Blackett blocks), Site 2 (Kerisoi and Londiani blocks), Site 3 (Kedowa and Kericho blocks). Stratified sampling method was used in each site, where the study area was subdivided into relatively homogenous parts of grassland, transition and forest zones.

Sampling Procedures
Forest, Transition and Grassland Zone Sampling

The belt transect method was used in the forest zone. Transects were randomly established using a table of random numbers. The belt transects was 2 m wide and 500 m long (Kent & Coker, 1992) and each transect was subdivided into ten subplots of 2 m by 50 m and in each subplot a 1 m by 1 m quadrat was set at the center. In the transition and grassland zone, belt transect method was applied. Transects were randomly established using a table of random numbers. The transects of 5 m wide and 30 m long, were then subdivided into six 5 m by 5 m subplots; each having 1 m by 1 m quadrat positioned at the centre. All non-herbaceous plant species in the subplots were identified by scientific name and counted. The count of each individual species was used to calculate the density and relative density of the species. In every quadrat within each subplot all ferns and herbs were identified by scientific names and subjective percent cover recorded. The percent cover was used to calculate the abundance of species.

Assessment of Plant Species Composition and Diversity

All the plant species from the forest, transition and grassland community were identified to the species level. Nomenclature followed Agnew and Agnew (1994) and Beentje (1994). Unstructured sampling was used to record additional species not represented in the sample plots. The total number of each species in the various forest sites was used to calculate Shannon-Weiner diversity index (Pielou, 1975).

Assessment of Regeneration

Regeneration and recruitment trends were determined by taking measurements on diameter at breast height (DBH) of mature trees, saplings at 1.45 m above ground level(Mueller and Ellenberge, 1974) and the count of seedlings along the belt transect from the forest community, transition zone and plots from grassland community. It was being categories as;

1. Seedlings (height < 1.3 m)
2. Saplings (DBH 1 – 9.9 cm and height > 1.3 m)
3. Mature trees, diameter classes (DBH >10 cm)

The DBH for mature trees and saplings were measured using a diameter tape. Densities and relative densities of seedlings, saplings and mature trees were calculated and regeneration and recruitment trends inferred.

Assessment of Human Impact

The human impact was determined by recording the following anthropogenic disturbances signs; footpath, charcoal burning, tree cutting, fire, grazing, and debarking as described by Silori, (2001) and Silori and Mishra (2001). The intensity of these human activities was determined by Likert's scores ranging from 1-5 where 1 represented least disturbance while 5 represented high disturbance (Likert, 1932). The scores were summed up and overall disturbance index calculated using the formula;

$$Disturbance\ Index = \frac{Disturbance\ score}{Total\ \max imum\ score} \times 100$$

Total maximum score was obtained by multiplying number of disturbances with maximum score.

Data Analysis

All statistical analyses were performed using STATISTICA 6.0 (StatSoft, 2001). Normality and homoscedasticity of data distribution was checked by means of the skewness and kurtosis (Zar, 2001). Spatial variation in plants abundance was analyzed using one-way analysis of variance, and plant abundance among sites in different zones was analyzed by two-way analysis of variance. Differences in plant species composition was analyzed using Chi-Square test. All statistical analyses were done at 95% level of confidence.

Results

Plant Species Composition

A total of 223 vascular plant species belonging to 83 families were identified and documented from the study area (Appendix). The number of species per family differed significantly in the forest (χ^2 = 154.618, df = 82, P < 0.05). The major families were Asteraceae with 18 species, Fabaceae with 16 species, Euphorbiaceae with 11 species and Rubiaceae with 10 species. Some 41 Families were represented by a single species each.
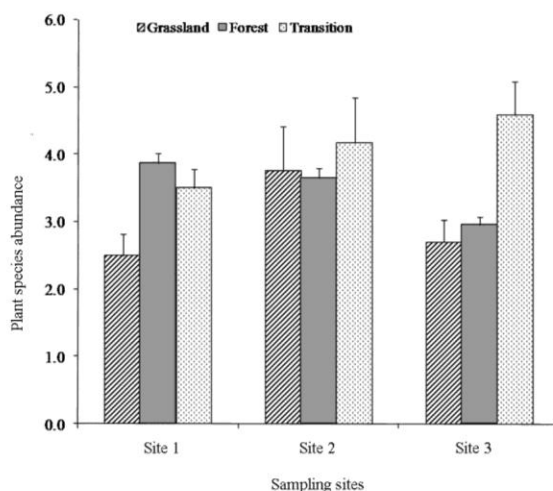
Plant Species Abundance

The abundance of non-herbaceous plant species sampled in Western Mau Forest is shown in Figure 2. There were highly significant differences in the plant forms encountered during sampling (χ^2 = 1259.589, df= 4, P < 0.05). The most abundant plant form was shrubs followed by seedlings and saplings and palms were the least in species composition.
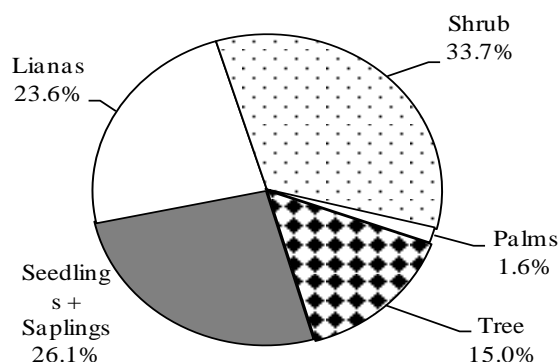
Figure 2. Non-herbaceous Plant form Abundance of Species Sampled in Western Mau Forest

The overall abundance of non-herbaceous plant species among sites and at different sampling zones is presented in Figure 3. There were significant differences in plant species abundance among sites and zones ($P < 0.05$). In Site 1, the highest species abundance was recorded for the forest, whilst in Site 3 the transition zone had the highest plant species abundance. On the other hand, Site 2 had no significant differences in the plant species abundance among sampling zones.

Figure 3. Overall Plant Abundance in the Three Sampling Sites

Species Diversity

Species diversity in the three sampling sites is presented in Table 1. The highest species diversity occurred at the forest zone in Site 1 (H' = 4.05), Site 2 (H' = 3.98) and Site 3 (H' = 3.90) with the lowest species diversity being grassland zone at Site 1 (H' = 1.77).

Table 1. Shannon-Weiner Diversity Index for Plant Species in the Western Mau Forest

Sites	Zones	Shannon-Weiner Diversity indices
Site 1	Grassland	1.77
	Forest	4.05
	Transition	3.10
Site 2	Grassland	2.29
	Forest	3.98
	Transition	2.47
Site 3	Grassland	2.62
	Forest	3.90
	Transition	3.30

Forest Regeneration

        The diameter breast height of the forest is shown in Figure 4. There were significant differences in the DBH in the three sites (P< 0.05). DBH was dominated by trees of < 3 cm and decreased thereafter in the forest. The diameter distribution followed the reverse J-curve.
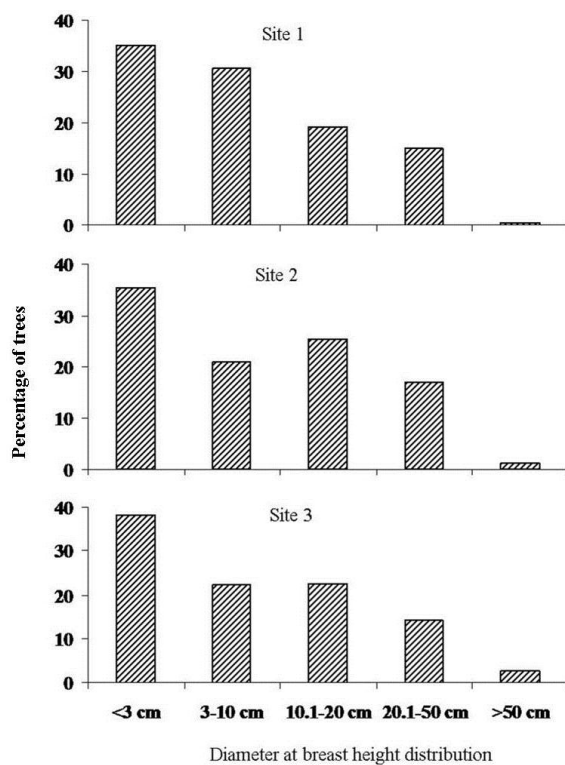

Figure 4. Diameter at Breast Height (DBH) of Trees in the Forest of Western Mau

Anthropogenic Disturbances

        The various types of human disturbances in the forest habitats are presented in Table 2. The most common form of disturbance was grazing, followed by footpaths and tree cutting. The event that had the least disturbance in the forest was charcoal burning. Site 3 was the most disturbed in the forest zone followed by Site 2. Site 3 was the most disturbed site in the transition zone whilst Site 1 and 2 had the same disturbance index. Site 3 was the most disturbed site in the grassland zone followed by Site 2, whilst Site 1 was the least disturbed.

Table 2. The Scores of the Various Types of Human Activity in Western Mau Forest

	Site 1			Site 2			Site 3			Disturbance intensity	Disturbance index
	Grassland	Forest	Transition	Grassland	Forest	Transition	Grassland	Forest	Transition		
Charcoal making	0	0	0	0	0	0	0	3	0	**3**	**10**
Tree cutting	0	4	2	0	4	0	0	5	4	**19**	**63.33**
Footpath	1	3	1	3	1	1	5	1	5	**21**	**70.00**
Fire	0	1	0	0	0	0	0	1	0	**2**	**6.67**
Grazing	4	0	2	3	2	4	5	4	5	**29**	**96.67**
Debarking	0	2	0	0	4	0	0	5	0	**11**	**36.67**
Disturbance intensity	**5**	**10**	**5**	**6**	**11**	**5**	**11**	**20**	**14**		
Disturbance index	16.67	33.33	16.67	20.00	36.67	16.67	36.67	66.67	46.67		

Discussion

Species Composition, Abundance and Diversity

        In this study, the species composition of Western Mau Forest was determined; it was established that there were 223 vascular plant species. The high number of species could be due to disturbance in the forest. Forest disturbance has been observed to stimulate establishment of varied species (Franklin *et al.*,

2002). It could also possibly indicate that the forest has an ideal habitat for floral growth and reproduction. This is because of high humidity witnessed in the forest during sampling; vegetative growth is more likely to be encouraged (Odum, 2008). Asteraceae was the most dominant plant family in the forest. The presence of Asteraceae in the forest can be attributed to their successful wind and animal dispersal (Fransen *et al*., 2006). Members of the Asteraceae are typical indicators of disturbance (Umberto *et al.,* 2010).

Plant species richness, abundance and composition differed substantially among the zones in the Western Mau Forest. The species composition of the different functional groups was fairly well-separated among zones, mainly because several species were strictly associated with the different ecological zones. This supports previous findings that after establishment, species form distinct combinations, depending on the suitability of small-scale environmental conditions (Myster, 2004). The results also showed that there were significant differences in sapling richness and abundance between the grassland, transition zone and forest zone. However, species richness and abundance of adult trees were high in the transition zone and forest zone, suggesting that previously disturbed areas transitioned towards forest type structure and composition. The transition zone and forest zone had higher plant dominance than the grassland zone, probably due to more intense grazing pressure in the grassland zone (Ostertag &Verville, 2002).

The highest species diversity occurred in the forest zone followed by transition zone whilst grassland had the lowest species diversity. The differences in the species diversity in Western Mau Forest can be attributed to differences in anthropogenic effects. In the grassland zone there was intense grazing which may have led to loss of some species. Plant diversity is enhanced through periodic disturbance of plant communities (Rogers & Ryel, 2008).

Forest Regeneration

The study showed gradual increase in species richness and abundance of tree seedlings, saplings and adult trees from the grassland zone towards the forest zone. This could indicate recovery in degraded natural forest (Duarte *et al.,* 2006). The analysis showed that, there were high frequency values in the lower DBH classes and progressively decreased to higher DBH class in all the three sites. The pattern had more individuals at seedling stage and decreasing number of individual successively at sapling and adult stages. This exhibited reverse J-shape curves but not perfectly in Site 2 and Site 3, typical of uneven-aged mixed forests. The reverse J-shape pattern signifies that the forest has a good regeneration potential (Meyer, 1952).

There was a higher density of trees at lower diameter classes compared to larger diameter classes. These results are similar to many previously reported findings. Sherma and Kumar (1992) and Geldenhuy and Murray (1993) reported that logging reduced the density of larger diameter class trees. This could result from slow recruitment of the residual trees in the lower diameter classes into higher ones after logging, because indigenous trees grow slowly (KFMP, 1994). Uncontrolled and continuous exploitation of the forest trees for timber and fuel wood by the surrounding settlements could also cause slow recovery of the forest. Extensive logging in the forest could therefore be increasing the diameter distributions in favour of the tree species with lower diameter at breast height (DBH) (Campos, 2001).

Human Disturbance

Although Western Mau Forest is under Kenya Forest Service (KFS), currently, the conservation status of the forest is at a very low status. Forest conservation has never been a concern for the local communities as the local people view a forest as a source of fuel wood, and a hindrance to cultivation. At the present, the largest proportion of this forest has been cleared for cultivation.

In this study, six factors were found to be the key agents of disturbance within the forest ecosystem. These include; tree cutting, charcoal making, footpaths, fire, grazing and debarking. The expanding rural population in the area which utilizes plant material from the forest for construction, fuel and charcoal, threatens the forest. One of the major activities of the local people being livestock production, the forest provides grazing area to the local communities. Grazing is likely to influence soil and above ground vegetation, which may significantly impede forest regeneration, particularly recovery of species composition. As an example, Haggar *et al.,* (1997) and Posada *et al.,* (2000) reported that severe reduction in regeneration of trees and shrubs in pastures were due to intensive browsing by livestock.

The footpaths and animal trails were evidence of easy human access in the forest, and usually bring about the trampling of seedlings and soil thus affecting forest regeneration (Serna, 1986). Disturbance levels seemed to decrease with distance from villages, indicating that the pressures of illegal logging, harvesting and other human impact were closely connected to accessibility and transport cost.

Conclusion

Western Mau Forest had high species diversity, that is, 223 species of vascular plants belonging to 83 families were recognized. Species diversity and richness varied among the zone types. The density of tree species in the forest decreases with increasing DBH, which implied the predominance of small sized individuals in the lower classes than in higher classes indicating good recruitment of the forest. Protection of the Western Mau Forest seems nominal; there is no proper management plan in place and no enforcement of the rules. There is a high rate of destruction because of the frequent visits of the people from nearby villages for fuel, fodder, wood for construction and other forest products. This has resulted in the depletion of the forest, thereby causing damage to plant diversity in the area.

Recommendations

The forest requires more strict protection if continuous forest regeneration are to be maintained. Relying on forest guards to protect the forest is not adequate if not ineffective. There is therefore a need to revise or improve the system currently being used to protect the forest. This may include involving the local people in efforts to conserve the forest.

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An Investigative Study of Diffusion of Commercial Aspirin (Acetylsalicylic acid) in Sodium Hydroxide Solution at 25°C

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Abstract

Diffusion is a macroscopic motion of components of a system that arises from concentration difference. Reaction diffusion is widely used to model developmental process. This project considers effective mechanism leading to effective diffusion coefficient. A mathematical formalism for transforming local transport law into diffusive terms is developed. The diffusion coefficient of drug aspirin was studied in basic NaOH of concentration range 0.01 to 0.1M at 25°C. The rate of diffusion was monitored by observing the boundary conditions of the indicator between the drug and solution. In the study five (5) aspirin tablets collected from a local pharmacy in Eldoret town were used for the study. From the profile it was observed that as the time progressed the boundary increased fast for non-coated tablets compared to the coated ones. All the aspirin were found to give values according to underlying mechanism. For the drug A (600mg) of aspirin the best value of diffusion coefficient of 1.69 x 10^{-4} cm^2 sec^{-1} was observed while the values for coated drug E with 75 mg aspirin was found to be slightly lower. Fickian mechanism is believed to be the consequence of drug molecule small size. First of all fractional drug uptake is linear and independent of the sample of thickness when In [NaOH] is plotted against square distance. A graph of x^2 against In [NaOH] was plotted which was used to calculate the diffusion coefficient. The experimental values of diffusion coefficient Do were within the experimental error to those of (4Dt)$^{-1}$. The study also adopted a descriptive case study; it was conducted at Kimumu municipality, Eldoret town. The target population consisted of 25 respondents. Data was collected using self-administered questionnaires and interview schedules, coded and analysed using SPSS version 16.0. Systematic quantitative review data was analysed using means and frequency tables and percentages while qualitative data was analyzed using inferential statistics chi-square. Data was presented using table, pie charts and graphs. The study found that most of the individuals preferred drug B.

Keywords: *Diffusion, Aspirin, Diffusion Coefficient, Sodium Hydroxide, Fickian Mechanism*

Introduction

Diffusion is a process by which substances are transferred from a region of high concentration to a region of low concentration through random molecular motion. It is a process that involves the existence of proportionality between the rate of flow across any cross section area A and concentration gradient expressed as that cross section. Diffusion as a scientific term has roots in an extremely broad range of disciplines. The concept subsumes the transport of entities as language, populations, genes and technology as well as heat, charge and atoms because of all this process involves a strong element of randomicity (Mortimer, 2000).

Diffusion in drug systems is described by Fick's second law which in many cases can be analytically solved if experimental data as well as initial and boundary conditions are provided in order to yield an effective mass transfer coefficient. Inversely, when the value of this coefficient is known a mass transfer simulation can be performed and the distribution of concentration in time and space in the drug can be obtained by solving Fick's equation. Analytical solutions covering on varying specimen geometry are found in the most well known (Crank, 1975). The so called effective diffusion coefficient has been used and misused in the drug literature, since drugs are characterised by complicated structure making the media involved and hence forth the mass transfer phenomena multiphase and multi-component.

Consequently the general theory of diffusion must be diffusion process; the entropy is the only increase. In the most elemental spontaneous isothermal mixing, the volume energy and total mole numbers constant. It should not be surprising that the Gaussian and error integral functions from probability play an important role in elemental diffusion theory. Basically solid liquid reactions are more complex than solid gas reactions and include a variety of technically important process such as electro

deposition. When a solid reacts with liquid the process involves the products forming a layer on solid surface or dissolving into the liquid phase. If the reaction products are partly or wholly soluble in the liquid phase, the liquid has access to the reacting solid and chemical reaction at the interface therefore becomes important in determining the kinetics (Kays, 2005; Laidler and Meiser, 1982).

The simplest solid-liquid reaction is the dissolution of a solid in a liquid. The rate of diffusion can be measured by a number of different methods by direct chemical analysis of samples at different distances after definite time intervals. The equations formally describing the diffusing migrations of atoms was proposed over a hundred years ago (Rinsema, 1999; Harris, 1999). No experimental data on diffusion was available then and Fick's equations was written in conformity with molecular diffusion within liquids (Jost., 1960).

Fick's first law has the following form:

$$J = -D\frac{\partial \phi}{\partial x}$$

Where J (diffusion current is the amount of substance passing through a reference substance of unit time mol/m^{2-s}, x is the co-ordinate perpendicular to surface area where D is the diffusion coefficient length^{2}time^{-1} (m^2/s) and Ø (for ideal mixtures) is the concentrations in dimensions of (amount of substance) length $^{-3}$, i.e. (mol /m^3). The diffusion coefficient controls the rate of diffusion. The dc/dx is the rate change of concentration in the x direction and minus sign indicates the flow from a higher to lower concentrations (Ladler and Meiser, 1982).

In Kenya as a result of trade liberalization and the boost in the local pharmaceutical manufacturing sector, people perceive the pharmaceutical market as a commodity market and an easy means of making profits. The general disregard to lay down rules of quality assurance and desire to reap huge financial profit and the motivating factors for quackery and faking makes it necessary for independent assessment of the quality of pharmaceutical products. Quality assurance is a wide ranging concept covering all matters that individually or collectively influence the quality of a product. Quality assurance incorporates good manufacturing practice (GMP) Quality control as well as other factors including product design and development.

The purpose of quality assurance system is to ensure an absolute quality product such that each product tablet will contain the amount of active drug claimed on the label within the stated limit, as well as other essential parameters such as bioavailability of the product.

Materials and Method

Two concentration sets of base were prepared; dilute and concentrated. To each sample two drops of methyl orange was added and the solution mixed in a disposable plastic curettes of cross section 1cm^2 and capacity 4.50ml while closed using a fitted stopper. The procedure was repeated with different concentrations of NaOH upto 0.01M. The contents were kept in an oven at a regulated temperature of 25°C.

An accurately weighed mass of commercial aspirin tablets was dropped into each of the cuvettes and time recorded at different intervals where boundary height between the alkaline and acidic parts of solutions formed.

Study Area

The target population comprised of a twenty five personnel based in Kimumu. This is because the sample must be enough to represent the critical characteristics of the target population.
Stratified sampling was used to select respondents to be included in the sample. This technique identifies sub-groups, in the population and their proportions and selected from each sub-groups to form a sample. It groups a population into separate homogeneous that share similar characteristics so as to ensure equitable representation of population in the sample.

Sampling Procedure and Sample Size

Both probability and non-probability sampling procedures were used in selecting samples from the secondary schools. The researcher used cluster or sampling techniques. According to the (Kothari, 2004) cluster sampling technique involving the selection of an interact group rather that individual elements for inclusion than the sample was appropriate for this study. Cluster was the different categories in the area. It is used if the population is scattered over a large geographical area and it is not easy to

obtain a sample frame. All members of such intact group in this case the elderly were included in sample and each because a unit of observation.

A small population of 200 or less of the entire population should be used as this enables a researcher to achieve level of precision and sampling error is eliminated as data on all units of observation are provided (Israel, 2008). Data was therefore collected from all schools in the region, (Kombo and Tromp ,2006) recommend the use of table in order to determine size of randomly chose sample for finite populations, thus a population of 25 was represented by the sample. The number of personnel who participated in this study was determined using non probability purposive sampling techniques.

The study employed two instruments for data collection: practical experimental lab work and interview from the questionnaires. They were used to collect data on the efficiency of drug aspirin use for the period 2010 to 2011. The questionnaire had specific questions related to specific objectives and research questions.

An interview schedule (Appendix I) for personnel as in depth data was collected on April 2011. Such information cannot be obtained without using a questionnaire (Mugenda and Mugenda, 1999). The questionnaire is referred to as Appendix I. Both instruments are divided into three parts. Part I seers to establish general information of the personnel. Part II inquires information on the drug aspirin.

Data Analysis

Data collected from the field was coded and entered into the computer for analysis using the statistical package for social science (SPSS version 18.0). Descriptive statistics including percentage and frequency count were used to analyze the data obtained (Bell and Rhodes 1996) maintains that when making the results known to a variety of readers, simple descriptive statistics such as percentages have a considerable advantage over complex statistics since they are easily understood (Olembo and Ross ,1992) also hold that the most widely used and understood standard proportion is the percentage. The results of data analysis both from laboratory and field were presented in frequency tables and bar graphs.

Results

The more soluble a drug is, the more quickly it passes from the digestive system into the bloodstream after being swallowed. Aspirin is a weak acid and methyl orange indicator was found to be a suitable indicator. The concentration of a simple case of solution containing a single solute. The solute spontaneously diffuses from a region of high concentration to one of low concentration. Chemically speaking the driving force of diffusion is the gradient of potential, but it is more usual to think of the diffusion of solutes in terms of gradient of their concentration. Although no individual solute particle in a particular volume shows a preference for motion in a particular direction, a definite fraction of molecules may be considered to be moving in any particular direction, for instance the x direction. In an adjacent volume the same volume may be moving in reverse direction. If the concentration in the first volume is greater than in the second, the overall effect is that more particle moving are leaving the first element for second and hence a net flow of solute in the x direction ,the direction of decreasing concentration. This was governed by Fick's law.

Experiment with Sodium Hydroxide Solution from 0.01M to 0.10M

The research showed typical data from a run using sodium hydroxide after an initial period of about one hour the rate of rising of the hydroxide was proportional to time and was dependent on the concentration of the bases and the weight of the commercial aspirin tablet. When the square of the height of the boundaries were plotted against time, straight lines passing near the origin were obtained (figure 2) the slopes of these plots were found to be dependent on the basic concentrations.

The rates of diffusion of aspirin in sodium hydroxide solutions increased with increased concentration of the base: - a solution that, agreed with expectations of diffusions with chemicals reactions.

Experiments with Sodium Hydroxide SOLUTION from 0.10M to 1.0M

The research showed the results of the basic solutions with concentration between 0.1M and 1.0M. The results may be classified into three groups.

1. 0.10-0.40M: acid has quantities of aspirin that are higher than those of the base into the solutions therefore the aspirin diffuses to the meniscus.

2. 0.50M base is in a class of its own: this type of behavior is observed when the number of moles of moles of aspirin is equal (or almost equal) to those of moles of OH⁻ in the basic solutions of the steady state at which the boundary remains at the some positions for a long time

interval indicates a situation where the rate of diffusion of the aspirin is exactly counter balanced by the rate of diffusion of the base.

3. 0.6M - 1.0M base: the amounts of base in such solutions usually exceed the quantity of acid in the tablet. Hence initially the acid diffuses into the base to a height that depends on the concentration of the base, after which the tablet begins to diffuse into the alkali.

When the squares of the boundaries were plotted against time, straight lines passing near the origin were obtained.

As the concentrations increased, the plots could not yield straight lines as the boundaries started dropping due to the fact that the base begins to diffuse into the acid.

The results also agree with the square root relationship for the diffusions into a semi-infinite medium involving the dimensionless parameter (Crank., 1975; Meriill, 2002):

In two aspects;

1. The distance obtained by any given concentration was proportional to the square root of the time.

2. The time needed for any point to reach a given concentration is proportional to the square of its distance from the surface where the diffusion occurs.

Table 1. Data of Basic Concentrations and Diffusion Coefficient for Drug A (0.01M to 0.1M)

Mass (grams)	Concentration	Slope V $\times 10^{-4}$	D $\times 10^{-5}$	Square roots	D' x square root $D_O' \times 10^{-6}$
1.120	0.01	9.42×10^{-4}	0.75×10^{-5}	$\sqrt{0.01}$	7.50
1.121	0.02	6.50×10^{-4}	5.17×10^{-5}	$\sqrt{0.02}$	7.31
1.120	0.03	5.46×10^{-4}	4.36×10^{-5}	$\sqrt{0.03}$	7.55
1.122	0.04	4.90×10^{-4}	3.91×10^{-5}	$\sqrt{0.04}$	7.82
1.120	0.05	4.39×10^{-4}	3.52×10^{-5}	$\sqrt{0.05}$	7.88
1.121	0.06	3.54×10^{-4}	2.84×10^{-5}	$\sqrt{0.06}$	6.98
1.121	0.07	3.05×10^{-4}	2.42×10^{-5}	$\sqrt{0.07}$	6.42
1.120	0.08	2.80×10^{-4}	2.23×10^{-5}	$\sqrt{0.08}$	6.30
1.122	0.09	2.57×10^{-4}	2.05×10^{-5}	$\sqrt{0.09}$	6.14
1.122	0.10	2.40×10^{-4}	1.91×10^{-5}	$\sqrt{0.10}$	6.05

$$69.95 \times 10^{-6} \text{ cm}^2\text{sec}^{-1}$$

Table 2. Data of Basic Concentrations and Diffusion Coefficient for Drug A (0.1 to 1M)

Mass (grams)	Concentration	Slope V $\times 10^{-5}$	D $\times 10^{-6}$	Square roots	D' x square root [OH⁻] $D_O' \times 10^{-6}$
1.120	0.1	7.19	5.72	$\sqrt{0.1}$	1.81
1.121	0.2	5.91	4.69	$\sqrt{0.2}$	2.10
1.120	0.3	5.53	4.40	$\sqrt{0.3}$	2.41
1.122	0.4	5.18	4.14	$\sqrt{0.4}$	2.62
1.120	0.5	4.87	3.87	$\sqrt{0.5}$	2.72
1.121	0.6	4.68	3.74	$\sqrt{0.6}$	2.90
1.121	0.7	4.46	3.56	$\sqrt{0.7}$	2.98
1.120	0.8	4.58	3.64	$\sqrt{0.8}$	3.26
1.122	0.9	4.62	3.67	$\sqrt{0.9}$	3.48
1.122	1.0	4.40	3.52	$\sqrt{1.0}$	3.52

Total value $27.80 \times 10^{-6} \text{ cm}^2\text{sec}^{-1}$

The average diffusion coefficient value is $4.89 \times 10^{-5} \text{ cm}^2\text{sec}^{-1}$

Table 3. Data of Basic Concentrations and Diffusion Coefficient for Drug E (0.01 to 0.1M)

Mass (grams)	Concentration	Slope V $\times 10^{-9}$	D	Square roots	D' x square root [OH⁻] $D_O' \times 10^{-10}$
0.120	0.01	1.38×10^{-8}	1.1×10^{-9}	$\sqrt{0.01}$	1.1
0.121	0.02	1.00×10^{-8}	7.8×10^{-10}	$\sqrt{0.02}$	1.13
0.120	0.03	8.67×10^{-9}	6.9×10^{-10}	$\sqrt{0.03}$	1.19
0.121	0.04	7.79×10^{-9}	6.2×10^{-10}	$\sqrt{0.04}$	1.24
0.120	0.05	7.35×10^{-9}	5.85×10^{-10}	$\sqrt{0.05}$	1.31
0.121	0.06	7.07×10^{-9}	5.63×10^{-10}	$\sqrt{0.06}$	1.38
0.121	0.07	7.07×10^{-9}	5.63×10^{-10}	$\sqrt{0.07}$	1.49
0.120	0.08	6.98×10^{-9}	5.55×10^{-10}	$\sqrt{0.08}$	1.57
0.120	0.09	6.97×10^{-9}	5.55×10^{-10}	$\sqrt{0.09}$	1.64
0.121	0.10	6.87×10^{-9}	5.50×10^{-10}	$\sqrt{0.10}$	1.73

$$13.78 \times 10^{-10} \text{ cm}^2\text{sec}^{-1}$$

Table 4. Data of Basic Concentrations and Diffusion Coefficient for Drug E (0.1M TO 1M)

Mass (grams)	Concentration	Slope $V \times 10^{-9}$	$D \times 10^{-10}$	Square roots	D' x square root [OH⁻] $D_O' \times 10^{-10}$
0.120	0.1	1.16×10^{-8}	9.23×10^{-10}	$\sqrt{0.1}$	2.92
0.121	0.2	8.04×10^{-9}	6.40	$\sqrt{0.2}$	2.86
0.120	0.3	6.11×10^{-9}	4.87	$\sqrt{0.3}$	2.67
0.121	0.4	4.81×10^{-9}	3.83	$\sqrt{0.4}$	2.42
0.120	0.5	3.93×10^{-9}	3.13	$\sqrt{0.5}$	2.21
0.121	0.6	3.46×10^{-9}	2.75	$\sqrt{0.6}$	2.13
0.121	0.7	3.01×10^{-9}	2.40	$\sqrt{0.7}$	2.01
0.120	0.8	2.78×10^{-9}	2.21	$\sqrt{0.8}$	1.98
0.120	0.9	1.72×10^{-9}	1.37	$\sqrt{0.9}$	1.30
0.121	1.0	1.53×10^{-9}	1.22	$\sqrt{1.0}$	1.22

$$21.72 \times 10^{-10} \, cm^2 sec^{-1}$$

The average diffusion coefficient value is $1.78 \times 10^{-9} \, cm^2 sec^{-1}$

The plots of height squared against time for the drug of concentration ranging from 0.01 to 0.1 for the aspirin drug A and E are shown from figure 2 while those of In [NaOH] against x^2 are illustrated as from figure 1.

Figure 1. Graph of In [NaOH] versus x^2 for Drug A (O.1M to 1.0M)
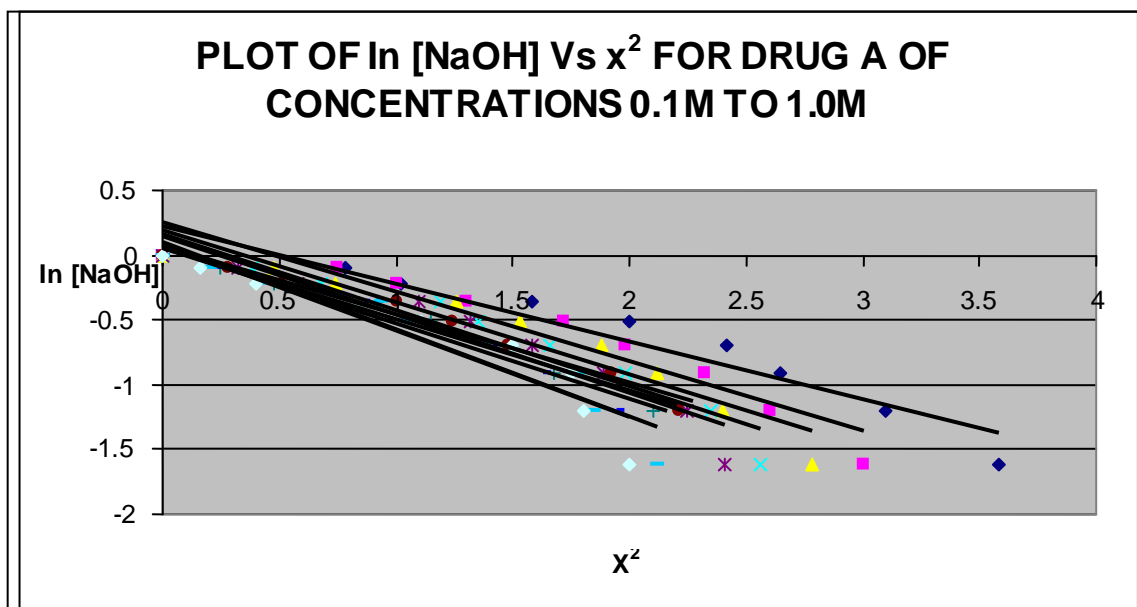
PLOT OF HEIGHT SQUARED VS TIME FOR CONCETRATIONS 0.1M TO 1.0M
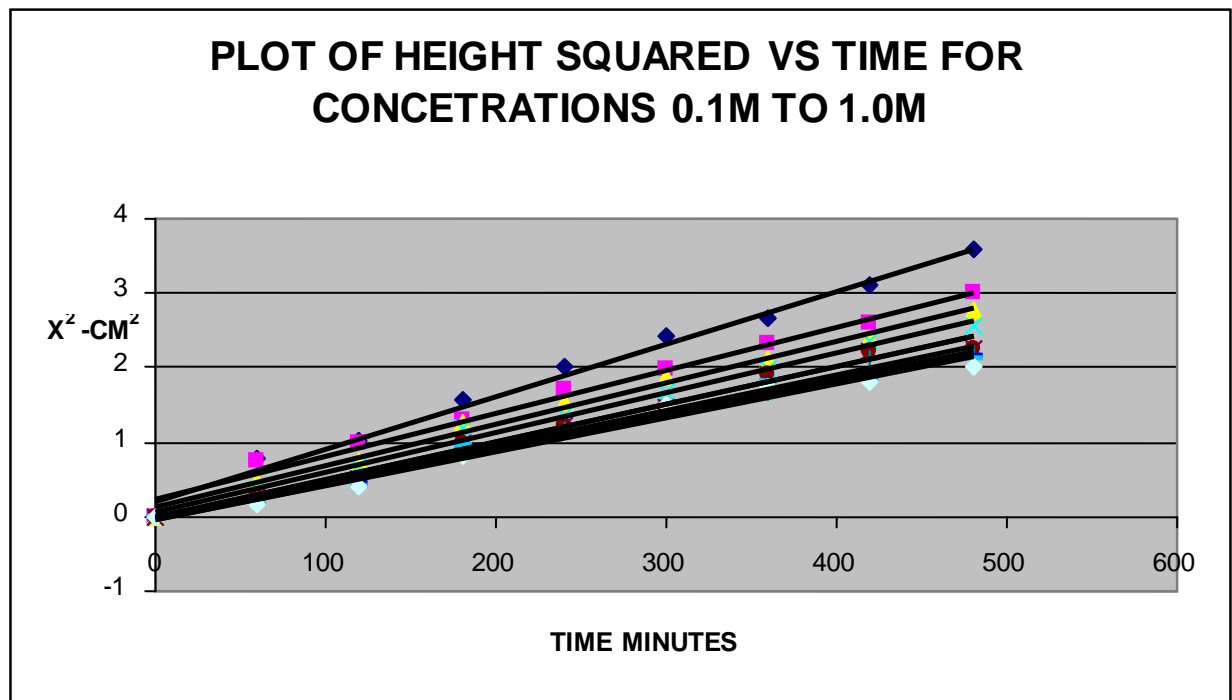

Figure 2. Graph of x^2 versus Time for 0.1M to 1.0M Sodium Hydroxide Solutions for Drug A0.1M to 1.0M

Comparison Methods of Diffusion Coefficient for Commercial Aspirin

The diffusion coefficient for a strong electrolyte at infinite dilution may be calculated from the equation illustrated

$$D_o = \frac{8.936 \times 10^{-10} T(v_1 + V_2) h_1^0 h_2^0}{v_1 z_1 (h_1^0 + h_2^0)}$$

Where T is the absolute temperature, v_1, v_2 are the numbers of cations and anions from dissolution of one molecule of the electrolyte, z, cationic charg $\Lambda+$ and $\Lambda-$ equivalent cation and anion limiting conductances.

$$D_o = \frac{8.936 \times 10^{-10} T \times 2 (50 \times 10^{-04} \times 36 \times 10^{-04})}{(50 \times 10^{-04} + 36 \times 10^{-04})}$$

$$= 1.11 \times 10^{-9} \ cm^2 sec^{-1}$$

$\Lambda^\circ = v_+ \Lambda_+ + v_- \Lambda$

$1 \times 50.08 \times 10^{-4} + 1 \times 36 \times 10^{-4} = 86.08 \times 10^{-4}$

$$D = \frac{RT\Lambda}{Z2F2}$$

$$D = \frac{8.936 \times 10^{-10} T \times 2 (86 \times 10^{-04})}{2(96000)^2}$$

$$= 1.15 \times 10^{-9} \ cm^2 sec^{-1}$$

$$D = \frac{2DA \times DB}{DA + DB}$$

$$D = \frac{2 \times 9.58 \times 10 - 10 \times 1.33 \times 10 - 5}{9.58 \times 10 - 10 + 1.33 \times 10 - 5}$$

$$= 1.92 \times 10^{-9} \ cm^2 sec^{-1}$$

The Do values for sodium and salicylate are 1.33×10^{-5} and $9.58 \times 10^{-10} \ cm^2 sec^{-1}$ respectively while the limiting conductances are 50.08×10^{-4} and $36 \times 10^{-4} \ m^2 Smol^{-1}$. The values obtained are close

from the one from the moving boundary method. The effect of electrostatic interaction of electroneutrality is the retardation of diffusion of salicylate ions and the acceleration of the diffusion of Na^+.

Questionnaire Return Rate

Twenty five (25) individuals were selected and issued with questionnaire seeking to establish their perceptions on the efficiency of the drug aspirin. Out of the 25 issued with interview schedules of them returned dully filled lists making an interview schedule return rate of 93.3%, 68% returned dull filled in questionnaires which represents 88.3% return rate. The overall return rate was 90.8% which the researcher found to be adequate representative of the target population. There is no standard for an acceptable response rate (Merrill, 2002), but published opinion indicates that below 80% bias is likely to occur and a response rate above 60% is acceptable. The age group of the individuals using drug aspirin is presented in table 5.

Table 5. Age Group of the Individuals Using Drug Aspirin

Age group of the Individuals using Drug Aspirin	Frequency	Percent
Adults	17	68.0
Both of them	5	20.0
Children	3	12.0
Total	**25**	**100.0**

Reasons for Using Drug Aspirin

The analysis found the reason for using drug aspirin were numerous, 28% said on health benefits, 12% said awareness. Therefore the best reason for using the drug aspirin was health benefits. Table 6 shows the reasons for using drug aspirin.

Table 6. Reasons for Using Aspirin Drug

Reasons for using drug aspirin	Frequency	Percent
Awareness	3	12.0
Health benefits	7	28.0
Access to drug product	4	16.0
Government policy	6	24.0
Availability of drug product	5	20.0
Total	**25**	**100.0**

Conclusion

The use of the diffusivity data may be used cautiously by the chemists, taking into account the special issues associated with the concept of this drug property.

Based on the findings of the study of number of conclusion were drawn.

All the aspirin tablet were found to produce values according to underlying mechanism. For the drug A loaded with 600mg of aspirin the best value of diffusion coefficient of $1.69\times10^{-4} cm^2 sec^{-1}$ was observed while the values for coated drug E with 75mg aspirin was found to be slightly lower ($1.78\times10^{-9} cm^2 sec^{-1}$).

Although the experimental technique described is a simple and needs no intricate equipment, it yields D values that are close to those calculated and from limiting conditions within experimental error.

The absence of an opposing applied force, all solutes tend to diffuse through solutions until the compositions are homogeneous throughout. Small molecules move with sufficient velocity to distribute the molecule throughout the solvent rapidly.

The rates at which a substance diffuses across a unit cross-sectional area depend not only on the molecular size and shape but also on the concentration gradient of the substance.

The diffusion coefficient can be recognized as the amount of solute that diffuses across a unit area in one sec under the influence of a unit concentration gradient. It was realized that the function had temperature dependence.

A graph of x^2 against In [NaOH] was plotted which was used to calculate the diffusion coefficient. The experimental values of diffusion coefficient D were within the experimental error to those of $(4Dt)^{-1}$. The test with ANOVA produced a result of no significant difference among the five drugs. Aspirin which hydrolyses into salicylic acid and should therefore be protected by monitoring and controlling the moisture content during production.

Acknowledgement

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Determination of the Pollution Levels of Waste Water from Nakuru Tanners, Kenya

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Abstract

Wastewater from leather processing industries is very complex and leads to water pollution if discharged before treatment, especially due to its high organic loading and chromium content. Over the past years, Nakuru Tanners Ltd has been discharging raw effluents into the Ndarugo River causing pollution of surface waters, groundwater and soil. Since the water from this river is used for drinking, agricultural and industrial purposes, the assessment of the effluents is necessary. A study to determine the level of toxicants in Nakuru tannery wastewater discharged to the environment was undertaken. Water samples from four sampling points (S1 – Pre-tanning Stage, S2 – Tanning Stage, S3 – Post-tanning Stage and S4 – Drainage to the river) were collected and analyzed. A comprehensive experimental evaluation of tannery wastewater was performed as a basis for the determination of the levels of different pollutants, BOD, COD, pH, turbidity, TSS, NO_3^- and NO_2^- and the values obtained were compared to the standards set by NEMA and WHO. The levels of the metals chromium, iron and lead were determined using FAAS, Kjeldahl method was used for the quantization of NO_3^-, NO_2^- and P determined by Mehlich II extraction while UV-Vis was used in colour determination. The results show that sampling point S1 (wastewater from the pre-tanning stage) recorded the highest parameter levels for pH, TSS and SO_4^{2-} of 11, 294.40 mg/L and 318.50 mg/L, respectively. Sampling point S2 had the highest levels of COD, BOD, Cr and Pb with corresponding values of 9,107 mg/L, 9,150 mg/L, 945 μg/L and 6.50 mg/L. Sampling point S3 recorded the highest parameters of temperature, DO, Fe, P and electrical conductivity of values 24.62 ^0C, 1.15 mg/L, 5.40 mg/L, 12.40 mg/L and 14720 μSCm^{-3} while S4 recorded the highest of NO_3^- and NO_2^- pollutants with respective values of 85.20 mg/L and 146.70 mg/L. These levels were, however, above the recommended values set by WHO and NEMA for such parameters in tannery waste water. The company should therefore take immediate counteractive actions to lower these levels of the toxicants in order to avert the associated effects to human and environment. This study has made various recommendations which if undertaken will help make the tannery effluents safe before disposal.

Key Words: Waste water, Physicochemical Parameters, Pollution, Tanning

INTRODUCTION

Background of the Study

The tanning industry represents an important sector in the economy of many countries. On the other hand, depending on the leather process, it generates large quantities of wastewater with ammonium, sulphates, surfactants, acids, dyes, sulphonated oils and organic substances, heavy metals Cr, Pb and natural or synthetic tannins (Schrank _et al._, 2004; 2005; Kurt _et al._, 2007; Preethi _et al._, 2009).

These chemical substances are applied to transform the animal skin into products with great capacities for dyeing, as well as to increase the mechanical and hydrothermal resistance. Considering that the greater part of these organic compounds are resistant to conventional chemical and biological treatments, the wastes discharged into natural waters increase environmental pollution and associated health risks. The treatment of this type of wastewater is very complex mainly because of the variety of chemical products added in different concentrations (Schrank _et al._, 2004; 2005; Kurt _et al._, 2007; Preethi _et al._, 2009). The fact that environmental legislation is very strict in almost all countries that are leather producers, a great deal of effort has been made to develop treatments for and remediation of the contaminated environments.

Several methods have been described in the literature, such as direct recycling, coagulation, flocculation, chemical precipitation, ion-exchange, adsorption, biological treatment, electrochemical treatment, membrane separation, thermal techniques and others. Physical chemistry processes, such as coagulation/flocculation, adsorption and membrane separation, have been the most utilized for the removal of coloured effluents. However, these treatments do not solve the problem because of the transfer of contaminants from one phase to another. However, in biological treatment, the microorganisms degrade the organic pollutants using them as a carbon source to produce metabolic energy for their survival (Song *et al.,* 1999; 2004 and Guo *et al.,* 2006). The pollution of aquatic environment is important because of its significant relation with public health. Some of the main pollutant sources are the industries, which take the natural river water and treated in different steps before draining out to the river. In some cases chemical pollutants, without any treatment, are drained to the river. This study was therefore aimed at establishing some of the aquatic and environmental effects of the waste released and water discharged from Nakuru Tanners to the environment both the surrounding and the dumpsite within the company before disposal to river Ndarugo in Nakuru town. Nakuru town is located in an environmentally sensitive area. It is sandwiched between Lake Nakuru National Park to the south and the Menengai crater and its associated volcanic landscapes. The population of Nakuru has been growing at the rate of 5.6% per annum and it is considered the fastest growing town in Kenya. Its population is estimated to be 500 000 (Nakuru Municipal council 2012).

Statement of the Problem

The operation of tannery industries in Kenya is causing severe environmental degradation due to the disposal of untreated effluent on land and in water bodies. There is urgent need for the proper treatment of tannery effluent prior to their disposal (Kiruthu, 2002).

About 130 different types of chemicals are applied in leather manufacturing (Ates *et al*., 1997). Wastewater from leather production is known to be heavily loaded with numerous contaminants, which cause diseases for aquatic organisms, hazardous public health, and a serious threat to the environment (Kiruthu, 2002). Therefore this study sought to determine the identity and the amount of toxic chemicals applied in the processing of the skins in Nakuru tanners located in town. Such a leather industry can cause immense effects not only to the environment but also to the inhabitants of the area including memory loss, increased allergic reactions, high blood pressure, depression, mood swings, irritability, poor concentration, aggressive behaviour, sleep.

Disabilities, fatigue, speech disorders, high blood pressure, vascular occlusion, neuropathy, auto-immune diseases, and chronic fatigue are just some of the many conditions resulting from exposure to such toxins (Tunay *et al*., 2006).

General Objective

To ascertain the level of different pollutants in the effluents from Nakuru Tanners limited.

LITERATURE REVIEW

Historical Developments of Tanning

Leather tanning is the process of converting raw hides and skins into leather (Covington, 1997). Tanning is claimed to be the second oldest profession in the world. In ancient times, tanning was considered as a noxious trade (Possehl, 1996). However, the industry has evolved with time. The leather industry is now recognized as a major industry of great economic importance on an international scale producing a host of products in one of the world's finest natural materials (Heidemann and Roether-Eduard., 1993). Tanning industry is sometimes criticized on environmental grounds, although the only other viable alternative of dumping the putrefying hides and skins can be more hazardous and can cause even more severe environmental damage (UNIDO, 2000).

Tanning Industry: A Global Outlook

Leather is a globally acclaimed product and there is an ever-increasing demand for leather and its related products. The current trade value of the leather industry is estimated to be approximately US$ 70 billion per year. The industry in total produces about 18 billion square feet of leather a year, with developing countries producing over 60% of the world's leather. About 65% of the world production of leather is estimated to go into leather footwear (ITC, 1999 and FAO, 2001). Its major expansion has taken place in developing and newly industrialized countries rather than in developed economies (ITC, 1999).

In developing and newly industrialized countries solid waste and wastewater treatments are not state of the art and there is a high labour content to the processes involved in the conversion of hides and skins into leather (Tchobanoglous *et al*., 2003). The United States, Germany, and other European countries remain major importers of leather products while China, India, Thailand, and Indonesia dominate the export of leather and leather products (ITC, 1999 and FAO, 2001).

Leather Industry in Kenya

Kenya has a profound tradition of processing leather. In this industry, presently, the rise of the tanneries from nine to eleven with two more under urgent revamping is a sign that the industry is poised for growth. This has further been demonstrated in the recent economic survey of 2008 that showed a 10.3% growth in the leather sector (Muchangi, 2012). Kenya has the potential to generate sizeable export earnings from the leather industry owing to its annual production of hides and skins. Table 2.1 shows the hides and skins production statistics of the three East Africa Community countries.

Tanneries as a source of pollutants

Hides and skins pass through many liquors in the entire tanning process, each quite different in chemical composition and each playing its part in the conversion of unstable fibrous nature protein into a relatively stable non putrescible leather (Verheijen *et al*., 1996).

The wastewaters discharged by a tannery are the liquid wastes produced from each of the processes and the washing following each operation. While the spent liquors from each operation are dumped in batches, the washing from these operations are intermittently or continuously discharged, which causes a high fluctuation in the discharge of main stream (Verheijen *et al*., 1996).

Tanneries are typically characterized as pollution intensive industrial complexes, which generate widely varying, high-strength wastewaters. Variability of tannery wastewaters not only from the fill and from draw type operation associated with tanning processes, but also from the different procedures used for hide preparation, tanning and finishing. These procedures are dictated by the kind of raw hides employed and the required characteristics of the finished product (Bosnic *et al*., 2000).

Composite wastewater from a tannery is highly coloured and foul smelling. It is also alkaline with high amount of suspended and dissolved impurities. Among the most contaminated wastewater streams in the tanning process are the liming and tanning streams. Other streams are less contaminated when compared with liming and chrome tanning streams since these two streams contain the two major toxic chemicals: sodium sulphide and chromium salts. This means that wastewater from tanneries should not be discharged directly into public sewerage systems before treatment processes (Wiemann *et al.,* 1998).

The major pollutants in tannery wastewaters include: suspended solids, sulphates, sulphides, heavy metals, chlorides, organic matter, nitrates, nitrites, chrome and colorings.

MATERIALS AND METHODS

Study Area
The study was done in Nakuru Tanners Co. Ltd. Located in Nakuru region of Kenya.

Wastewater Sampling
The effluent samples were collected from four strategic sites in the tannery and the surrounding area. The first sampling point was the pre-tanning stage that is, the effluents released after all the soaking, liming and de-liming processes. A 500 mL sample was collected from this point and denoted S1 located immediately after the tanning process just before the screens.

The second sampling point of collection was the tanning stages that is, the effluents after the chrome and vegetable tanning. A 500 mL sample was collected from this point and denoted S2.

The third sampling point was the post-tanning/finishing stage just before the water is pumped to the river. A 500 mL sample was collected from this point and denoted S3.

The final sampling point was the public sewer where the wastewater is dumped. A 500 mL sample was collected from this point and denoted S4.

Containers of 500 mL were used for sampling. Samples were collected in autoclaved reagent glass bottles and immediately stored in ice before being transported to the laboratories of University of Eldoret.

After collection, the samples were transported to the chemistry laboratory of the University of Eldoret for refrigeration at 4 ^{o}C mainly to inhibit biological activity of samples.

BOD and DO Analysis
Since samples for BOD analysis may change greatly during handling and storage, testing was done within 48 hours after collection. Chlorine being a strong oxidizing agent, it inhibits the growth of living bacteria in the BOD test; hence samples were pretreated to remove chlorine before the BOD test was run. This was done by adding sodium sulphite to the samples. A 100 mL portion of each sample was pipetted into BOD bottles of 500 ml containing aerated dilution water. The DO content was determined and recorded and then the bottles were incubated in the dark for five days at 20 °C. At the end of five days, the final DO contents were determined and the difference between the final DO reading and the initial DO reading were calculated for each sample. The decrease in DO reading for each sample was collected for sample dilution, and the difference represents the BOD of the sample.

For each test bottle meeting the 2.0 mg/L minimum DO depletion and the 1.0 mg/L residual DO, BOD was calculated as following the standard formula of APHA (1995).

COD Analysis
In this case, the samples, standards, and blanks were heated at 150 ^{0}C in a closed reactor for two hours in the presence of acid dichromate solution. The samples were oxidized by digesting in sealed reaction tubes with sulphuric acid and potassium dichromate in the presence of silver sulphate catalyst. The amount of dichromate reduced was proportional to the COD of each sample. A reagent blank was prepared prior to each batch of tubes in order to compensate for the oxygen demand of the reagent itself.

Over the range of the test, a series of colours from yellow through green to blue were produced. The colours were indicative of the COD of each sample and were measured using a photometer. The results were expressed as milligrams of oxygen consumed per Litre of each sample.

Determination of TSS

The filters were washed using distilled H_2O and dripped prior to the analysis. The pre-washed and prepped filters were weighed and the weight recorded. Each sample was slowly filtered to completion. After the completion of the filtration process, the filter papers were carefully removed from filtration apparatus using forceps and transferred to a glass weighing dish as a support and dried for 1 hour at 110 °C in drying oven.

After drying was complete in the oven, the filters were reweighed and the weights recorded. The TSS was calculated as follows:

$$TSS \left(\frac{mg}{L}\right) = \frac{(Residue + Filter)(mg) - Filter (mg)}{Sample\ filtered\ (mL)} \times 1000 \left(\frac{mL}{L}\right)$$

Determination of pH

pH of the individual samples were measured immediately after collection. The determination of the pH values of the samples was done using the pH meter by following the standard procedure.

Measurement of temperature of samples at collection points

The temperatures of the surface waters at the sampling points were measured by using the conventional mercury thermometer by dipping the thermometer for about a minute. The temperatures were then recorded appropriately.

Determination of turbidity

Turbidity level of each of the four samples was determined using turbidometer tube. In this case, each wastewater sample was stirred thoroughly in order to disperse the solids and to eliminate any trapped air bubbles. Each sample was then poured into the turbidometer tube and turbidity read directly from the instrument scale and recorded appropriately.

Determination of total phosphorus

This was done using a UV-Vis spectrometer. In this case, 50 mL of each sample was transferred into a clean Erlenmeyer flask and 1 mL of conc. sulphuric acid added.

A 0.40 g ammonium per sulphate was added and then the mixture was boiled gently until a final volume of about 10 mL was reached. The mixture was then cooled and diluted approximately to 40 mL then filtered. The total phosphorus in each sample was then determined by measuring the absorbance at 650 nm with flame atomic absorption spectrophotometer model and then determining the phosphorus concentration from the standard curve.

Determination of total Chromium (Cr)

A 100 mL portion of each sample was taken, filtered through Whatman 42 filter paper and then acidified with concentrated HNO_3 to bring down the pH up to 2.0. A 100 mL of sample was taken and 5 ml concentrated HNO_3 added. The mixture was digested in a closed chamber for 30 minutes then the volume made up to 100 mL with distilled water.

The Cr (VI) concentrations in samples were determined colorimetrically by using flame atomic absorption spectrophotometer at 540 nm by diphenylcarbazide (DPC) method.

Determination of total sulphates

This was done by acidifying a 10 mL portion of each sample with HCl and then $BaSO_4$ added to the sample in order to precipitate sulphates as BaCl. After a period of digestion, the precipitate was filtered

off and washed thoroughly with water in order to remove all the chlorides. The precipitate was then ignited and weighed as $BaSO_4$. The amount of sulphate was then easily calculated using the equation:

$$\frac{mg}{L}(SO_4^{2-}) = \frac{mg\ BaSO_4\ x\ 411.5}{mL\ of\ the\ sample}$$

Determination of Pb

A 10 mL portion of each sample was taken, filtered through Whatman 42 filter paper and then acidified with concentrated HNO_3 to bring down the pH up to 2.0. A 5 mL of conc. HNO_3 were added to 100 mL of each sample and then the mixture digested in a closed chamber for 30 minutes after which the solution was made up to 100 mL with distilled water. Digested samples were analyzed for Pb concentrations by flame atomic absorption spectrophotometer.

Determination of Fe

10 mL portion of each sample was taken, filtered through Whatman 42 filter paper and then acidified with concentrated HNO_3 to bring down the pH up to 2.0. Approximately 5 mL of conc. HNO_3 was added to 100 mL of each sample and then the mixture digested in a closed chamber for 30 minutes after which the solution was made up to 100 mL with distilled water.

Flame atomic absorption spectrometer equipped with hollow cathode lamps was used for the determination of Fe in the four waste water samples. The photometric measurements were carried out at a wavelength of 510 nm.

## RESULTS AND DISCUSSION

Clour and Odour

The effluent released from Nakuru tannery industry was brown in colour and had an offensive odour. The colour of this effluent could be due to the presence of biodegradable and non-biodegradable high molecular weight organic compounds and high amount of chemicals used during the processing while the odour could be due to the processing of skin and hides by soaking and liming. The yellowish brown colour could be hindering the penetration of sunlight causing depletion in the rate of oxidation process.

Electrical Conductivity

The high electrical conductivity average value (14,640 μScm^{-2}) (Table 4.1) of the effluent indicates that the discharge of chemicals as cations and anions were higher in the wastewater. The higher conductivity alters the chelating properties of water bodies. Therefore creating an imbalance of free metal availability for flora and fauna recorded that the electrical conductivity, pH, sulphides, BOD, and COD recorded in tannery effluent were much higher than the tolerance limits for industrial effluent discharged into land surface.

pH

pH of the four different samples greatly varied. Each section of the tannery plant had different pH values. Minimum pH was, however, recorded in chrome tanning section (pH 3.70) while liming section was having maximum pH (pH 11.0). Figure 1 is a bar graph which represents the differences in pH between the four main sampling points of the three sets of samples
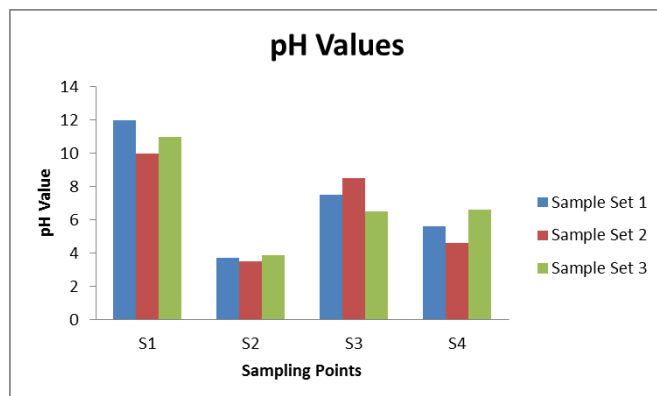
Figure 1: pH variations in the four main sampling points of the three sets of samples

This variation in pH cold be attributed to different kinds of acidic or basic salts which are used in respective sections of leather tanning. The pH of the effluents from the pre-tanning/preparatory process was 11.0 (Table 1), which is highly alkaline. This and liming section/step utilize $CaCO_3$, Na_2S and $NaHS$ which are basic in nature hence cause an increase in the pH of the effluent in this section. The pH of chrome tanning sections was in the range of 3.7, which is not surprising since it uses $NaCl$, H_2SO_4, formic acid and salts of Cr-III and Cr-VI.

At the final stage, the pH of the effluents was found to be 7.5 mainly because effluents from different sections (pre-tanning and the tanning stages) are mixed up thus the pH of the main effluent samples was found to be within the desirable limits. This pH value could also be attributed to the neutralization of the effluents which takes place in this stage.

The heavy metals studied were found to vary in concentration with pH. A lower pH increases the competition between metal and hydrogen ions for binding sites. A decrease in pH may also dissolve metal-carbonate, and metal sulphate complexes, releasing free metal ions into the water column (Connell and Miller, 1984). This implies that as pH of the effluent increases the concentration of the various heavy metals increases and vice versa.

Temperature

The temperature of the effluent is very important with regard to the chemical reactions, biological life and sludge treatment. The average effluent temperature did not, however, fall below 21°C. Thus, the tannery does not cause havoc as far as the environment is concerned.

Table 1, it is evident that the effluent temperatures significantly differed and were below the maximum permissible limits of 30 °C set by NEMA at point source (Table 2). High temperature raises the metabolic rate of surviving fish and microorganisms, leading to increased oxygen consumption and oxygen is less soluble at higher temperature. High temperature outside the optimum range for a prolonged period causes organisms to undergo stress and die. Sampling point 1 significantly differs from the rest since the temperatures were within the maximum permissible limit of 30 °C set by NEMA (Table 2).

Suspended Solids

Suspended solids include salt from raw skin / hide dusting; raw skin /hide trimmings; hair from the liming / dehairing process, which may contain lime and sulphides; and fleshing from raw skins /hides. Other solid wastes include wet-blue shavings, which contain chromium oxide (Cr_2O_3); wet-blue trimming,

which is generated from finishing processes and contains chromium oxide, syntans and dye; and buffing dust, which also contains chromium oxide, syntans, and dye.

Total Suspended Solids (TSS)

Maximum limit of TSS allowed in liquid industrial effluents is 100 - 150 mg/L (Table 4.5). However, in this study most of the effluents examined were having the values greater than the permissible limits. Amount of total solids in pre-tanning section (S1) was 294.4 mg L^{-1} (Table 4.1) mainly due to the fact that in this section, protein, hairs, skin and emulsified fats are removed from the hides. Therefore these components result in the increased weight of total solids in this section.

The amount of total solids in tanning section (S2) was 224.60 mg L^{-1} (Table 1). This is mainly due to the extra suspended solids which result from the tanning and vegetable tanning especially the tannins which are difficult to break down. These cannot be removed easily and are intensively coloured, causing a non-toxic but highly non-degradable pollution load. The amount of total solids in final neutralization section (S3) was 158.25 mg $L^{-}1$ (Table 1) which though lower, is still higher than the maximum permissible limits. This could be attributed to the thorough sieving of the effluents which is practiced before the effluents are released into the sewage system. At the dumping site (S4), however, the value rose a bit to 214.30 mg/L and this upsurge could be attributed to the additional satiable solids already in the river where these effluents are dumped directly.

Trivalent Chromium (Cr III)

Trivalent chromium salts (Cr III) are among the most commonly used tanning agents, accounting for the majority (approx. 75%) of the Cr in the wastewater stream. The remainder is typically generated from post-tanning wet processes, stock drainage, and wringing. The reducing characteristics of tannery sludge serve to stabilize Cr (III) with respect to hexavalent Cr (Cr VI) content, as a result of the presence of organic matter and sulphide (Szpyrkowiez *et al.*, 1991).

There was a variation of results in Nakuru Tanners for Cr which was 680.00, 700.00, 945.00 and 0.00 mg/L (Table 1) which seemed, however, higher compared to those from effluents of six different leather industries of Bara and Parsa districts (Nepal) whose amounts of this elements present in the effluents industries and water of Sirsiya River were found to vary between 0.12-345.00 mg/L. This could be due to the time of sampling and the type of treatment the effluent undergoes which are poor and thus pose a hazard to the environment. Where the sampling was done immediately after the tanning process, has shown maximum concentration of chromium (Szpyrkowiez *et al.*, 1991).

Chromium and Sulphide are among the most hazardous effluents of the tanneries (Song *et al.*, 2004). The use of excessive amount of these chemicals in tanning process gives rise to their high concentrations in the effluents. It has been reported that approximately one half of the sulphides used in tannery appear in the plant wastewaters. Chromium has been declared a carcinogen by the US EPA (FAO, 2001). The recommended limit for maximum amount of Cr in the tannery effluent is 1.0 mg L^{-1}. For Cr analysis, samples taken directly from the tanning section showed extremely high values of Cr (945 mg/L) (Table 1).

The concentration of Cr in the sample of the pre-tanning section (S1) was (0.00 mg/L) (Table 1). This value could be attributed to the concentration of Cr in the pre-tanning section which is extremely low, far below detectable limits. Thus Cr concentration was not detected due to extremely low concentration or total absence. Studies from   The sample taken from the effluent from the final/finishing section S4 showed Cr values of 700 mg/L (Table 4.1) which is much lower than the tanning sections S2 (945 mg/L) but even then higher than the permissible concentrations. These high concentrations of chromium in all the tanneries could probably be due to the chromium salt (chromium sulphate salt) used for tanning.

At the dumping site (S4) right within the company before disposal to Gioto dumpsite, the level of Cr dropped a bit to 680 mg/L (Table 4.1). This could be attributed to complexation and coagulation of some of Cr by chelating agents in the river water leading to a slight decrease in the levels of detectable Cr (Stepniewska *et al*., 2004).

Chemical Oxygen Demand (COD)

COD is the amount of oxygen required for the oxidation of organic matter present in the effluent samples. In this study, it was found that samples collected from the tanning site showed highest value for COD (9,107 mg/L) (Table 1). This could mainly be due to the fact that in vegetable tanning, different kinds of plant materials which produce tannins are used along with some other chemicals. Tannins are mixtures of different kinds of glucosides of various phenols. Their action is to combine with and between the collagen fibres of the skin. Use of this organic matter results in the increased COD (Kurt *et al*., 2007).
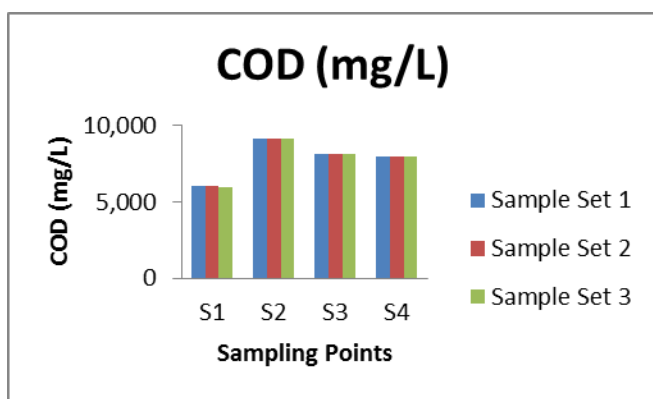
Figure 2: COD variations in the four different sampling points in the three sets of samples.

The finishing section had (S4) low COD (8,145 mg/L) (Figure 2) possibly due to the use of neutral salts added up for the washing of the chrome from tanned hides. Effluents of this section had low concentration of chemically oxidizable materials and which justifies the low COD results.

The COD level of the sample from the pre-tanning (S1) section was, however, 6000 mg/L (Table 1). This could be because effluents of this section had low concentration of chemically oxidizable materials and is justified by the low COD results.

The permissible limits for COD set by NEMA is 250 mg L^{-1} (Table 2). The COD values for all the samples were far above the recommended standards even at the dumping site (S4) where the COD values were found to be 7,930 mg/L (table 2).

Biochemical Oxygen Demand (BOD)

BOD is the amount of oxygen required for the biodegradation of organic matter. It is almost directly proportional to the COD values but always less than COD. BOD is the parameter, which is widely used to determine the pollution load of wastewater.

The average BOD of tannery effluent was found to be 6555 mg /L (figure 4.6), which was higher than that of the NEMA and WHO limits (100 - 300 mg/L) (Table 4.5). The BOD value of each sample was approximately equal to the COD value for the same reasons.

BOD (mg/L)
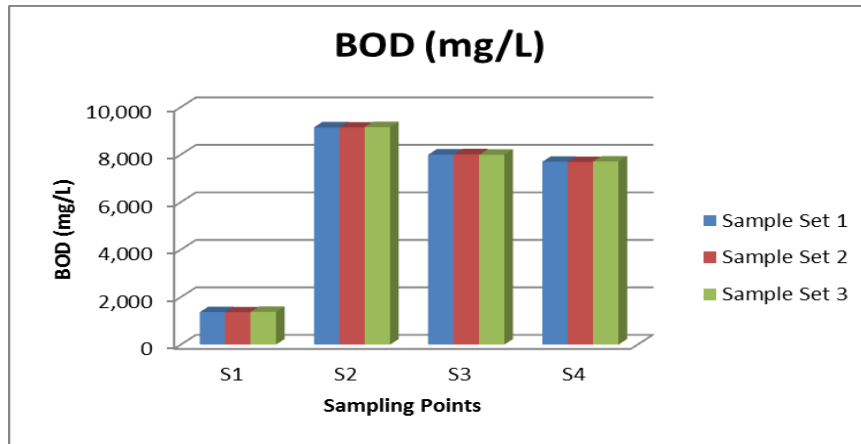
Figure 3: Differences in BOD in four sampling points of the three sets of samples

Sulphate Levels

Sulphate levels in all the samples studied varied from 212.50 to 318.50 mg L^{-1}(Table 1). The high values for this pollutant could be attributed to the fact that sulphates are compounds of tannery effluent emanating from the use of sulphuric acid or products with high sodium sulphate content. These high concentrations of sulphate in all the samples could also be due to many auxiliary chemicals used containing sodium sulphate as a by-product of the manufacturer or chrome tanning powders containing high levels of sodium sulphate.

Nitrates and Nitrites

The nitrate levels in all the effluents studied varied between 39.40 to 83.30 mg L^{-1} within the four points sampled. These high levels of nitrate could be as a result of several components in tannery effluent containing nitrogen as part of the chemical structure and the nitrogen contained in proteinaceous material (from liming unhairy operation).
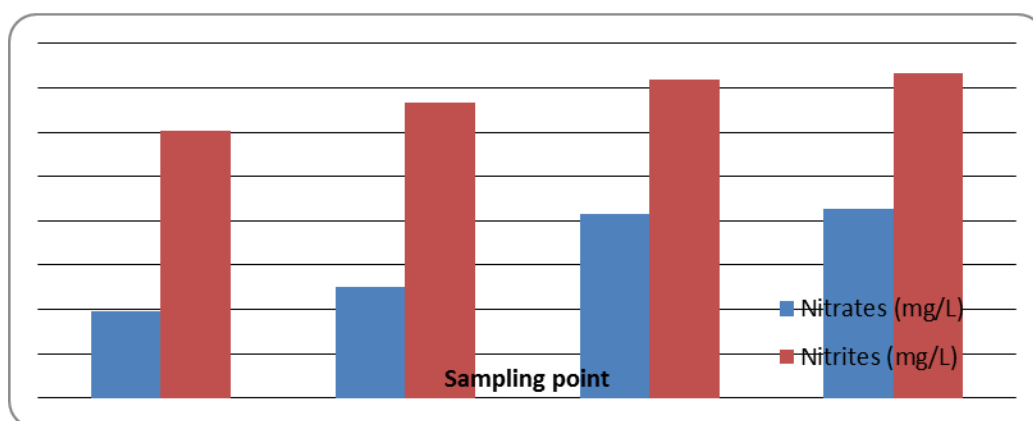
Figure 4. 1: Variations in nitrates and nitrites in the four sampling points

National and international bodies regulate the nitrate content in industrial effluent. NEMA set limit of 20 mg L^{-1} and the WHO limit of 6 mg L^{-1} (Table 2) nitrate levels are safe limits for babies. The samples from this effluent exceed these limits. Thus, nitrate concentration is considered to pose a problem for the domestic use of water from these rivers in which these effluents are deposited into.

The average nitrite level for all the four samples was 132.44 mg/L, a value lower than the mean concentration of nitrate but higher than the concentration limits stipulated by WHO and NEMA (Table 2). Bacteria quickly converts Nitrite (NO_2^-) to other more stable nitrogen ions and therefore, nitrate measurements typically represent the cumulative nitrate and nitrite concentrations (Szpyrkowicz *et al.*, 1991).The low nitrite level indicates that the tannery wastewaters had high bacteria levels meaning highly polluted with organic matter.

Lead (Pb), Phosphorus (P) and Iron (Fe)

The average concentrations of Pb, P and Fe in the effluent were 5.13 mg/L, 10.88 mg/L and 4.25 mg/L, respectively (Table 1). All these elements were present in higher concentrations compared to the prescribed limits of WHO and NEMA. The tannery wastewater is contaminated with high levels of these pollutants. Irrigation using such contaminated water pollutes the soil, vegetables and crops, which when consumed cause serious health hazards. The presence of Pb and other heavy metals in the environment has become a major threat to plant, animal and human life due to their toxic effect and therefore must be removed from industrial effluent before discharge.
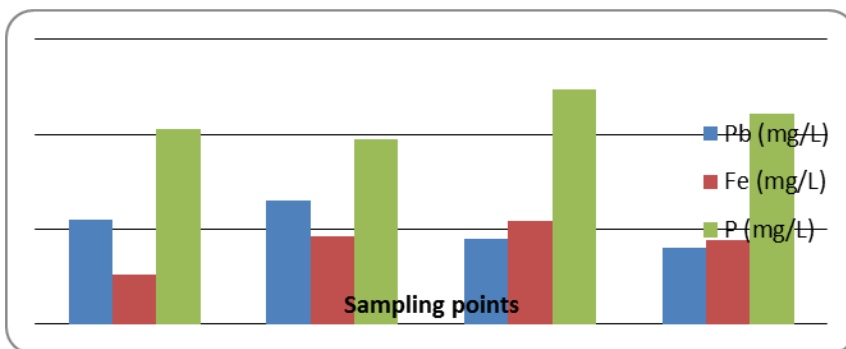

Figure 5: Comparison of the concentration of P, Fe, and Pb in four samples

Dissolved Oxygen (DO)

Hydrolysis of acidic material used in the tannery causes a decrease of water pH values. These acidic conditions cause the DO values to drop drastically in wastewater. Once deposited in rivers, the low DO level could result in the non-maintenance of conditions favourable to the gill-breathing aquatic organisms and increase the sensitivity of fish to chemicals.

There is an inverse linear correlation between TSS and DO levels and therefore, high TSS values always correspond to low DO level. In this study, the average DO level was 0.87 mg/L (Figure 4.12). Such occurrences could be possible due to the presence of high concentration of TSS and turbidity from suspended solids that reduce water clarity; cloudy water absorbs more heat and blocks light penetrations. Therefore, increased turbidity increases water temperature and prevents photosynthesis which in turn reduces the concentration of DO since warm water holds less DO than cold water.

From Figure 4.10, it is evident that there was a general increase in DO values from sampling points S1-S4 possibly due to treatment of the effluent by the tannery. This trend in the graph could be attributed to the biological degradation and complexation of the effluent over time (Mumford, 2010).
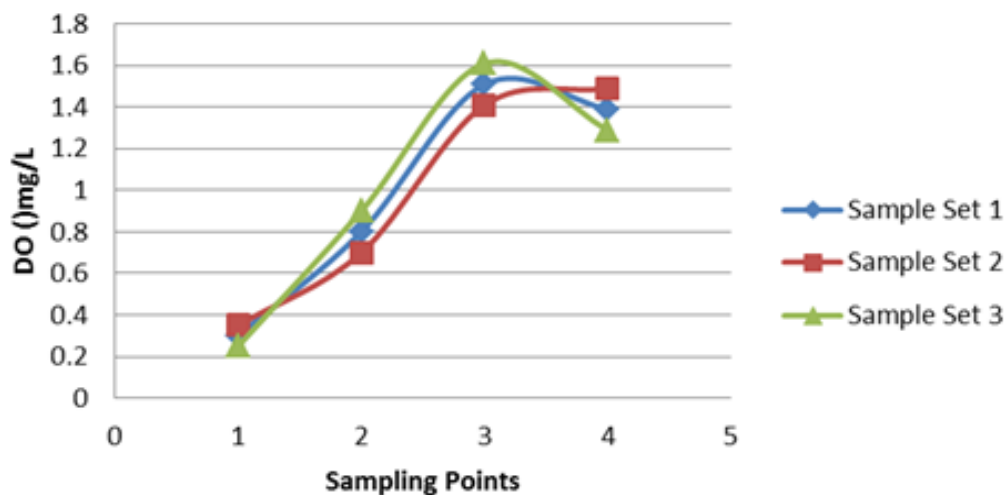
Figure 6: Variations of the DO in the four sampling points of the three sets of samples

Conclusion

The levels determined from samples prior to treatment clearly establish the fact that they are all well above the permissible limit as outlined by WHO and NEMA and no general trend was observed thus hazardous to the environment.

From the obtained results, it is clear that even though the NEMA and other international environmental regulators for the tanning industry are equally stringent, the pollution load coming from the tanneries is still heavy, and it is a problem both for the people living nearby, and for the river and ground water.

Most tanneries in the developing countries do not use conventional systems for treatment of the mixture of all production effluents. This is mainly because of the high cost of the treatment facilities thus no effective treatment is undertaken. Such a calamitous approach makes it impossible to meet environmental regulations.

The process modifications suggested by various groups have indicated that these values can be significantly brought down to decrease the pollution load on the treatment plant. To prevent pollution risks for waters and soils, proper effluent collecting and treatment systems must be established in the tannery fields as initial precaution.

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Table 1: Averaged results obtained from the analysis of all the three set of samples from Nakuru tannery

Sample	Ph	Temp (^{0}C)	DO (mg/L)	COD (mg/L)	BOD (mg/L)	TSS (mg/L)	SO_4^{2-} (mg/L)	Cr (mg/L)	Pb (mg/L)	Fe (mg/L)	NO_3^- (mg/L)	NO_2^- (mg/L)	P (mg/L)	EC (μScm^{-2})
S1	11	24	0.3	6,000	1,369	294.4	318.5	0	5.5	2.6	39.4	120.44	10.29	14550
S2	3.7	22.1	0.8	9,107	9,150	224.6	267	945	6.5	4.6	50	133.35	9.71	14670
S3	7.5	24.62	1.51	8,145	8,000	158.25	214.5	700	4.5	5.4	83.3	143.53	12.4	14720
S4	5.6	22.8	1.39	7,930	7,700	214.3	212.1	680	4	4.4	85.2	146.7	11.1	14620

Table 2: Maximum NEMA and WHO permissible values in waste water

PARAMETER	WHO	NEMA
pH	5.5 – 8.5	5.5 – 9.0
Temperature (^{0}C)	40	20 – 35
TSS (mg/L)	150	100
Electrical Conductivity (μScm^{-2})	400	400
Turbidity (NTU)	350	300
Pb (mg/L)	0.05	0.1
NO_3^- (mg/L)	100	100
BOD (mg/L)	100 – 300	100 – 300
Fe (mg/L)	300	300
COD (mg/L)	260	250
BOD (mg/L)	350	360
NO_2^- (mg/L)	50	50
TDS (mg/L)	600	500
SO_4^{2-} and S^{2-} (mg/L)	15	18
Cr mg/L	0.5	0.05
Phosphate (PO_4) mg/L	30	30

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