Online ISSN: 2249-4626
Print ISSN: 0975-5896

Global Journal

of Science Frontier Research: D

Agriculture and Veterinary

Plant Maturity Stage

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Discovering Thoughts, Inventing Future

VOLUME 13 ISSUE 13 VERSION 1.0

Global Journal of Science Frontier Research: D
Agriculture & Veterinary

Global Journal of Science Frontier Research: D
Agriculture & Veterinary
Volume 13 Issue 13 (Ver. 1.0)

Open Association of Research Society

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USA Tax ID: 98-0673427

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Contents of the Volume

Global Journal of Science Frontier Research
Agriculture and Veterinary
Volume 13 Issue 13 Version 1.0 Year 2013
Type : Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4626 & Print ISSN: 0975-5896

Fodder Productivity of *Flemingia Macrophylla* under Different Planting Density, Defoliation Management and Fertilizer Application

By R. P. Ghimire, K. P. Kayastha, N. R. Devkota & M. R. Tiwari
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Abstract- Flemingia macrophylla (Willd) Merril is a perennial leguminous shrub with higher potential of fodder use. The objective of the study was to identify its appropriate planting density, defoliation management, and fertilizer doses to the mature stands. The planting density experiment consisted of five treatments of different planting densities (15873, 18518, 22222, 27777 and 37037 plants ha-1) with four replications in a Randomized Complete Block Design (RCBD). Similarly, the defoliation management experiment was conducted in a 2x3 factorial combination using RCBD. The combinations of different levels of two factors; defoliation frequency (8 and 12 weeks interval) and defoliation intensity (0.25, 0.50 and 0.75 m defoliation height above the ground level), were used as treatments and replicated five times. Subsequent experiment was conducted on the three-year old mature stands of F. macrophylla for testing the treatments of five graded levels of phosphorus (P), viz. 0, 10, 30, 50 and 70 kg ha-1. Each level of P was combined with 30 kg N ha-1. The experiment was conducted in RCBD with four replications.

Keywords: biomass, defoliation height, defoliation interval, planting density, digestibility.

GJSFR-D Classification : FOR Code: 070101

Strictly as per the compliance and regulations of :

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R. P. Ghimire [α], K. P. Kayastha [σ], N. R. Devkota [ρ] & M. R. Tiwari [ω]

Abstract- Flemingia macrophylla (Willd) Merril is a perennial leguminous shrub with higher potential of fodder use. The objective of the study was to identify its appropriate planting density, defoliation management, and fertilizer doses to the mature stands. The planting density experiment consisted of five treatments of different planting densities (15873, 18518, 22222, 27777 and 37037 plants ha^{-1}) with four replications in a Randomized Complete Block Design (RCBD). Similarly, the defoliation management experiment was conducted in a 2x3 factorial combination using RCBD. The combinations of different levels of two factors; defoliation frequency (8 and 12 weeks interval) and defoliation intensity (0.25, 0.50 and 0.75 m defoliation height above the ground level), were used as treatments and replicated five times. Subsequent experiment was conducted on the three-year old mature stands of F. macrophylla for testing the treatments of five graded levels of phosphorus (P), viz. 0, 10, 30, 50 and 70 kg ha^{-1}. Each level of P was combined with 30 kg N ha^{-1}. The experiment was conducted in RCBD with four replications. The results of the planting density experiment revealed that the F. macrophylla yielded highest fodder dry matter (DM) at very low plant density ($p<0.001$), without affecting nutrient composition ($p>0.05$). Likely, the results of the defoliation management experiment showed that higher fodder DM was obtained from the treatment of 12 weeks defoliation interval. The fodder DM was found higher while the defoliation was done in 0.75 m from the ground level. The interaction effects of defoliation intervals and defoliation heights were similar ($p>0.05$). The results from the P fertilization experiment had revealed that the fertilization by 50 kg P ha^{-1} with 30 kg N had significantly higher ($p<0.001$) fodder DM than lower levels of P application, whereas fertilization of different levels of P had similar nutrient composition on the fodder. The results of these experiments suggested that F. macrophylla could produce higher biomass at low level of planting density (15873 plants ha^{-1}); with delayed defoliation interval of 12 weeks maintaining 0.75 m defoliation height. Likewise, the fodder yield of mature stands of F. macrophylla could be substantially increased by the fertilization with 50 kg P and 30 kg nitrogen per hectare. The information could be used for the preparation of cultivation practices of F. macrophylla to increase the fodder productivity.

Keywords: biomass, defoliation height, defoliation interval, planting density, digestibility.

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I. Introduction

Ruminant livestock production systems in many of the Asian and African countries rely on the green fodders. Feed deficit, especially the green fodders, is the foremost problem of ruminant livestock enterprises in those countries (Younas and Yahoob, 2005; Upreti and Shrestha, 2006; Pariyar *et al.*, 2013). To tackle with this situation, it has thus been necessary to promote possible shrubs, trees and herbs which may produce larger biomass of quality fodders (Yadav and Devkota, 2005).

Flemingia macrophylla (Willd.) Merrill is a multipurpose perennial leguminous shrub that can supply fodders all the year round. It is a woody deep rooting shrub naturally distributed in Southeast Asia, Southern China, Taiwan, India and Sri Lanka in the sub-humid to humid. It is relatively high yielding legume fodder with high calcium and protein content (Dzowela *et al*., 1995). Where adopted and once established, the species grows very vigorously (Singh, 2000) and has an excellent coppicing capacity and re-growth after cutting. When cut, the plant forms a tussock by producing numerous shoots from buds at the lower part of the stem near the base (FFTC, 2004). *F. macrophylla* is receiving the significant attention as a fodder in recent years due to its higher biomass productivity (Kharel, 2000) and better fodder quality (Sharma, 2006; Chaudhari, 2007). But, the information on appropriate cultivation practices, especially planting density, defoliation management and fertilization to mature stands are scanty. Therefore, the experiments were conducted during 2003/04 to 2006/07 at Rampur, Chitwan, Nepal with the objectives of investigation in appropriate cultivation practices of *F. macrophylla*.

II. Materials and Methods

The experiments were carried out on upland site of Rampur, Chitwan district, Nepal at 27°40' N, 84°19' E and 228 masl. The soil was sandy loam, fairly well drained with medium fertility having 5.4 pH. The maximum temperature on the experimental site was ranged from 24.34°C (December) to 36.04°C (May) and minimum temperature was from 7.8°C (January) to 26.2°C (July). Likely, the annual rainfall varied from

2105.8 to 2468.5 mm during the experimental years with higher precipitation in June to September.

A couple of experiments were carried out from 2010 to 2012. Planting density experiment was conducted by using Randomized Complete Block Design (RCBD) with five treatments and three replications. Five different planting densities; 15873, 18518, 22222, 27777 and 37037 plants ha^{-1}, were used as treatments. Constant row to row (RR) of 0.9 m distance were maintained for every treatment and plant to plant (PP) distance was varied. The treatments were: very low plant density (0.9×0.7 m^2), quite low plant density (0.9×0.6 m^2), normal plant density (0.9×0.5 m^2), high plant density (0.9×0.4 m^2), and very high plant density (0.9×0.3 m^2) . The plot size was 37.80 m^2 and the numbers of plants were adjusted for different densities. The nutrient content of the soil was 2.83% organic matter, 0.15% nitrogen (N), 43.7 kg ha^{-1} P and 183.4 kg ha^{-1} potash (K). Three months old saplings, which were raised in the polythene pots, were transplanted. The saplings were 20 to 25 cm in height and three to six leaf-stage with thin-stem. The fodder was harvested at the height of 50 cm above ground level. Three harvestings were monitored during the study and their cumulative DM production was calculated.

The subsequent experiment on defoliation management was conducted by using RCBD in 2×3 factorial arrangements, with five replications. The treatment combinations of two levels of defoliation frequency (8 and 12 weeks defoliation interval), and three levels of defoliation intensity (defoliation height of 0.25, 0.50, and 0.75 m from the ground level) were used for the study. The plot size was 7.56 m^2 $plot^{-1}$ and each plot consists of 12 plants. The RR and PP distances were maintained 0.90 m and 0.70 m, respectively. The fresh green fodder mass were monitored in three harvestings and cumulative DM yield was calculated.

Phosphorus fertilization experiment was conducted during June 2010 to January 2012 to assess the effect of different levels of P fertilization on the fodder yield of three-years-old mature stands of *F. macrophylla*. Five treatments of different graded P levels were compared with four replications in RCBD. The treatments (0, 10, 30, 50 and 70 kg P ha^{-1}) were used with uniform basal dose of N (30 kg ha^{-1}). The experiment was executed by maintaining the spacing of 0.90 m RR and 0.70 m PP. Before setting of the experiment, average number of branches of the three-year old mature stands of *F. macrophylla* was 17.33 $plant^{-1}$; average branch height was 1.21 m and average number of compound leaves $plant^{-1}$ was 305. The observations were taken by defoliating at 0.75 m height from the ground level at 12 weeks defoliation interval. Two harvests of fodders were monitored during the study and the cumulative DM yield was calculated.

a) Herbage Analysis

The nutrient analysis of green leaf samples were done in the laboratory of Animal Nutrition Division, Khumaltar, Lalitpur, Nepal and Animal Nutrition Laboratory, IAAS, Rampur, Chitwan, Nepal. Samples from each experiment were dried at 70°C for 24 hours and dry matter (DM) content calculated. The proximate constituents; crude protein (CP), ether extract (EE), crude fiber (CF), total ash (TA), nitrogen free extract (NFE) were determined according to the conventional method (AOAC, 1990). Estimation of neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL) (sulfuric acid lignin) was carried out according to the methods suggested by Van Soest *et al.* (1991).

b) Statistical Analyses

The data were analyzed by using analysis of Variance (ANOVA) for all of three experiments. The statistical analyses were carried out by using GenStat Discovery Edition (2011). The multiple comparisons among treatment means were performed by using Duncan's Multiple Range Test (DMRT).

III. Results and Discussion

a) Effect of planting density to fodder production

Dried fodder yields for the different planting density of *F. macrophylla* were significantly different ($p<0.001$). Plants under very low plant density had produced significantly higher fodder mass than other treatments ($p<0.001$), where as very high plant density produced lower fodder dry matter (Table 1). The fodder DM yield under quite low density, normal density and high density were statistically similar ($p>0.05$).

Table 1 : Effects of planting density on fodder yield of *F. macrophylla*

Treatments	Fodder yield (DM, t ha^{-1})
Very low density (0.9 × 0.7m^2)	4.46^a
Quite low density (0.9 × 0.6 m^2)	3.06^b
Normal density (0.9 × 0.5 m^2)	2.93^b
High density (0.9 × 0.4 m^2)	2.73^{bc}
Very high density (0.9 × 0.3 m^2)	2.26^c
S.E.	0.14

The mean within the same column with different superscripts differ significantly.

The Nutrient compositions of *F. macrophylla* fodder produced under different planting density are presented in Table 2. The proportions of CP, CF and TA were not significantly affected by the variation in planting densities ($p>0.05$). The CP, CF and TA contents of the fodders were ranged from 15.96 to 16.91%, 23.46 to 23.79% and 6.05 to 6.35%, respectively.

Table 2 : Effect of different planting density on nutrient composition of *F. macrophylla*, %

Treatments	Crude protein	Crude fibre	Total Ash
Very low density (0.9 × 0.7m^2)	16.91	23.62	6.34
Quite low density (0.9 × 0.6 m^2)	16.37	23.54	6.35
Normal density (0.9 × 0.5 m^2)	16.57	23.79	6.19
High density (0.9 × 0.4 m^2)	16.37	23.66	6.05
Very high density (0.9 × 0.3 m^2)	15.96	23.46	6.21
S.E.	0.26	0.89	0.14

b) Effect of defoliation frequency and defoliation intensity to fodder production

Both defoliation interval and defoliation height had significant effect ($P<0.001$) to the fodder yield of *F. macrophylla*, where as the interaction effects of defoliation intervals and defoliation height were obtained non significant ($p>0.05$).

The effect of defoliation interval was significant to the fodder DM yield ($p<0.001$). Accordingly, the fodder yield of *F. macrophylla* defoliated at 12 weeks interval was significantly higher ($p<0.001$) in comparison to the fodder defoliated at 8 weeks interval. Similarly, the plant defoliated at the 0.75 m height above the ground level had produced significantly higher fodder yield ($p<0.001$). The experimental plants defoliated at lowest regime (0.25 m above ground level) had yielded lowest fodder DM.

Table 3 : Effects of defoliation interval and defoliation height on the yield of *F. macrophylla*

Treatment	Fodder yield (DM, t ha^{-1})
Defoliation interval*	
8 weeks	4.42
12 weeks	9.46
S.E.	1.07
Defoliation height*	
0.25 m from the ground	4.84
0.50 m from the ground	6.55
0.75 m from the ground	9.80
S.E.	1.31

**The values are significantly different at $p<0.001$).*

c) Effect of different levels of phosphorus application to the mature stands

The dried fodder yield of *F. macrophylla* for different graded levels of P fertilization is presented in Table 4. The fodder DM yield was obtained higher for the treatments of 70 and 50 kg P ha^{-1} compared to lower levels of P fertilization ($p<0.001$). But, the fodder yield was statistically similar for those two higher levels of P fertilization ($p>0.05$), viz. 70 and 50 kg P ha^{-1}.

Table 4 : Effect of different levels of P fertilization on the fodder yield of *F. macrophylla*

Treatments	Fodder yield (DM, t ha^{-1})
0 kg P ha^{-1} and 30 kg N ha^{-1}	2.96^{b}
10 kg P ha^{-1} and 30 kg N ha^{-1}	3.40^{b}
30 kg P ha^{-1} and 30 kg N ha^{-1}	3.19^{b}
50 kg P ha^{-1} and 30 kg N ha^{-1}	4.91 ^{a}
70 kg P ha^{-1} and 30 kg N ha^{-1}	4.96^{a}
S.E.	0.423

The mean within the same column with different superscripts differ significantly.

d) Effect of different levels of P application on the nutrient composition of fodders

The effect of different levels of P fertilization to the nutrient composition of *F. macrophylla* is presented in Table 5. The nutrients; CP, NDF, ADF, calcium (Ca) and P, were statistically similar for all the treatments ($p>0.05$). Accordingly, mean CP content was ranged from 16.43% to 18.09 %. Likewise, the range of NDF and ADF portions were 61.91 to 65.46% and 58.95 to 63.51%, respectively. Similarly, the Ca and P contents were ranged from 1.03 to 1.22% and 0.25 to 0.29%, respectively.

Table 5 : Effect of different levels of P fertilization on the nutrient composition of fodders, %

Treatments	CP	NDF	ADF	Ca	P
0 kg P ha^{-1} and 30 kg N ha^{-1}	17.00	61.91	60.23	1.19	0.29
10 kg P ha^{-1} and 30 kg N ha^{-1}	17.26	63.14	61.05	1.17	0.25
30 kg P ha^{-1} and 30 kg N ha^{-1}	18.16	62.76	58.95	1.22	0.29
50 kg P ha^{-1} and 30 kg N ha^{-1}	18.41	63.08	60.06	1.18	0.28
70 kg P ha^{-1} and 30 kg N ha^{-1}	17.19	65.46	63.51	1.03	0.26
S.E.	1.74	3.29	3.23	0.24	0.05

IV. Discussion

Maximum fodder DM yield was obtained from very low plant density (15873 plants ha^{-1} from the spacing of 0.9 ×0.7 m^2) of *F. macrophylla.* In deed the cumulative fodder DM yield was consistently increased with lowering the planting density. In consistent with the findings of present study, Buddleman and Siregar (1997) reported that the RR distance of 0.90 m and PP distance of 0.60 m would be best and the most effective planting geometry for *F. macrophylla* to produce higher biomass production in Indonesia. Increasing planting density might have increased the interplant competition, which could negatively affect the different fodder attributing characters. The influences on plant stature and number of leaves $plant^{-1}$ due to competition for light, aeration and nutrients availability was obtained in another study performed in the case of intercropping of maize and cowpea (Ibrahim *et al.*, 2006). In the present study, the higher fodder yield of *F. macrophylla* under very low plant density could have been related to the lessen effect of competition for sunlight as well as water and soil mineral absorption.

The results of defoliation frequency and intensity showed that *F. macrophylla* responded well to the defoliation interval and defoliation height. Late cutting (12 weeks interval) produced comparatively higher fodder yield compared to early cutting (8 weeks interval) without affecting nutrient composition of the fodder. The results of other several studies on *Leucaena* agree with the findings of the present study. Longer cutting interval resulted larger branch size and higher fodder mass in the case of *Leucaena* (Goevarra *et al*., 1978) and had shown greater edible biomass production while defoliated at 12 weeks than defoliated in 6 weeks (Ella *et al*., 1989).

The result of the present study showed that fodder yield of *F. macrophylla* was obtained higher while defoliating at 0.75 m from the ground level compared to shorter heights indicating negative effects of shorter harvesting heights for fodder mass accumulation. Taller defoliation height improved the shoot development than lower heights (0.70 m vs. 0.30 m and 0.50 m) in another study in the case of *Gliricidia sepium,* a browse species (Asare, 1985). The similar results were found in the case of *Leucaena* too (Krishna Murthy and Munegowda, 1982; Isarasenee et al., 1984). The greater re-growth response of plants for higher defoliation height in the experiment might be due to the greater mass of active meristematic tissues (buds) leftover after defoliation, higher amount and photosynthetic capacity of residual leaf area and greater mobilization of available carbohydrates and other reserves from plant material which remains after defoliation. The factors perhaps favored better re-growth of the *F. macrophylla* as in the case of other legume fodder trees and shrubs as stated by Stur *et al*. (1998). The author reported that the lower cutting heights result reduced numbers of leaves, and prolonged lag phase before high growth phase, because new growth has to be supported initially by stored carbohydrate reserves.

a) Phosphorus fertilization and herbage mass production

The result of the present study revealed that the three-years old mature stands of *F. macrophylla* had acquired higher fodder yield under 50 kg P with 30 kg N ha^{-1}. Since the legumes are highly responsive to the P fertilization *(*Geethakumari, 1981; Jain *et al*., 1986), the response further increased for the mature stands of the perennial fodder legumes. Phosphorus is a vital nutrient for N fixation, root proliferation and growth in legumes (Singh and Thrivedi, 1981; Rajasree and Pillai, 2001). The application of P stimulates early vegetative growth of plant by increasing the rapid cell division, root formation and other physiological roles. Moreover, the application of P might have increased the uptake of other minerals, especially N as reported by Khatri-Chhetri (1991). Simultaneously, lower fodder yield in the case of control and lower P fertilization treatment (0, 10 and 30 kg P ha^{-1}) might have been related to the situation mentioned by Haque and Jutzi (1984) that the P deficiency in the soil that affected especially to the N fixation through its effect on root infection, nodule development and nodule function and plant growth. In deed the soil under the continuous cultivation of perennial legumes becomes P deficit hence a certain soil P level is required for the plant establishment (Andersson *et al*., 2002) and optimum growth (~50 kg P ha^{-1}; present study). Hence, the findings of present study suggest the need of moderate level of P fertilization which could be perhaps varied in amount and dose as per the inherent variation in plant uptake, characteristics to the plant type and soil condition and structure (Rajasree and Pillai, 2001).

In the present study, chemical composition of the *F. macrophylla* was altered neither by the planting density nor by the levels of P application. Planting of *F. macrophylla* with very low planting density and application of 50 kg P ha^{-1} with 30 kg N ha^{-1} may increase the herbage mass without any deterioration in the quality of the fodder. In addition, higher CP content (approximately 16%) of *F. macrophylla* indicates the potential of good quality fodder from this leguminous shrub. These evidences support the fact that *F. macrophylla* could be considered as good quality fodder.

V. Conclusion

The results of the experiments conducted in the present study revealed that low density planting (15873 plants ha^{-1}) by providing the spacing of 0.9 × 0.7 m^2 $plant^{-1}$, defoliation at 0.75 m height from the ground level in an interval of 12 weeks are the appropriate practices

for the cultivation of *F. macrophylla* fodder. The findings also revealed that yields of three-years old mature stands of *F. macrophylla* can be substantially increased by the application of 50 kg P with 30 kg N ha^{-1}. The information could be useful for the preparation of cultivation practices of *F. macrophylla* for the better fodder productivity. With the inclusion of these cultivation practices, it can be well expanded as a promising leguminous shrub, particularly to that of high humidity and dried areas of sub-tropical climate. It could contribute to mitigate the fodder deficit of farming communities as an alternative nutritious legume fodder for dry seasons with higher biomass yield.

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Global Journal of Science Frontier Research
Agriculture and Veterinary
Volume 13 Issue 13 Version 1.0 Year 2013
Type : Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4626 & Print ISSN: 0975-5896

Simulation of Runoff and Sediment Load for Reservior Sedimentation of River Ole Dam using *Swat* and *Wepp* Models

By Olotu Yahaya, Akanbi O. P, Ahanmisi E. & Adeniyi E. A
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Abstract- Reservoirs are considered as vital sources of water supply, provide hydroelectric power support, diverse aquatic habitat, and provide flood protection. Ole Dam is a hydraulic structure on the River Ole in Nigeria with 8.1 billion m3 storage capacity. The reduction of reservoir capacity of this dam has seriously complicated the water supply for potable and nonpotable applications. This reduction in the capacity is a result of sediment leaving into the reservoir of the dam through two tributaries. Simulation analysis using both hydrological and meteorological data around the site for 11-year (2000-2011) was subjected to iteration using WEPP and SWAT simulation models. The sediment load leaving into the reservoir is a function of rainfall depth, the gradient of reservoir site, soil formation and runoff generated. Maximum average sediment load value of 10.2*103ton/ha with rainfall depth of 75.4 mm and surface runoff of 34.2 mm were generally observed in month of September for the simulation period.

Keywords: *reservoir, sediment load, runoff, storage capacity, simulation, rainfall, river.*

GJSFR-D Classification : *FOR Code: 070199*

Strictly as per the compliance and regulations of :

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Olotu Yahaya [α], Akanbi O. P [σ], Ahanmisi E. [ρ] & Adeniyi E. A [ω]

Abstract- Reservoirs are considered as vital sources of water supply, provide hydroelectric power support, diverse aquatic habitat, and provide flood protection. Ole Dam is a hydraulic structure on the River Ole in Nigeria with 8.1 billion m^3 storage capacity. The reduction of reservoir capacity of this dam has seriously complicated the water supply for potable and non-potable applications. This reduction in the capacity is a result of sediment leaving into the reservoir of the dam through two tributaries. Simulation analysis using both hydrological and meteorological data around the site for 11-year (2000-2011) was subjected to iteration using WEPP and SWAT simulation models. The sediment load leaving into the reservoir is a function of rainfall depth, the gradient of reservoir site, soil formation and runoff generated. Maximum average sediment load value of $10.2*10^3$ton/ha with rainfall depth of 75.4 mm and surface runoff of 34.2 mm were generally observed in month of September for the simulation period. However, minimum observed sediment load of simulated and observed values of 3.1 $*10^3$ton/ha and $2.8*10^3$/ha through the tributaries to the reservoir was estimated in the month of March with the observed lowest rainfall depth of 19.7 mm and runoff depth of 2.5 mm respectively. This implies that significant sediment load entered the reservoir from these two considered tributaries. If the sediment load continues unchecked the reservoir is expected to silt up completed by the next 20-year starting from 2043. Increasing the life span of the hydraulic structures requires the construction of check dam across the two tributaries and ensures strong soil conservation measures around the reservoir site.

Keywords: reservoir, sediment load, runoff, storage capacity, simulation, rainfall, river.

I. Introduction

Runoff and sediment load analyses of the River Ole in Auchi basin have been a subject of considerable discussion. Runoff estimation is important for realistic assessment of soil erosion and also in planning irrigation activities, drinking water supply management strategies, etc. (Pielke, 1999; Sparovek *et al*., 2002). Also, the design of facilities and structures based on hydraulic engineering depends on accurate runoff estimation (Yanmaz & Coskun, 1995; McCuen & Okunola, 2002). As a result of runoff from rainfall or snowmelt, soil particles on the surface of a watershed can be eroded and transported through the processes of sheet, rill, and gully erosion. Onceeroded, sediment particles are transported through a river system and are eventually deposited in reservoirs, in lakes, or at sea. The surface runoff is mainly responsible for sediment detachment, its transport and deposition (Hergarten *et al*., 2000). Therefore, runoff plays a major role when analysed in the context of the soil erosion process, and it also has a significant importance by itself. Yang et al. (2002) analysed sediment discharge and suspended sediment concentration (SSC) of two hydrological stations (Datong and Yichang stations) from 1951 to 2000 to show the variations in river sediment supply to the delta.

Sediment deposition is a key factor reducing the life of dams around the world. This mechanism has significant effect on the reservoir capacity of the erected hydraulic structure due to the sedimentation process, which in thus leads to decrease and shortage of water supply for agricultural and non-agricultural applications to the surrounding communities. Studies have shown that 75% of reservoir capacity of dam built across River Ole has been silted up and if adequate measure is not put in place, this could reduce the life span of the hydraulic structure. Reservoirs around the world are losing on average about one percent of their storage capacity annually (WCD, 2000), causing serious problems for water and electricity supply, flood control but also for ecosystem development up-and downstream of large dams.

Sediment loss rate can be difficult to measure accurately, because they are highly variable spatially and influenced by many factors. Modelling is, therefore, a very useful tool for extrapolating available measurements and predicting sediment inputs to river systems under different conditions. Process-based mathematical models are becoming popular in predicting runoff, soil erosion and sediment yield for different climates with varying land-use and management practices. Reservoirs are expensive to build and their construction usually also entails high social and environmental costs. Having considered present and projected negative effects of reservoir

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sedimentation on water supply, destruction of aquatic life and degradation of other environmental issues, this research study therefore focuses on simulating the hydrologic processes such as rainfall, surface runoff, sediment transport, slope and soil formation around the study area. The expected outputs will be technically applied to creating realistic sediment load rate management and reduction processes.

II. Materials and Methods

a) Study Area

The studied area is located Central of Edo north at bank side Ole Dam reservoir as shown in plate 1. Runoff and sediment load entered into the reservoir from two main tributaries. The dam site is planted with both seasonal and perennial crops. The soil formation is mineral soil. The dam is 54.8 km north of Auchi.

Plate 1 : Area view of Reservoir side of Ole Dam

b) Hydrological Modelling

Hydrological data of annual runoff, rainfall and suspended sediment load of Idah stations along Ole River, and annual runoff and suspended sediment load from Idah station from tributaries A_p and A_x of Ole River basin were taken by *Edo Hydrological Discharge Station in collaboration with Meteorological Unit of Auchi Polytechnic, Auchi.* The most accurate method for determining the long-term sediment yield from a watershed is by direct measurement of sediment deposition in a reservoir (Blanton, 1982) or by direct measurement of streamflow, suspended sediment concentration, and bedload. Sediment concentrations were collected on a monthly basis and yields were determined using the relationship between runoff and sediment concentration. The density of the sediments was determined by combining the empirical relationships shown below:

$$\boldsymbol{Wt = Wo + 0.4343 * K * \left\{\frac{t}{t-1} * (lnt)\right\}} \quad (1)$$

Wt refers to the average bulk density of sediments after t years of operation, W_0 stands for the mean bulk density. K is the consolidation coefficient. Both the coefficients of unit weight and the consolidation coefficient per fraction are empirical and were reported by Lara and Pemberton (1995). The total mass of sediments present in the reservoir is now calculated by multiplication of the average density (Wt) and the volume of sediments present. The trap efficiency refers to the percentage of incoming sediments that is retained in the reservoir, and depends principally on the sediment characteristics, the stream flow velocity and the reservoir operation (Vanoni, 1977). Various empirical relations have been developed to estimate the trap efficiency. However, more technically-based relations are available, that requires some more input data (Verstraeten & Poesen, 2000).

$$\mathbf{TE = 100 * (1 - \frac{1}{(1+D*\frac{C}{A})})} \quad (2)$$

Based on the rainfall characteristics, surface runoff, soil formation and sediment transportability of the study area the trap efficiency in equation (2) is modified as follows:

$$\mathbf{TE = 100 * 2.33c * (1 - \frac{1}{(1+D*\frac{C}{A})})} \quad (3)$$

Where; TE, stands for trap efficiency (%), C for the capacity of the reservoir (m^3) and A for the drainage area of the basin (km^2). D is a constant between 0.09 and 2.1 and depends on the reservoir type. For the purpose of this research study, D is taken to 1.2; C is the proportionality factor for the site erodibility.

The modelled values of runoff and sediment yield were evaluated by visual inspection of the graphs

that plotted the range of observed and modelled values. To evaluate the model performance, the coefficient of determination (r^2) was determined from regression analysis between model-simulated and measured runoff and sediment yield. The Nash-Sutcliffe coefficient of efficiency (COE) was calculated as (Nash & Sutcliffe, 1970).

$$COE = 1 - \frac{(P-Q)}{(O-Om)} \quad (4)$$

Where *P* and *O* are the corresponding modelled and observed values, respectively. The reservoir life estimation was calculated as follows:

$$LDS = \frac{CDS}{SDR} \quad (5)$$

Where; LSD is the life of dead storage, CDS is the capacity of dead storage (Mm^3) and SDR is sedimentation deposition rate (Mm^3) respectively.

III. Results and Discussion

Daily meteorological variables such as rainfall data, maximum and minimum temperature, sunshine, humidity, and wind speed of Ole Dam station were considered for this research study for the period 2000 to 2011. Hydrological data such as runoff volume and intensity obtained with the use of automatic runoff meter. The obtained data were used to estimate the annual sediment load generated from the river tributary. WEPP and SWAT models were considered for the monthly and annually simulation of runoff and sediment load. Table 1 shows the output of SWAT validation on observed hydrological and meteorological variables. Average of eight months of moderate rainfall for 11-year was considered for simulation analysis. Highest average rainfall depth (75.4 mm) in the month of September which also generated maximum runoff depth of 34.2 mm corresponded with the maximum observed and simulated sediment load of $10.2*10^3$ ton/ha and $11.1*10^3$/ha respectively. However, minimum observed sediment load of simulated and observed values of 3.1 $*10^3$ton/ha and$2.8*10^3$/ha through the tributaries to the reservoir was estimated in the month of March with the observed lowest rainfall depth of 19.7 mm and runoff depth of 2.5 mm respectively.

Table 1 : SWAT validation for Observed and Simulated average Rainfall, Runoff and Sediment yield

N/S	Month	Observed RF(mm)	Simulated RF (mm)	Observed Ru(mm)	Simulated Ru (mm)	Observed Sl(*10^3ton/ha)	Simulated Sl(*10^3ton/ha)
1	March	19.7	18.3	2.5	2.9	2.8	3.1
2	April	28.2	29.2	5.2	5.1	3.2	3
3	May	39.5	37.2	10.1	8.7	4.4	4.5
4	June	45.8	42.8	12.2	13.4	4.6	4.4
5	July	62.5	66.9	24.6	27.3	6.7	6.2
6	August	40.6	37.2	15.3	14.7	4.9	4.5
7	Sept.	75.4	72.4	34.2	30.4	10.2	11.1
8	Oct.	41.5	40.1	14.2	13.7	4.6	4.3

Where;

RF = Rainfall (mm)

Ru = Runoff (mm)

Sl = Sediment load (ton/ha)

The coefficient of determination (R^2) between monthly modelled and measured rainfall, runoff and sediment yield were 0.94, 0.97 and 0.87 as shown in fig.1, 2 and 3 respectively. Computed *COE* of the model for monthly rainfall, runoff and sediment yield simulation were 0.81, 0.76; and 0.73, this shows a strong agreement with the simulation model.

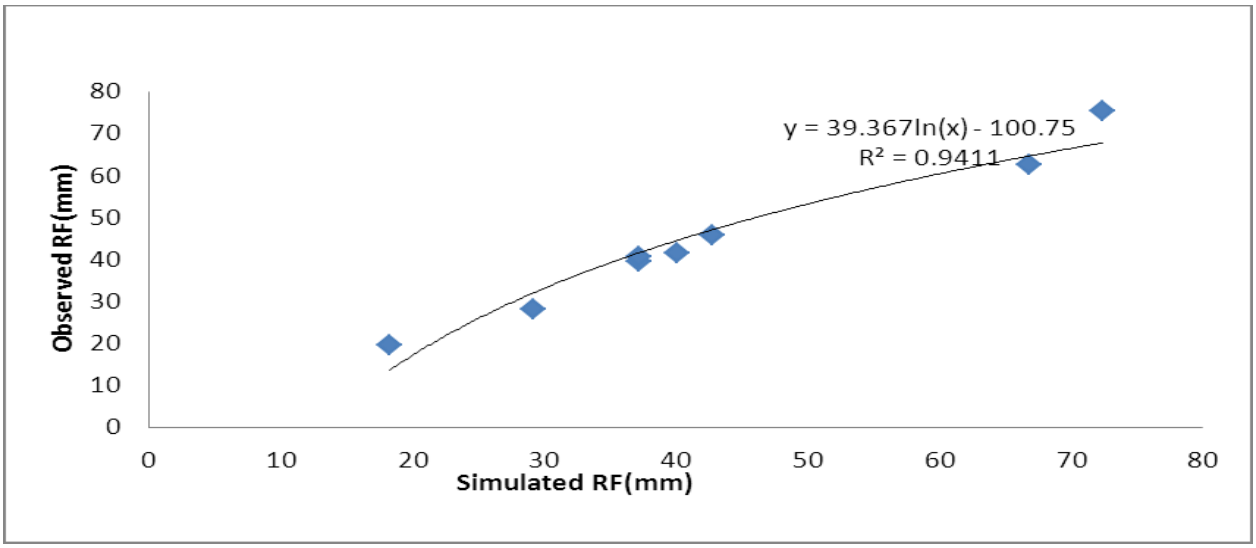


Fig. 1 : Rainfall simulation curve

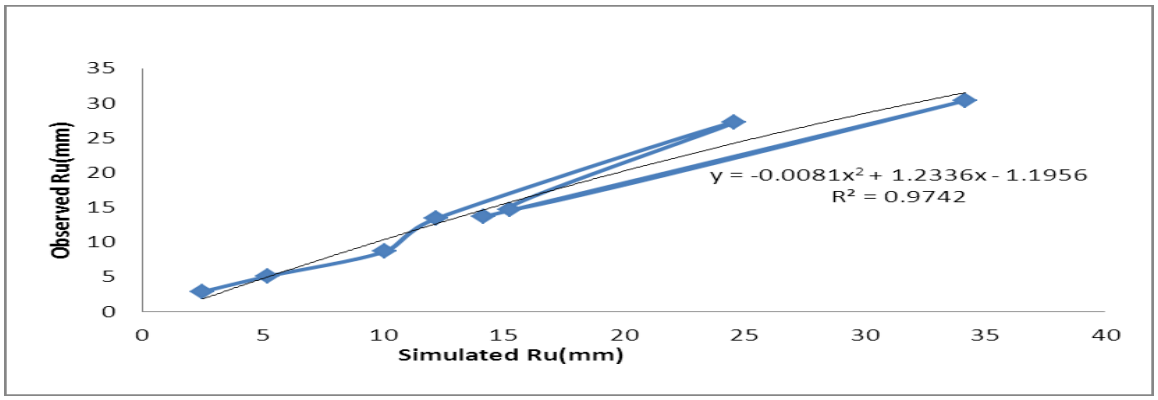


Fig. 2 : Runoff simulation curve

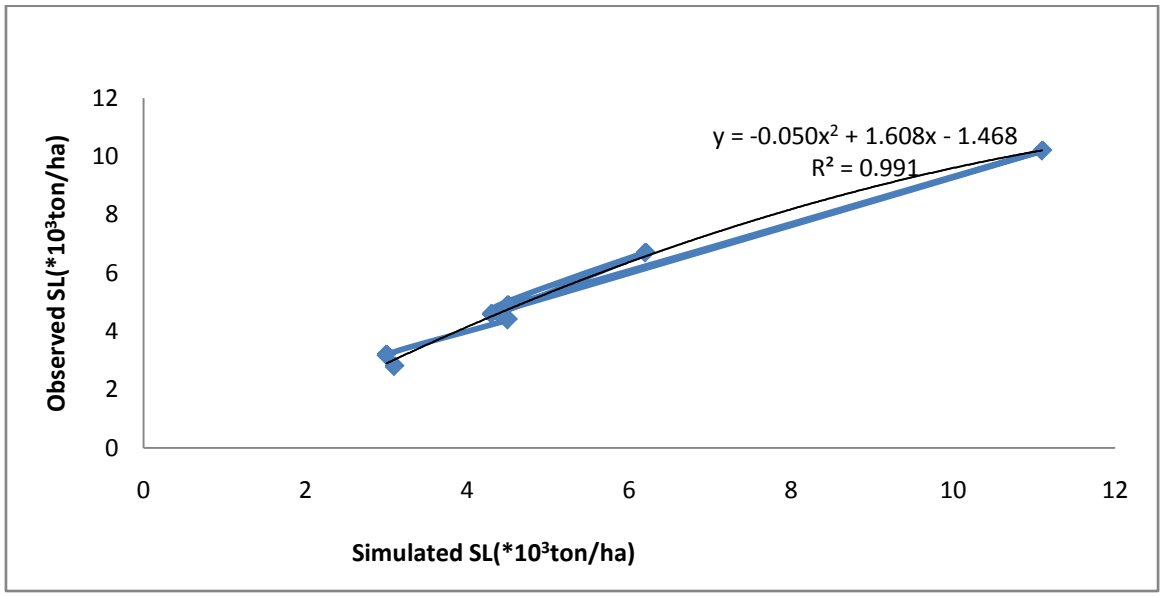


Fig. 3 : Sediment load simulation curve

The results of sediment load and runoff changes of Rive Ole station is shown in Fig. 4 and 5. It could be seen increasing from the month of March and reduced to in the month of August, October and June with the sediment load values of $4.9*10^3$ton/ha, $4.6*10^3$ton/ha and $4.6*10^3$ton/ha respectively. Again,

maximum sediment load and runoff depth of value 10.2 $*10^3$ ton/ha; 34.2 mm and 6.7 $*10^3$ ton/ha; 24.6 mm were generated in every month of September and July for all the 11-year of consideration. Usually, annual sediment load in most large river systems increases with annual precipitation and water discharge (Trenhaile, 1997), more water discharge will have more power to transport more sediment, and therefore a good correlation should be held between annual sediment load and runoff. Sensitive analysis outcomes indicated that the values of the simulated sediment yield matched the measured values for the whole simulation period reasonably well.

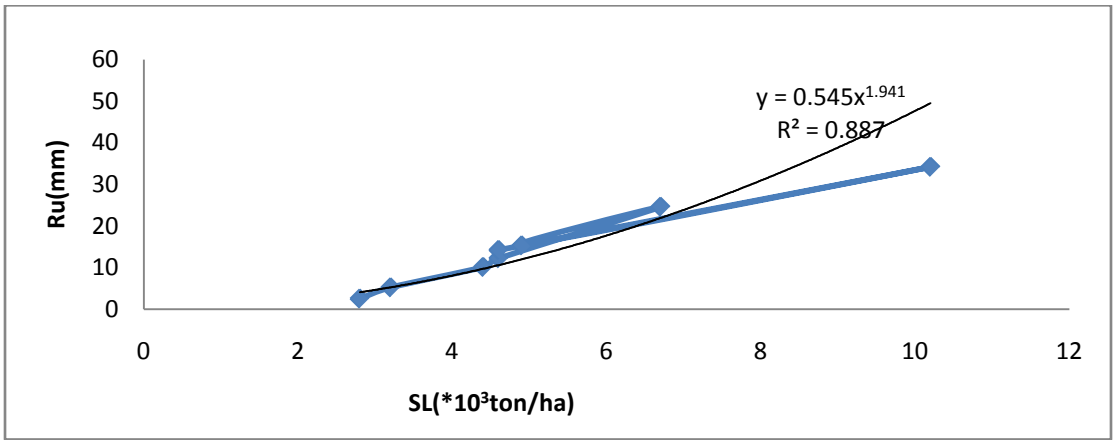


Fig. 4 : Sediment load calibration curve

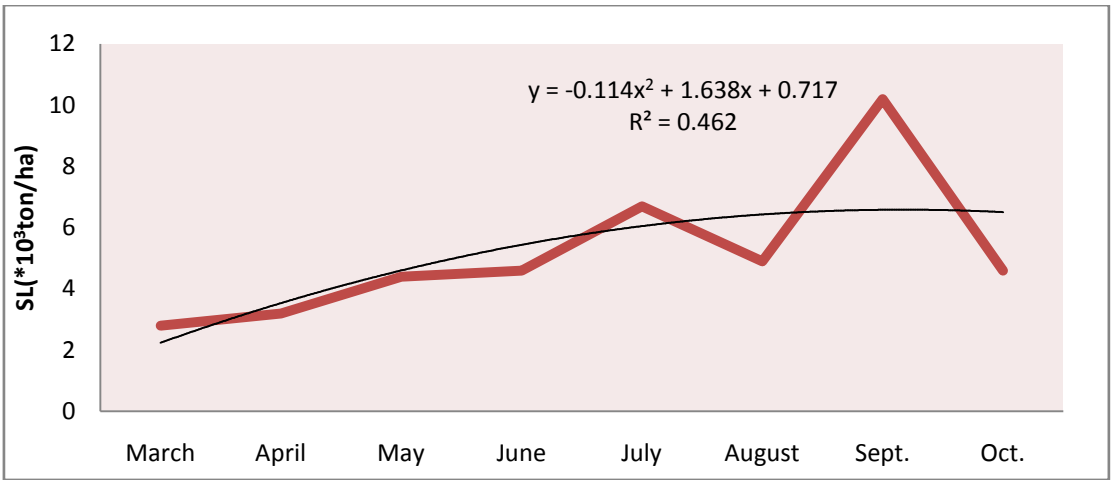
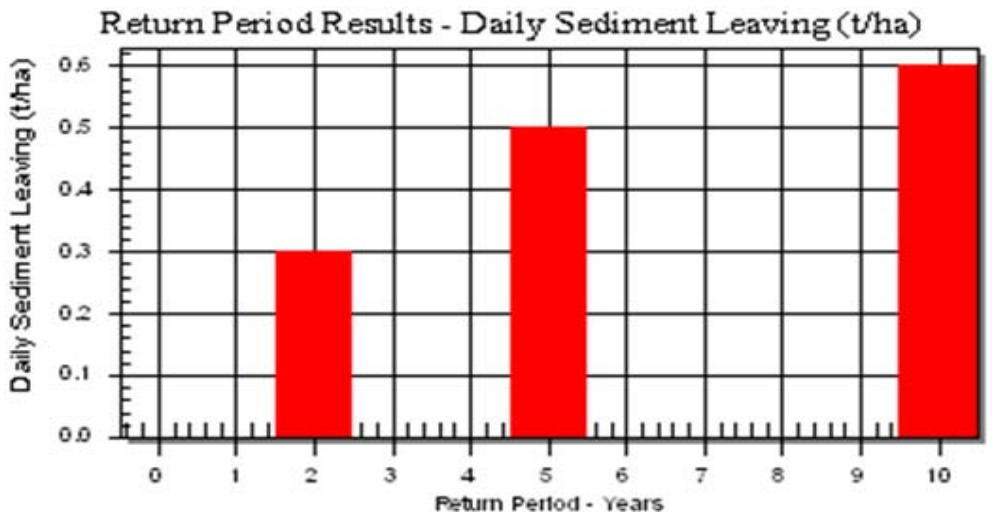


Fig. 5 : Sediment load rate calibration



WEPP simulation outputs for 2-year, 5-year and 10-year return period for daily sediment leaving (ton/ha) is shown in the Return Period Results-Daily Sediment Leaving. It was observed that there is increase in sediment load with increase in years of return period. In 2-year return period, daily sediment leaving of 0.3ton/ha was obtained, while 0.5ton/ha and 0.6 ton/ha were obtained for 5-year and 10-year respectively. The average sediment deposition rate obtained from the model was $41.4*10^3$ton/ha/year with the average trapping efficiency of 85.3% and 86.4% respectively.

IV. Conclusion

The simulation of runoff and sediment load from 2001 to 2001 using SWAT and WEPP models produced reasonably accuracy result. The output of yearly sediment load entering the reservoir from the two tributaries is highly significant. The generation of $445*10^3$ton sediment leaving into the reservoir is a major constrain to the reservoir capacity of the hydraulic structure. Due to continuous inflow of sediment leaving into the hydraulic structure, the reservoir is projected to be silted up in another 15-20 year. The yield—volume elasticity concept shows that storage capacity was reduced by 0.56% $year^{-1}$ due to silting, that the risk of water shortage almost doubled in less than 20 years for the Ole Dam reservoir. If the catchment area around the reservoir is treated with soil conservation measures, the dead storage level increases for about 35 years. However, reducing the sediment leaving into the reservoir 56% check dams should be constructed along the two major tributaries producing significant sediment load.

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Global Journal of Science Frontier Research
Agriculture and Veterinary
Volume 13 Issue 13 Version 1.0 Year 2013
Type : Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4626 & Print ISSN: 0975-5896

Current Status and Future Prospects of the Endangered Sheko Breed of Cattle (African Bos Taurus) in Ethiopia: A Review Paper

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Abstract- Sheko breed is one of the Ethiopian indigenous cattle breeds which represents the last remnants of Africa's original Bos taurus cattle that were probably the first to be domesticated in eastern Africa. The geographical distribution of Sheko cattle is mainly restricted to Bench Maji Zone and partly in the adjoining parts of Kaffa and Shaka Zones of south west Ethiopia. The breed is valued for its milk yield, adaptation and exhibit superior trypanotolerance than any other indigenous cattle populations found in Ethiopia. Despite the unique chatarcterers and attributes of the breed, there is a shrinkage in effective population size of the breed. The population estimate of the breed by the year 1999 was about 31,000, However, another estimates by the year 2007 indicated that the population size declined to 4040 a more recenet estimates reported the population of the breed as low as 2400 heads.

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GJSFR-D Classification : FOR Code: 070201

Strictly as per the compliance and regulations of :

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Abstract- Sheko breed is one of the Ethiopian indigenous cattle breeds which represents the last remnants of Africa's original Bos taurus cattle that were probably the first to be domesticated in eastern Africa. The geographical distribution of Sheko cattle is mainly restricted to Bench Maji Zone and partly in the adjoining parts of Kaffa and Shaka Zones of south west Ethiopia. The breed is valued for its milk yield, adaptation and exhibit superior trypanotolerance than any other indigenous cattle populations found in Ethiopia. Despite the unique chatarcterers and attributes of the breed, there is a shrinkage in effective population size of the breed. The population estimate of the breed by the year 1999 was about 31,000, However, another estimates by the year 2007 indicated that the population size declined to 4040 a more recenet estimates reported the population of the breed as low as 2400 heads. Strong physique and aggressive temperament of Sheko cattle for the herders as well as indiscriminate crossbreeding and replacement mainly with thoracic-humped zebu cattle were among the reasons for declining trend of the breed. Different phenotypic and genetic studies revealed that Sheko breed is characterized by high levels of genetic diversity and several unique alleles which are vital for future conservation and sustainable utilization of genetic resources. Although this unique breed is currently facing a clear risk of extinction there are no organized and visible efforts targeted for saving the breed from extinction. In addition, information is lacking on productive and reproductive performance of the breed. The current Artificial Insemination service and introduction of Borana cattle breed by the office of ministry of agriculture and rural development into the home area of sheko breed will exacerbate the extinction of the breed. Finally, it is recommended to generate information on productive and reproductive potential of the breed under different management system and designing In situ conservation schemes within their production environments.

Keywords: sheko breed, bos taurus, genetic diversity and conservation.

I. Introduction

Sheko is among the recognized cattle breeds in Ethiopia (DAGRIS, 2007) the breed represents the last remnants of Africa's original Bos taurus cattle which were probably the first to be domesticated in eastern Africa (Hanotte et al., 2000). These cattle were first reported in 1929 from South-western Ethiopia, and later in 1982 (Albero and Haile-Mariam 1982), at present some of the Sheko cattle manifest small humps that they inherited from zebu introgression. These cattle are generally smaller in body size and have shorter or no horns than the Humpless Longhorns, which made them much easier to manage. They also appear to have been deliberately developed for milk production (Rege, 1999).

The breed is valued for its milk yield, adaptation to humid tsetse infested environment and trypanotolerance (Lemecha, et al. 2006). Sheko is restricted to the humid Sheko and Bench districts in Southwest Ethiopia where they are maintained by a small number of local farmers. Sheko breed possesses unique genetic traits that may be useful in confronting new tropical diseases and unpredictable changes in environment conditions in the future. Characters related to disease resistance and adaptation to extreme environments could prove fundamental to food security for the present and future human generations (Dadi et al . 2009) Sheko exhibit superior trypanotolerance than other indigenous cattle populations found in Ethiopia (Lemecha, et al. 2006), implicating the genetic potential of this breed to perform cost-effectively in humid tsetse infested habitats where thoracic humped cattle may not survive in the absence of veterinary intervention.

Despite the unique chatarcterers and attributes of the breed, there is a shrinkage in effective population size of the breed from time to time. Diffrent research findings (Taye et al 2007'; Dadi et al . 2009) indicated that there is a high tendency of replacing the sheko breed with other types of breed as a reason of high feed intake as well as agressive nature of this breed than the others. This breed reflects historical and cultural identity of local communities and represents a unique component of the global domestic animal biodiversity that deserve priority for further research and conservation. The objective of this paper is to illustrate the current status of the breed in terms of population, genetic diversity and other productive performance of the breed and forward possible workable recommendations for conservation and sustainable utilization of this unique genetic resource.

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II. Origin, Population Size and Genetic Diversity

a) Origin

Despite recent evidence for possible presence of an African centre of domestication (Grigson 1991; Bradley *et al* 1996; Hanotte et al. 2002), archaeological evidence indicates that the first cattle on the African continent were of taurine origin introduced from Asia, through the Nile Valley in Egypt, or via the Horn of Africa (Epstein 1971). They occupied most of the areas surrounding the present day Saharan desert and the Abyssinian region. They also expanded to the humid habitat of the West African coast, with the present trypanotolerant breeds, and on the East part of the continent down to the Mount Elgon area at the Kenyan–Ugandan border (Epstein 1971). However, the taurine breed distribution pattern was deeply modified with the massive importation of zebu cattle to the continent, mainly after 700 ad, and later with the rinderpest epidemics affecting more especially taurine cattle (Epstein 1971; Blench 1993). Today the Abyssinian region, and to an extent, the Lake Victoria region are the cradle of the largest number of African zebu breeds and have the highest density of zebu populations on the continent (Rege & Bester 1998). Only one breed is still classified as taurine in the region, the Sheko, but several others are still considered as crossbred populations and classified as sanga (Felius 1995; Rege *et al*. 1996). Studies on mitochondrial DNA show that these breeds still have a taurine mitochondrial DNA (Bradley *et al*. 1996).

b) Population Size and Genetic Diversity

The geographical distribution of Sheko cattle is mainly restricted to Bench Maji Zone and partly in the adjoining parts of Kaffa and Shaka Zones of south west Ethiopia (Taye et al 2007).The population estimate of the breed by the year 1999 was about 31,000 (rege, 1999), However, another estimates indicated that the population size declined to 4040 (Taye et al 2007) a recenet estimates reported by Dadi, et al (2009) reveled that the population of the breed become as low as 2400 heads. A secondary data collected by the authers of this review by the year 2011 from office of south bench distric minestry of agriculture office revealed that the population size of the breed was around 1967 heads of which 562, 231, 421, 651, and 102 were heifers, buls, oxen, cows and calf respectivly. The populatio estimates reported so far at diffrent periods clearly indicate the sharply declining trend in the total population size of the breed (Fig 1).

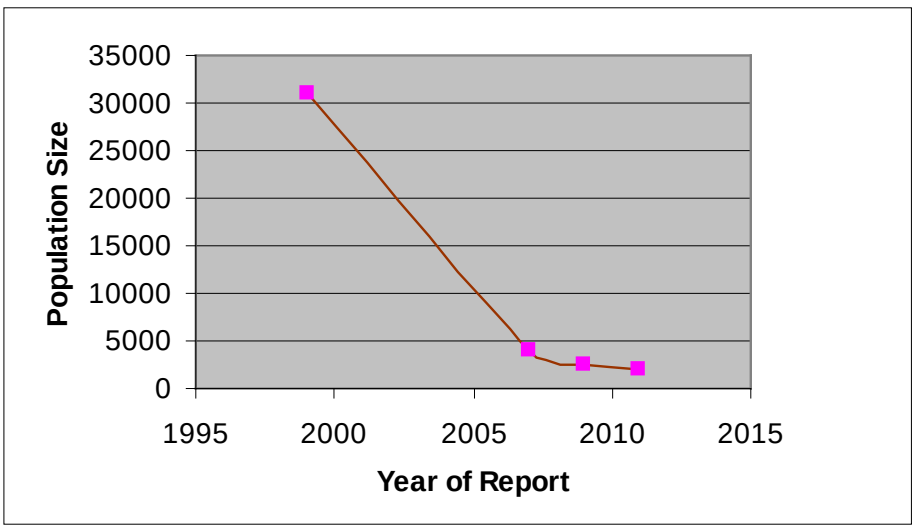

Fig 1 : Population size of sheko cattle breed reported at different years

Diffrent reasons were mentioned for the declining population trend of the breed, the most prominat reason mentioned was by Takele et al (2010) who contend that due to the high feed requirements of Sheko cattle, which cannot match with ever increasing feed shortage because of expansion of farm land to feed the rapidly growing population, sheko breed is less preferred to other local breeds by herders. Moreover, due to the strong physique and aggressive temperament of Sheko cattle, especially older individuals face difficulties in practicing tethered feeding which is now becoming the most common feeding strategy since there is shrinkage of grazing land. As a result, Farmers are compelled to continuously replace the breed with other local humped zebu cattle. Another reason mentioned by Dadi et al (2009) for the reduction in population size is indiscriminate crossbreeding and replacement mainly with thoracic-humped zebu cattle.

Effect of the recent decline in population size of sheko cattle on genetic diversity and bottleneck has been investigated by Dadi et al (2009). It is well known that genetic bottlenecks can increase demographic

stochasticity, rate of inbreeding and loss of genetic variation, thereby increasing the probability of population extinction. The same study revealed that there is no evidence for genetic bottleneck in sheko breed and the mean number of alleles detected at the population level was 6.93, a value that falls within the range of mean number of alleles (MNA) reported in various other African cattle breeds 5.1 – 7.9 (Rege, J.E.O. *et al*. 2001) Levels of heterozygosities were also comparable to results reported in this literature. Reduction in population size among Sheko cattle seems not to have had a negative impact on its genetic diversity. Other study by Dadi et al (2008) also revealed that Sheko breed is characterized by high levels of genetic diversity and several unique alleles (*CSRM60*: 91bp; *MM12*: 137bp, 139bp; *BM2113*: 122bp; *MB1824*: 185bp; *ILSTS006*: 299bp) which may be vital for future breed conservation in spite of demographic population contraction in recent years.

Different molecular characterization studies have been conducted on indigenous breeds of Ethiopia (Fedlu et al, 2007; Dadi et al. 2009). For instance genetic variability assessment between and within breed of five indigenous Ethiopian cattle (Horro, Sheko, Arsi, Abigar and Guraghe highland) using RAPD markers indicated that sheko breed formed a distinct cluster whereas the remaining breeds formed another cluster (Fedlu et al, 2007).

The study further indicated that the higher diversity value observed in Sheko may be due to the divergent breed group of the breed when the other four breeds share some Zebu type background. Moreover, the Sheko is believed to have a different and longer evolutionary history (Epstein, 1971), perhaps associated with a different pattern of natural selection for adaptation under harsh environmental conditions of the warm and humid climate of southwestern Ethiopia and continual exposure for Trypanosomosis. The same study reported the minimum genetic distance of Sheko breed with Abigar (a Sanga type being a cross of Zebu and taurine) than the other indigenous breeds depicting the fact that both sharing a taurine ancestor and a possible interbreeding of the breeds as they share a common border in their habitat. A more recent study on genetic differentiation, population structure and levels of admixture among Ethiopian cattle populations by using analysis of microsatellite markers indicated that the overall estimate of population differentiation is low due to high level of inbreeding within populations. Similarly, low magnitudes of genetic distances were observed between all possible pairs of Ethiopian cattle populations. The lowest and highest genetic distances were observed between the Arsi and Ambo populations and between the Sheko and Sanga populations respectively. The dendrogram constructed for the 11 Ethiopian cattle populations by the same authors showed two main separate clusters composed of two genetic groups; one group had only Sheko, while the other group contained all the other Ethiopian cattle populations, irrespective of their morphological classifications. All the phylogenetic studies undertaken so far on Ethiopian cattle population categorized Sheko breed as a distinct group from the rest of the population and indicated the breed as the original short horn taurine cattle of east Africa.

Sheko breed which is locally named as *"Godda"* (meaning hornless or polled) by the local community has been recognized as one of Africa's "Big Five" vintage cows having great potential to form the genetic backbone for future survival (ILRI, 2007). This unique breed is currently facing a clear risk of extinction due to rapid shrinkage of population size (Taye et al 2007), admixing with other local breed (Dadi et al. 2009) and nearly elimination of specific allele on Y chromosome which indicates taurine origin in African indigenous cattle (Hanottee et al 2000).

III. Phenotypic Characteristics and Productive Performance

Detailed studies and characterization on productive and reproductive performance of the breed is not yet conducted. However, there are few and scanty surveys and monitoring research activities undertaken so far (Alberro, and Haile-Mariam, 1982; Ayalew et al, 2001; Taye at al, 2007). Different color patterns were reported for the breed and the coat color is predominantly red in plain (75%), patchy (15%) or spotted (9%) (Werkeneh, et al 2001) other study (Taye et al, 2007) indicated the color is dominated by glossy red hair coat while Alberro, M and Haile-Mariam, (1982) reported the dominant color as Brown or black and white. The studies reveled that, lack of uniformity in color pattern and presence of possible admixture of the breed with other local cattle population. All of the studies undertaken so far clearly indicated that majority of the sheko population is polled and having a small or no hump (Table 1).

The productive and reproductive performance of the breed is summarized on table 3. A survey by Taye et al, (2007) revealed that Average age at puberty for male and female population is 41.6 and 42.1 months, respectively and average age at first calving and mean calving interval is 54.1 and 15.6 month, respectively. The same survey reveled that average lactation milk yield is 698.3 liter with associated average lactation length of 9.9 month, nearly, 22.1 and 7.8 percent of the sampled Sheko cows were reported to produce on average more than 1000 and 1400 liter of milk per lactation, respectively. Sheko oxen on average start draught work at 3.4±0.81 year and have an average draught work life of 8.5±2.67 year. Moreover, majority of herders reported as Sheko oxen surpass their Zebu counterparts in draught stamina and speed (Taye et al, 2007). Ayalew

(2001) reported height at withers for adults, 105 cm; body length, 102 cm; heart girth, 136.7 cm, and live weight 179 kg.

At present there is no active research and development work targeted towards conservation of the endangered sheko breed. An observation made by the writers of this review during the year 2011 at Bech maji zone indicated that there is awareness by the district beuro of agriculture and rural development on the declining population trend of the breed although there is no clear plan and action to be implemented by concerned stakeholders. On the contrary, the current efforts on provision of AI service in the home land of sheko breed by ministry of agriculture and introduction of Borana breed and distribution to farmers with a subsidized cost in some selected districts of bench maji zone are the major treats and challenges identified for conservation of the breed.

Table 1 : Phenotypic description of Sheko Cattle as reported by different Authors

Color Description	The coat color is predominantly red in plain (75%), patchy (15%) or spotted (9%) pattern.	Workneh, A. 2001
	They are dominated by glossy red hair coat.	Taye, T. et al, 2007
	Brown or black and white color.	Alberro, M.; Haile-Mariam, S. 1982
Horn description	Many are polled or with small jersey-like horns.	Alberro, M.; Haile-Mariam, S. 1982
	predominantly polled (84.8 and 89.9% in male and female population, respectively)	Taye, T. et al, 2007
Hump description	Without or with small hump.	Alberro, M.; Haile-Mariam, S. 1982
	Most of them are humpless; some bulls and a few cows have small and cervico-thoracic hump,	Workneh, A. 2001
	Most of them have reduced type cervico-thoracic hump.	Taye, T. et al, 2007

Table 2 : Summary of Sheko Breed performance reported by different authors

Traits	Values/descriptions	Source
Average age at puberty for male (Months)	41.6	Taye, T. et al, 2007
Average age at puberty for female (Months)	42.1	Taye, T. et al, 2007
Average age at parturition (months)	36 - 48	Alberro, M.; Haile-Mariam, S. 1982
	54.1	Taye, T. et al, 2007
Average calving interval	15.6	Taye, T. et al, 2007
Average daily Milk Yield (lit)	1-2	Alberro, M.; Haile-Mariam, S. 1982
Average lactation milk yield	698.3	Taye, T. et al, 2007
Average lactation length (months)	9.9	Taye, T. et al, 2007
	6 – 8	Alberro, M.; Haile-Mariam, S. 1982
Adult live weight Female (Kg)	188.4	Workneh, A. 2001
Adult live weight Male (Kg)	208.3	Workneh, A. 2001
Adult live weight overall(Kg)	194.4	Workneh, A. 2001

IV. Trypanotolerance of Sheko Breed

Trypanosomosis is one of the major impediments to livestock development and agricultural production in Ethiopia contributing negatively to the overall development in general and to food self-reliance efforts of the nation in particular. While tsetse-borne trypanosomosis is excluding some 180,000–200,000 km^2 of agriculturally suitable land in the west and southwest of the country, 14 million head of cattle, an equivalent number of small ruminants, nearly 7 million equines and 1.8 million camels are at the risk of contracting trypanosomosis at any one time (Langridge, 1976; MoARD, 2004).

A comparative study on the response of four indigenous cattle breeds of Ethiopia, namely Abigar, Horro, Sheko and Gurage, to natural challenge of trypanosomosis in the Ghibe valley reveled that Sheko breed has manifested very high overall average packed cell volume (PCV) values, the lowest mean trypanosome prevalence rate and the least number of trypanocidal treatments and lower mortality rate as compared to the other studied breeds (Lemecha et al, 2006). Reproductive performance of the four breeds was also studied. The results showed that the Sheko had more calves than other breeds, slightly higher birth weights, and the highest calving rate of 51%. The Abigar breed exhibited the worst reproductive performance with only 1 calf in the study time, less aggressive sexual behavior, and the lowest calving rate of 3% due to high tsetse challenge (Lemecha et al 2006). The Good reproductive

performance under trypanosomosis challenge is also considered to be strong indicator of trypanotolerance.

V. Conclusion and Recommendations

The following conclusion and recommendations can be drown from the review :

- From the research reports so far it is possible to conclude that the effective population size of the breed is declining from time to time and the breed can be designated as critically endangered.
- Genetic and phenotypic studies undertaken on Ethiopian indigenous cattle population described the unique genetic make up of the breed which makes it different from the rest of the breeds.
- The future for livestock production in tsetse infested areas of Ethiopia has never been brighter. This ability to take unproductive land and make it productive, through trypanotolerant livestock, will help to ensure sustainable agriculture for generations to come. The current evidences showed that sheko breed is a better choice in areas with high level of tsetse infestation.
- The current effort of introducing AI service and distributing borana cattle to the native areas of sheko population will aggravate the rate of admixture with other breed and exacerbates the extinction of the breed.
- All the concerned stakeholders in the area including, bureau of agriculture and rural development, Bonga research center , Jimma University and institute of biodiversity conservation should design an *in situ* conservation schemes to conserve the breed in its own native environment.
- The potential of the breed for milk and meat production under different management conditions should be evaluated and improvement program should be implemented.

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Global Journal of Science Frontier Research
Agriculture and Veterinary
Volume 13 Issue 13 Version 1.0 Year 2013
Type : Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4626 & Print ISSN: 0975-5896

Effects of Feeding Frequency on Growth and Nutrient Utilization of *Oreochromis Niloticus* (Linnaeus 1757) Fingerlings

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Abstract- A 58-day feeding trial was conducted in concrete tanks (2m x 2m x 1.25m) of 400L capacity to determine the effects of O. niloticus (3.40g + 0.04) fed pelleted diet to apparent satiation at different feeding frequencies (once (FF1) at 0900hr, twice (FF2) at 0900 and 1700 h, three (FF3) at 0900, 1300 and 1700 h and four times (FF4) 0900, 1200, 1500 and 1800 hs daily respectively. Fish were fed with 35% protein diet at 5% body weight. There was a significant increase ($P < 0.05$) between feeding frequency of three times (FF3) daily, 19.33+ 0.67 and other feeding frequencies of once (FF1) 9.33+0.33, twice (FF2)13.67+ 0.33 and four times (FF4) daily, 17.67+0.33 with respect to final mean weight. Also Feed Conversion Ratio (FCR) of the fish fed feeding frequency of three times (FF3) daily, 13.96 + 1.66, is the best of the four feeding frequencies. O. niloticus survival was not ($P < 0.05$) affected by the different frequencies.

Keywords : *feeding frequency, oreochromis niloticus, feed intake, growth performance.*

GJSFR-D Classification : *FOR Code: 070799*

Strictly as per the compliance and regulations of :

Effects of Feeding Frequency on Growth and Nutrient Utilization of *Oreochromis Niloticus* (Linnaeus 1757) Fingerlings

Temitope Jegede [α] & Oluwaseun Tola Olorunfemi [σ]

Abstract- A 58-day feeding trial was conducted in concrete tanks (2m x 2m x 1.25m) of 400L capacity to determine the effects of *O. niloticus* (3.40g ± 0.04) fed pelleted diet to apparent satiation at different feeding frequencies (once (FF1) at 0900hr, twice (FF2) at 0900 and 1700 h, three (FF3) at 0900, 1300 and 1700 h and four times (FF4) 0900, 1200, 1500 and 1800 hs daily respectively. Fish were fed with 35% protein diet at 5% body weight. There was a significant increase ($P < 0.05$) between feeding frequency of three times (FF3) daily, 19.33± 0.67 and other feeding frequencies of once (FF1) 9.33±0.33, twice (FF2)13.67± 0.33 and four times (FF4) daily, 17.67±0.33 with respect to final mean weight. Also Feed Conversion Ratio (FCR) of the fish fed feeding frequency of three times (FF3) daily, 13.96 ± 1.66, is the best of the four feeding frequencies. *O. niloticus* survival was not ($P < 0.05$) affected by the different frequencies.

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I. Introduction

Tilapia is a global commodity reaching a production of 3.5 million tonnes in 2010 (Rana 2013). It is one of the most productive and internationally traded food fish in the world (Modadugu and Belen 2004). They are a major protein source in many of the developing countries. The commodity is not only the 2nd most important farmed fish globally, next to carp in global production (Fitzsimmons *et al*., 2013) but also described as the most important aquaculture species of the 21st century (Shelton 2002). Its species have since been introduced in different parts of the world to improve fisheries or to develop aquaculture (Lèveque, 2002). There are about 70 species of tilapias, most of them native to Western rivers of Africa (Anon 1984). Out of these, nine species are used in aquaculture worldwide among which are *Oreochromis niloticus* and *Tilapia zillii* (Hepher and Pruginin 1981, Mair 2001, FAO 2002).

The global tilapia production (*Oreochromis niloticus* inclusive) in 2010 was approximately 3.5 million metric ton and should have increase to more than 3.7 million mt in 2012 (Fitzsimmons 2013).

One of the most crucial elements influencing the ability of cultured fish to exhibit its potential for growth and reproduction is nutrition (Başçınar 2007). A good nutrition in animal production stem is essential to economically produce a healthy, high quality product (Nekoubin, and Sudagar 2012). They are greatly influenced by factors such as feed quality, fish behaviour, daily ratio size, feed intake and water temperature. Feed is the most expensive component in intensive aquaculture (El-sayed, 2004), accounting for 40-60% of the aquaculture production (El-sayed, 1999 and Anderson *et al.,* 1997 and, ADCP, 1983). Aqua-feed alone represent the largest single cost item in management of semi-intensive and intensive farming operations. Feed quality and feeding strategy are of great importance in fish nutrition (Güroy *et al*., 2006).

In addition, both over- and underfeeding can be detrimental to the health of the fish and may cause a marked deterioration in water quality, reduced weight, poor food utilization, and increased susceptibility to infection (Priestley *et al*., 2006). Feed consumption rate is dependent on species type, dietary composition, fish size, meal size, environmental conditions and feeding frequency (Reche 2000). The growth of fish at all stages is largely dependent by ration, the kind of food, feed intake, feeding frequency and its ability to absorb the nutrients. Among these, feeding frequency is an important aspect for the survival and growth of fish at the early stage (Shaoushaki *et al*., 2012). The objective of this study therefore is to evaluate effect of *O. niloticus* fed pelleted diet to satiation at different feeding frequencies and determine the effect on growth and nutrient utilization.

II. Materials and Methods

a) Diet formulation and preparation

Feedstuffs were purchased from Metrovet Agroallied shop, Ado Ekiti and were separately milled to small particle size (< 250 μm) using pulverizing machine (Model BCC-2516). The ingredients weighed on a Metler top-loading balance (Model PB-8001). The isonitrogenous diet was formulated (Table 1) at 350g crude protein and 18.5KJ gross energy/g^{-1} diet, respectively. The feedstuffs were thoroughly mixed in a Hobart A-200T pelleting machine. Hot water was added at intervals to gelatinize starch. The diet was pelletized using a die of 0.8 mm diameter. The diet was air-dried at ambient temperature for 72 hours; broken, sieved into

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small pellet sizes, packed in air-tight plastic containers, labelled and stored. Prior to storage, the diet were analyzed for proximate composition according to standard AOAC methods AOAC (1990). Crude protein was determined using a Kjeltec Auto 1003 Analyser after digestion with concentrated H_2SO_4 in a digester. Crude lipid was estimated by extracting in chloroform: methanol (2:1) using a Soxlet extraction HT6 unit. Crude fiber was determined using a Fibretec System 1020 Hot Extractor and ash content was determined by igniting at 550°C in a muffle furnace for 12 hours. Gross energy content was determined using a ballistic bomb calorimeter (Gallenkamp Co. Ltd., Loughborough, England).

b) Experimental system and animals

O. niloticus fingerlings were obtained from a reputable fish farm in Ekiti State, Nigeria, and acclimated for 14 days in concrete tanks (2m x 2m x 1.25m) of 400L capacity. Two-third of each concrete tank was filled with water. Continuous aeration was provided using a blower and air stones (Tecas air pump AP-3000; two ways). The fish were acclimatized in the concrete tanks for 7days while being fed on a commercial pelletized diet (30% crude protein). Four treatments namely, daily feeding frequencies of once (F1) at 0900hr, twice (F2) at 0900 and 1700 h, three (F3) at 0900, 1300 and 1700 h and four times at 0900, 1200, 1500 and 1800 h, respectively. After acclimation, twenty (20) *O. niloticus* (3.40g $\pm$ 0.04) were randomly stocked in each concrete tank (2m x 2m x 1.25m) supplied with 400 litres of fresh water (water temperature, 27°C; pH, 7.3; alkalinity, 50ppm; dissolved oxygen, 7.6-7.9 mg/L). Each treatment was replicated thrice. Feeding commenced a day after stocking and lasted 58 days. The fish were hand-fed to apparent satiation at different feeding frequencies (once (FF1) at 0900hr, twice (FF2) at 0900 and 1700 h, three (FF3) at 0900, 1300 and 1700 h and four times (FF4) 0900, 1200, 1500 and 1800 h, respectively. All fish were removed from each concrete tank every fortnight and batch weighed. Mortality was monitored daily and recorded. Growth performance and nutrient utilization indices were determined as final fish weight (g), survival (%), specific growth rate (SGR, % day-1) and feed conversion ratio (FCR). Growth parameters were calculated as:

[1] % weight gain (%. fish^{-1}) = [(final wt. – initial wt.)/initial wt.)] x 100

[2] weight gain (g) = (final wt. – initial wt.)

[3] specific growth rate (%. day-^{1}) = [(ln final wt. – ln initial wt.)/no of days] x 100

[4] feed conversion ratio = feed intake (g)/body weight gain (g)

Water temperature and dissolved oxygen were measured daily using a combined digital YSI DO meter (YSI model 57); pH was monitored weekly using an electronic pH meter (Metler Toledo 320 model). Two weeks before the completion of the feeding trial, faeces were collected from each tank, 8 h after each feeding daily. The ashes were digested by acid insoluble ash (AIA) as described by Halver *et al.* (1993). The value obtained for AIA was used as indicator in the calculation of digestibility coefficient. The digestibility coefficient was calculated as follows:

Digestibility = 100-100(%AIA in feed) × (% nutrient in faeces)/(%AIA in faeces)(% nutrient in feeds).

All data obtained were subjected to one-way Analysis of Variance (ANOVA) test using the SPSS Version 11. Fisher's pairwise comparison was used in comparing differences among individual mean.

III. Results

Crude protein of 35% was used in the formulation of the experimental diets for *Oreochromis niloticus* fingerlings (Table 1). The proximate composition of the experimental diet are; the crude protein is 355.0± 0.50, crude fibre 17.8±1.20, lipid 102.2±0.26, ash 129.8±1.53, moisture 57.0±1.21 while Nitrogen Free Extract (NFE) is 318.2(g/kg^{-1} DM) (Table 2).

At the expiration of 58days, *O. niloticus* fed thrice a day, Treatment 3 (F3) had significant (P<005) the highest weight gain (19.33g $\pm$ 0.67) and protein intake (114.42 $\pm$ 10. 57) than the other diets (Diets 1, 2 and 4) (Table 3). The least weight gain was evident in fish fed once per day, Treatment 1(F1) 9.33 $\pm$ 0.33). *O. niloticus* survival was not significantly affected by the treatments. Water quality during the feeding trial was within the acceptable range for tilapia culture (water temperature, 27 °C; pH, 7.3; alkalinity, 50 ppm; dissolved oxygen, 7.6 - 7.9 mg/L).

Table 1 : Ingredients composition of the basal diet (35% crude protein)

Ingredient	g/kg Diet
Menhaden fish meal	150
Soybean meal	450
Yellow maize	250
Cod liver oil	40
Vegetable oil	60
Vitamin-mineral mix	30
Corn starch	20

[1]Fish pre-mix. Colborne Dawes Nutrition Ltd., United Kingdom.: vitamin A, 1600 IU; vitamin D, 2400 IU; vitamin E, 160 mg; vitamin K, 16 mg; thiamin, 36 mg; riboflavin, 48 mg; pyridoxine, 24 mg; niacin 288 mg; panthotenic acid, 96 mg; folic acid, 8 mg; biotin, 1.3 mg; cyanocobalamin, 48 mg; ascorbic acid, 720 mg; choline chloride, 320 mg; calcium 5.2 g; cobalt, 3.2 mg; iodine, 4.8 mg; copper, 8 mg; iron, 32 mg; manganese, 76 mg; zinc, 160 mg; Endox (antioxidant) 200 mg.

Table 2 : Proximate composition of the experimental diets

Proximate composition (g/kg^{-1} DM)	Diet
Crude protein	355.0
Ether extract	102.2
Crude fibre	17.8
Ash	129.8
Moisture	57.0
Nitrogen free extract	318.2
Gross energy (KJ g^{-1})	18.5

Table 3 : Growth performance and nutrient utilization of *Oreochromis niloticus* fingerlings fed at different feeding frequencies

	Treatment 1 FF1	Treatment 2 FF2	Treatment 3 FF3	Treatment 4 FF4
Weight Gain	9.33±0.33^{d}	13.67±0.33^{c}	19.33±0.67^{a}	17.67±0.33^{b}
Percentage Weight Gain	53.38±8.34^{b}	50.00±8.39^{b}	57.09±7.97^{b}	78.44±3.44^{a}
Specific Growth Rate	0.76±0.09^{a}	0.72±0.09^{a}	0.81±0.08^{a}	0.61±0.03^{b}
Protein Intake	21.32±2.74^{c}	66.64±7.76^{b}	114.42±10.57^{a}	95.71±15.45^{ab}
Survival Rate	73.33±3.33^{b}	83.33±3.33^{ab}	90.00±5.77^{a}	86.67±3.33^{ab}
Feed Conversion Ratio	14.16±2.19^{a}	18.57±2.01^{a}	13.96±1.66^{a}	6.53±0.84^{b}
Gross Feed Conversion Efficiency	7.44±1.23^{b}	5.52±0.62^{b}	7.40±0.78^{b}	15.85±2.08^{a}

Mean and Standard Error having the same superscripts are not significantly different.

Table 4 : Carcass composition of *Oreochromis niloticus* fingerlings fed at different feeding frequencies

	Initial	Treatment 1 FF1	Treatment 2 FF2	Treatment 3 FF3	Treatment 4 FF4
Moisture Content	3.67	4.19	4.24	4.25	4.35
Ash(%)	29.63	16.40	15.04	16.05	16.05
Lipid(%)	10.90	20.57	18.67	21.29	20.19
Crude Protein (%)	38.24	40.23	55.17	57.25	54.62
Nitrogen Free Extract	17.56	18.61	6.88	1.16	4.79

IV. Discussion

The crude protein of 35% used in the formulation of the experimental diets for *Oreochromis niloticus* fingerlings (Table 1) falls within the recommended ranges of 25-35% crude protein requirement for Tilapia species (Santiago and Lovell 1988), and 30%-35% recommended by N.R.C (1981) and N.R.C (1983), and satisfied the nutrient requirements for tilapias (Jauncey, 2000). *O. niloticus* fed thrice daily frequency, Treatment 3 (FF3) had significantly (P<005) the highest weight gain (19.33g ± 0.67) and protein intake (114.42 ± 10. 57) than the other daily frequencies (FF1, FF2 and FF4) .Also the FCR of *O. niloticus* fed daily frequency FF3 (13.96± 1.66) is better than FF1, FF2 and FF4 (Table 3). The least weight gain was evident in fish fed once per day, Treatment 1(FF1) 9.33 ± 0.33. This study corroborate a similar study by Başçınar (2007) where growth, feed consumption and conversion ratios of Black Sea trout (*Salmo trutta labrax*) subjected to daily feeding frequencies showed that fish fed trice daily frequency had better final live weight and SGR value than all the other frequencies when evaluated. *O. niloticus* survival was not significantly affected by the treatments. The trend in the proximate analysis of the fish carcass in all

the treatments(Table 4) are similar to that obtained by El-Sayed (1998) where the effects of total replacement of animal protein sources in *Oreochromis niloticus* was investigated. An appreciable increase in crude protein and lipid were reported in the carcass of *Oreochromis niloticus* fed Poultry by Product (PBP) as against the other diets. Increase in crude protein and lipid of the carcass of fish is a pointer to the superiority of the fish quality Sahu *et al*., (2000). The water quality during the feeding trial was within the acceptable range for tilapia culture (Ross, 2000) and do not differ significantly among treatments. Acceptance of the diets was good and fish became accustomed to the diets within the first week.

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Global Journal of Science Frontier Research (D) Volume XIII Issue XIII Version I Year 2013
24

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Global Journal of Science Frontier Research
Agriculture and Veterinary
Volume 13 Issue 13 Version 1.0 Year 2013
Type : Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4626 & Print ISSN: 0975-5896

Effect of Plant Maturity Stage on Digestibility and Distance Walked for Diet Selection by Goat at North Kordofan State, Sudan

By Abdel Moniem M.A. El hag, Ali A. hassabo, Bushara I, M.O. Eisa & I.A.Ishag

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Abstract- The main objective was to study grazing behavior of goats; diet selection, nutritive value, digestibility of range plant and body gained at flowering and seed setting stage at September and November 2010 respectively in El-khuwei locality (El Rosa). A completely randomized design was used (CRD). Sampling was done by two stage flowering and seed sating stage were selected diets and feed intake locating a 2000 x 2000 m plots. The average weights gains during the flowering and seed setting stage were 17 and 18.28kg respectively. Goats during the flowering stage was preference on bite counts of the different species, however highly ($P < 0.0001$) at the flowering and least during the seed setting stage. Goat preference ranked Bano (Eragrostis tremula), Huskneet (Cenchrus biflorus), Difra (Echinocloa colonum), leflef (Luffa aegyptiaca), Gaw (Aristida spp.), Fisiya (Fimbristyls hispidula), Himeira (Hymenocardia acida), Nuida (Sida cordofolia), Tmrfar (Oldenlandia senegalensis) and Aboelrakhus (Andropogon gayanus), while Gadgad (Geigeria alata), Buid (Commelinia subulata), Simeima (Sesamum alatum), Abodaib (Ceraotheca sesamoid) and Rabaa (Zalea spp) least than that.

Keywords: availability, palatability, selectivity, digestibility, distant walked and body weight gains.

GJSFR-D Classification : FOR Code: 070799, 070199

Strictly as per the compliance and regulations of :

Effect of Plant Maturity Stage on Digestibility and Distance Walked for Diet Selection by Goat at North Kordofan State, Sudan

Abdel Moniem M.A. El hag [α], Ali A. hassabo [σ], Bushara I [ρ], M.O. Eisa [ω] & I.A.Ishag [¥]

Abstract- The main objective was to study grazing behavior of goats; diet selection, nutritive value, digestibility of range plant and body gained at flowering and seed setting stage at September and November 2010 respectively in El-khuwei locality (El Rosa). A completely randomized design was used (CRD). Sampling was done by two stage flowering and seed sating stage were selected diets and feed intake locating a 2000 x 2000 m plots. The average weights gains during the flowering and seed setting stage were 17 and 18.28kg respectively. Goats during the flowering stage was preference on bite counts of the different species, however highly ($P < 0.0001$) at the flowering and least during the seed setting stage. Goat preference ranked Bano *(Eragrostis tremula)*, Huskneet (*Cenchrus biflorus)*, Difra (*Echinocloa colonum)*, leflef (*Luffa aegyptiaca)*, Gaw (*Aristida spp.*), Fisiya (*Fimbristyls hispidula)*, Himeira (*Hymenocardia acida)*, Nuida (*Sida cordofolia)*, Tmrfar (*Oldenlandia senegalensis)* and Aboelrakhus (*Andropogon gayanus*), while Gadgad (*Geigeria alata)*, Buid (*Commelinia subulata)*, Simeima (*Sesamum alatum)*, Abodaib (*Ceraotheca sesamoid)* and Rabaa (*Zalea* spp) least than that. A significant higher ($P < 0.001$) goats selective feed intake, *in vitro* dry matter digestibility, dry matter, organic matter and crude protein higher at flowering stage and lowers during the seed setting stage. However; ash contents and crude fiber of plants were significantly higher at the seed setting stage. Body weight gain was significantly highest during the flowering stage, while the distance walked by goats for diet search was significantly longest during the seed setting stage. It was concluded that flowering stage beneficially goats highly preference and selectivity different species, feed intake and inviter dry matter digestibility and body weight gained. The seed setting stage was highly ash contents, crude fiber distant walked.

Keywords: availability, palatability, selectivity, digestibility, distant walked and body weight gains.

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I. Introduction

Sudan is the largest country in Africa, with an area of 1.88 million Km^2. It has a population of 33.42 million (CBS, 2011) and has the second largest animal population in Africa. In 2006, there were 138.2 million livestock, of which 50.39 million sheep, 42.76 million goats, (Ministry of Animal Wealth and Fisheries, 2006). Western Sudan has the most livestock (40%), followed by southern Sudan (27%) and central Sudan (23%). The majority of breeds is raised within tribal groups and often carries the name of the tribe. They are well adapted to the harsh environment and often trek long distances in search of feed and water. Productivity is low but can be improved with good management in more favorable conditions. Cattle are mainly descended from boss Taurus, or zebu. In central Sudan they are generally kept for milk, and in western Sudan for meat production. Sheep are of the Sudan Desert type, with live weights up to 70 kg and excellent meat and carcass characteristics. Goats, mostly of the large, black Nubian type, are found in central Sudan and are kept for milk. There are two types of the single-humped camel, one kept for riding and the other as a pack or baggage animal. Camels are exported mainly for meat. Forage produced from natural pastures represents 86.6% of national animal feed requirements, and about 14% of the population is involved in livestock production activities on the rangelands (MAW, 2005). North Kordofan amounts to almost 25 million ha, out of this area; 14.5 million ha are rangeland (AFRICOVER, 2004). The State is considered among the leading regions of Sudan in terms of animal and range resources, where more than 13 million heads of sheep, goats, camels and cattle are present (RPA, 2005). Animal production in the State is mainly practiced under traditional extensive systems, depending on natural rangeland (Cook and Fadlalla, 1987). Cattle dominate the southern part of the State, while sheep, goats and camels are present in larger numbers in the northern and drier part (El-Hag, 1993). The main objective of this paper was to investigate effects of grazing behavior on the various distances walked and digestibility from a diet selection by goats.

II. Materials and Methods

a) Study area

This study was conducted at El-khuwei locality (El Rosa). It lies between longitudes 28:33' to 28°:30'N and latitudes 12°:14' to 14°:12'E, about 105 Km west of El Obeid town, North Kordofan State lies between latitudes 11°:20' to 16°:36'N and longitudes 27°:13' to 32°:24'E. The close range system was established in 2007 in an area of about 500 ha, El-khuwei locality own large export market of animals (Hammer sheep) in west Sudan according to (MAWF, 2009). The long term average annual rainfall is about 300-mm, consisting of storms of short duration between July and September with the highest rainfall generally occurring in August. The soil of the site lies within the sand dune area locally known as "Goz" soil. The site is naturally dominated main grasses include namely Huskneet (*Cenchrus biflorus),* Shuleny (*Zornia glochidiata*) and Bigual (*Blepharis linarifolia*). The trees Humied (*Sclerocarya birrea*), Higlig (*Balanites*), Arad (*Acacia etbaica*) and Sider (*Zizuphus spina).* The Shrubs include Kursan (*Boscia senegalensis*), Usher (*Calotropis*), Mereikh (*Polygala eriotera*) and Aborakhus (*Andropogon gayanus*) according to (MAWF, 2009).

b) Sampling and experimental animals

Sampling was done on two stages of plant maturity at flowering and seed setting in selected locations (2 km^2 each). Within each stage twenty goats randomly selected, their average weights gains were 17.00 and 18.28kg, respectively (Fadlalla and Cook, 1985).

c) Nutritional value of range quality

i. *Feed or diet selection*

The parameters measured diet botanical composition was estimated using the bite-count techniques, (Fadlalla and Cook 1985). The parameters measured included diet botanical composition and voluntary intake of dry matter. Within each season twenty goats was kept for this study. The first goat was followed for five times, and then the second one followed for another five minutes and so on for all goats. The procedure was repeated tine times, thus each goats followed for one hour in the first day, was also followed by observer for three days and 600 bites, and species of plant ingested and bite were recorded.

ii. *Voluntary feed intake and in vitro dry matter digestibility*

The total fecal collection and *in vitro* dry matter digestibility techniques were used to measure voluntary intake. In this technique, the total faces produced by grazing goat were collected into appropriately designed collection bags attached to animals. Collection bags attached to goats were emptied at least twice a day and weighted. *In vitro* DM and *In vitro* dry matter digestibility determined (Tilly and Terry, 1963). The sample for flowering and seed setting stages was obtained by observing plant species and plant parts selected by goats during grazing and then collecting similar material for analysis by Tilley and Terry (1963). I*n vitro* dry matter digestibility *INVDMD* was calculated according to the following formula:

$$INVDMD\% = \frac{\{\text{Sample DM} - (\text{Residue sample-Mean.resid DM inoc.blank})\}*100}{\text{Sample DM}}$$

The voluntary intake of DM was determined according to Fadalla and Cook, (1985).from the following formula:

$$\text{Dry matter intake (DM)} = \frac{\text{Total fecal output /24 hr}}{\text{100 - DM digestibility (}\textit{in vitro}\text{)}} *100$$

d) Measuring Parameters

i. *Average distance walked*

Distance from the goats search to voluntary feed intake. The first goat was followed for five minutes, and then the second one followed for another five minutes and so on for all goats. The procedure were repeated distance walked at five minutes of bite count by matter, thus each goat followed for one hour in the first day, ware also followed by observer for the total of distance walked under four days. However measured distance refers to the distance grazing area as measured by meter per hour according to Fadlalla and Cook (1985).

ii. *Average body weight gains*

Two stages flowering and seed setting were measuring body weight gains (2 km^2 each). Within each season twenty goats was kept for this study. The procedure was repeated initial and final body weight of goats before and after grazing. The weight between initial and final equal weight change gram/day were recorded at three weeks on two stages Fadlalla and Cook (1985). Weight and body condition, for instance, provide a measure of the nutritional response, integrated over weeks or months (Lambourne *et al*, 1983).

iii. *Laboratory Analyses*

Dry-matter weight (DM) is determined by drying the feed in the oven at 105°C for 12-15 hours and weighing. Organic matter (OM), crude protein (CP) was determined by (AOAC, 1980). Crude fiber (CF) was determined by (Van Soest, 1982). *In vitro* dry matter

digestibility (*INVDMD*) was determined (Tilley and Terry, 1963).

iv. *Statistical Analysis*

Completely Randomized Design (CRD) was used in this experiment. Data were subjected to analysis of variance and means were estimated. Chi Square test was used to compare diet selection (Steel and Torrie, 1960). SPSS (Statistical Package for Social Sciences) computer software was used for the statistical analysis.

III. Result and Discussion

a) Bite Counts

Table 1 shows the bite counts of range species by goats during the flowering and seed setting stages. Goats during the flowering stage was preference on bite counts of the different species, however highly ($P < 0.0001$) at the flowering stage and least during the seed setting stage. Laca *et al* (2001) indicated that rates of nutrient intake are reduced at too low or too high levels of plant biomass. Intake is influenced by bite size; bite rate, and grazing time. Goat and sheep differed significantly ($P<0.001$) in selection of different range plants supporting the findings of (Hodgson, 1979).

b) Voluntary feed intake and digestibility

Voluntary feed intake and *in vitro* dry matter digestibility were presented in table 2. Feed intake was significantly ($P<0.001$) higher at the flowering stage compared to the seed setting stage. The results revealed that the goats had significantly ($P< 0.0001$) better *in vitro* dry matter digestibility during the flowering stage compared to seed setting stage. The decreasing digestibility of dry matter during seed setting stage may be due to age of grasses. McDonald *et al* (1973) who reported 50-80% dry matter digestibility was higher for young grasses. The animals' feed preferences are influenced by feed availability, plant structure, nutrient deficiencies (e.g. salt) and appetite and, of course, different species of animals prefer different types of feed Chacon *et al* (1978). For instance, seasonal rainfall is often assumed to be an indicator of feed conditions while stocking rate has been used as a substitute for feed intake (Abel *et al,* 1987).

c) Live weight gains

Table 3 shows the live weight gains of goats during two stages of plant maturity. During the flowering stage goats significantly ($P<0.0001$) gained more body weight (25.00 g/day), when compared to seed setting stage (0.47 g/day). Devendra *et al* (1970) reported the forage intake of the goat has been taken as 2.5% of body weight, based on a range of 2.1 to 3.2%. When making comparisons between animals of different size to determine the importance of nutrition as a constraint, DM intake should be expressed in relation to the live weight (and preferably the metabolic weight, i.e. LW0.75) of the animal (Graham, 1972).

d) Distance walked

Table 4 shows the distance walked per hour (m/hr) by goats. Also the results revealed that the goats significantly ($P<0.0001$) walked more distance during the seed setting stage (92.63 m/h) compared to the flowering stage (44.50 m/h). De Leeuw and Chara (1985) used the technique to compare goat and sheep browse preferences in mixed Maasai flocks in Kenya. Range condition is based on density and production of native, palatable, perennial grasses. A better criterion might be the diversity of palatable forage species. It might be desirable if up to 20% of yearly forage production is composed of palatable annuals (Holechek, 1984).

e) Nutritive value of diet

Table 5 shows the nutritive value of diet intake. The nutritive values of diet such as dry matter (DM), organic matter (OM) and crude protein (CP) were significantly higher during the flowering stage compared to seed setting stage. However; ash content and crude fiber (CF) were significantly ($P<0.0001$) higher during the seed setting stage than the flowering stage. Leaves of grasses from forbs and shrubs are generally higher in protein, crude fiber, dry matter, organic matter and ash content than the grass leaves and stems at comparative stages of growth (Vansoest, 1982).

IV. Conclusion

It was concluded that flowering stage beneficially goats highly preference and selectivity different species, feed intake and inviter dry matter digestibility and body weight gained. The seed setting stage was highly ash contents, crude fiber distance walked.

Table 1 : Bite counts (%) ♀ of the different range species by goat during the flowering and seed setting stages at El-Khuwei locality, north Kordofan, Sudan.

Plant species		Bite count (%)	
Latin names	Local name	Flowering stage	Seed stage
Eragrostis tremula	Bano	74.25	34.67
Cenchrus biflorus	Huskneet	48.46	30.56
Echinocloa colonum	Difra	33.85	29.99
Luffa aegyptiaca	Leflef	31.71	24.10
Aristida sp	Gaw	29.55	20.82

Fimbristyls hispidula	Fisiya	23.20	19.00
Hymenocardia acida	Himeira	21.09	14.07
Sida cordofolia	Nuida	18.18	13.89
Oldenlandia senegalensis	Tmrfar	17.99	11.21
Andropogon gayanus	Aborakhus	16.50	8.86
Geigeria alata	Gadgad	14.98	-
Commelinia subulata	Buid	10.14	-
Sesamum alatum	Simeima	4.00	-
Ceraotheca sesamoid	Abodaib	2.86	-
Zalea sp	Rabaa	2.86	-
Zornia glochidiata	Shuleny	2.50	-

Chi Square test =37.11*

Table 2 : Feed intake and *in vitro* dry matter digestibility during the flowering and seed setting stages at El

Parameters	Flowering stage	Seed setting stage	SE±
Feed intake (g/day)	0.54	0.36	0.04**
IVDMD **(%)**	67.46	60.15	1.05***

Means in the same column under the same factor with different letters are significantly different
* = significant (P < 0.05), ** = high significant (P < 0.01) and *** = highly significant (P < 0.001)

Table 3 : Body weight gains of goats, during the flowering and seed setting stages at El-Khuwei locality, north Kordofan, Sudan

Parameter	Flowering	Seed setting	SE ±
Body weight gains (g/day)	25	0.47	1.58***

Means in the same column under the same factor with different letters are significantly different
* = significant (P < 0.05), ** = high significant (P < 0.01) and *** = highly significant (P < 0.001)

Table 4 : Distance walked (m/hr) by goats at the flowering and seed setting stages at El-Khuwei locality, north Kordofan, Sudan

Parameter	Flowering	Seed setting	SE ±
Distance walked (m/hr)	44.50	92.63	2.34***

Means in the same column under the same factor with different letters are significantly different
* = significant (P < 0.05), ** = high significant (P < 0.01) and *** = highly significant (P < 0.001)

Table 5 : Nutritive value of diet (%) during the flowering and seed setting stages at El-Khuwei locality, north Kordofan, Sudan

Parameter	Flowering	Seed setting	SE±
DM	0.96	0.95	0.10***
OM	0.86	0.83	0.18***
Ash	0.09	0.12	0.35***
CF	0.31	0.37	0.47***
CP	0.14	0.10	0.12***

Means in the same column under the same factor with different letters are significantly different
* = significant (P < 0.05), ** = high significant (P < 0.01) and *** = highly significant (P < 0.001)

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Global Journal of Science Frontier Research (D) Volume XIII Issue XIII Version I Year 2013
30

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Global Journal of Science Frontier Research
Agriculture and Veterinary
Volume 13 Issue 13 Version 1.0 Year 2013
Type : Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4626 & Print ISSN: 0975-5896

Eco-Silvicultural Interventions for Rehabilitation of Gregariously Flowered Bamboo Forests with Special Reference to *Dendrocalamus Strictus* (Roxb) Nees

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Abstract- Bamboo is of vital importance from ecological, commercial and socio-economic points of view. The bamboo resources in the country are shrinking day by day due to various reasons, particularly due to un-establishment of bamboo clump after the gregarious flowering of bamboo. After gregarious flowering, the natural regeneration of bamboo species forms carpet on forest floor and remained in whippy stage for several decades. The present paper deals with the eco-silvicultural interventions for rehabilitation of bamboo after gregarious flowering. The treatments were given after formation of bamboo elites. The findings revealed that after post flowering treatments, the clump formation and culms growth found significantly improved. Without post flowering treatments the bamboo growth found in whippy stage even after the decades of gregarious flowering. The post flowering treatments should include protection from fires and grazing, proper spacing along with digging of carpet regeneration, cut back operations, soil working and canopy manipulation.

Keywords: gregarious flowering, rehabilitation, spacing, soil working, canopy manipulation.

GJSFR-D Classification : FOR Code: 300699p

Strictly as per the compliance and regulations of :

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Abstract- Bamboo is of vital importance from ecological, commercial and socio-economic points of view. The bamboo resources in the country are shrinking day by day due to various reasons, particularly due to un-establishment of bamboo clump after the gregarious flowering of bamboo. After gregarious flowering, the natural regeneration of bamboo species forms carpet on forest floor and remained in whippy stage for several decades. The present paper deals with the eco-silvicultural interventions for rehabilitation of bamboo after gregarious flowering. The treatments were given after formation of bamboo elites. The findings revealed that after post flowering treatments, the clump formation and culms growth found significantly improved. Without post flowering treatments the bamboo growth found in whippy stage even after the decades of gregarious flowering. The post flowering treatments should include protection from fires and grazing, proper spacing along with digging of carpet regeneration, cut back operations, soil working and canopy manipulation.

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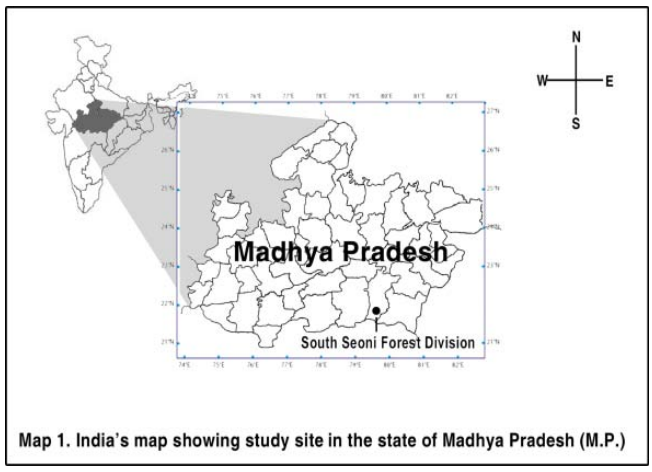
I. Introduction

Traditionally, bamboo is recognized as "poor man's timber" as it is directly related with human life from cradle to eternal voyage. Versatile characteristics of bamboo make it useful for variety of purposes both in herbal and rural sectors, and play vital role for Indian prosperity. The bamboo has vital environmental value in reducing air pollution, water pollution, land pollution, and to ameliorate climate. The bamboo being a C-4 plant absorbs more carbon-dioxide from the atmosphere and gives out oxygen at faster rate. Its roots are highly capable of VAM infection, and consequently to improve soil conditions. The plant's leaves absorb toxic heavy metals like Fe and Zn. It is very promising species for planting on farmlands, homesteads, stream margins, boundaries and degraded lands. The bamboo resources in India are shrinking day by day due to gregarious flowering and seeding and subsequent dying. The flowering in bamboo is a rare phenomenon. Generally it occurs at long intervals. The period of physiological cycle (the period between two consecutive flowerings) is species-specific. The demand of bamboo has risen tremendously. For meeting the demand, it is therefore necessary to take steps to increase the yield of bamboo through developing rehabilitation techniques for gregariously flowered bamboo areas. Gregarious flowering is coupled partly due to genetic and partly by environmental factors. The seedlings which appear during rains are disappeared soon in the absence of congenial conditions, biotic closure and silvicultural treatments. In gregarious flowering, entire populations in a given area will bloom, with all clumps, and in all culms of the clumps. Time of flowering may extend from a few months to a few years. In gregarious flowering, the affected clumps will invariably die. The physiological cycle of gregarious flowering varied from 17 to 50 years in different areas. Very little attempts were made on eco-silvicultural interventions for management of gregariously flowered bamboo forests. The present paper deals with the effects of silvicultural treatments in bamboo forests flowered gregariously during 2005-2006 at Rukhad range of south Seoni forest division in the state of Madhya Pradesh, India (Map 1).



Map 1. India's map showing study site in the state of Madhya Pradesh (M.P.)

II. Materials and Methods

In south Seoni division, Rukhad range was identified for the study. This experiment includes 05 treatment plots of different spacing and 01 control plots

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without spacing. At Rukhad different spacing plots were fenced using barbed wire. In all spacing plots, all intervening rhizomes were dug out and kept in a rhizome bank established at the Institute (Table 1).

Table 1 : Silvicultural interventions pertaining to different spacing at Rukhad range of South Seoni forest division (Madhya Pradesh, India)

SN	Treatment code	Treatment detail of different spacing	Plot details	Compartment no.
1.	S-1	2m x 2m	Fenced and protected from grazing and fire, canopy density 0.4	409
2.	S-2	4m x 4m	Fenced and protected from grazing and fire, canopy density 0.4	409
3.	S-3	6m x 6m	Fenced and protected from grazing and fire, canopy density 0.4	409
4.	S-4	8m x 8m	Fenced and protected from grazing and fire, canopy density 0.4	409
5.	S-5	10m x 10m	Fenced and protected from grazing and fire, canopy density 0.4	409
6.	S-0	No spacing (Natural)	Open for grazing and fire (without fencing), canopy density 0.4	409

The randomized block design (RBD) was used. The plot size in all treatment was 50mX50m. Each treatment was divided into three replicates of 16.66 m X 16.66 m. The observation of height and girth of each plant was taken in each treatment. The mean observation of plants in each replicate was considered for statistical analysis. Each replicate had equal number of observations. The parameters taken for statistical analysis were height increment, girth increment and production of number of culms clump^{-1} during the five years period. The statistical analysis was made using SPSS software.

III. Results

At Rukahd (compartment no. 409), 5 spacing viz., 2mx2m, 4mx4m, 6mx6m, 8mx8m and 10mx10m were tried to study their effects on culms and clump growth. Of these 5 spacing tried, 4mx4m spacing gave better results in terms of height and girth increment of regeneration/elite seedling and other growth parameters of clump formation. The height and girth increments in five years period with 4mx4m spacing were found to be 589 cm and 10.31 cm respectively, followed by 2mx2m spacing (465 cm increase in height and 8.17 cm increase in girth), 6mx6m spacing (463 cm increase in height and 8.04 cm increase in girth), 8mx8m spacing (438 cm increase in height and 7.67 cm increase in girth), 10mx10m spacing (413 cm increase in height and 6.72 cm increase in girth). All the treatments were found significantly superior over control. In open (control), the average increase in height and girth after five years period was found to be 189 cm and 4.93 cm respectively. Besides the increase in culms growth, the clump formation (11.67 culms clump^{-1}) was also found superior with 4mx4m spacing, followed by spacing of 2mx2m (10.43 culms clump^{-1}), 6mx 6m (10.28 culms clump^{-1}), 8m x 8m (10.08 culms clump^{-1}), 10mx10m (10.04 culms clump^{-1}) and control (6.96 culms clump^{-1}) (Table 2).

Table 3 shows the descriptive statistics i.e. number of cases, mean, standard deviation, lower and upper bound at 95% confidence interval for mean, minimum and maximum values. The perusal of descriptive results reveals that treatments do differ in mean and range (i.e. maximum and minimum observation). One-way ANOVA reveals that all treatments differ significantly for parameters under study at 95 % level of significance. If the number 0.000 increases more than 0.05 the treatments may not differ significantly at 95% level of confidence. However, in the study site, it is less than 0.05, Hence, f value in the adjoining column in more than the tabulated F value at 95% level of significance. So, it is clear that all treatments show significant difference from each other on different parameters. Further it can be interpreted that height increment, girth increment and number of culms per clump were significantly different between and within groups among various treatments. To establish one treatment as the best among the lot, we have to compare it with others based on critical difference. If one treatment is the best among the group, its mean difference with any other should be more than the critical difference. Spacing treatments at different intervals are compared with each other with reference to increment in height, girth and number of culms per clump during the five years study period. In the first

column, the dependent variable is shown as height increment, girth increment and number of culms per clump. The 6 spacing treatments viz; S1 (2mx2m), S2 (4mx4m), S3 (6mx6m), S4 (8mx8m), S5 (10mx10m) and S0 (Control) given in column 2 (I) were compared between the other groups as given in column 3 (J). The star (*) marks show that the mean difference is more than the critical difference at 95% significant level. The negative sign in the column of mean difference shows that treatment under comparison is inferior to other treatments. The positive sign indicates that the treatment is superior to other treatments under compared. Perusal of results indicated that treatment S2 (4mx4m spacing) was the best among the other treatments in terms of height and girth increment and number of culms per clump. The mean difference of treatment S2 (spacing of 4mx4m) is significant as compared to other treatments in terms of height increment, girth increment and number of culms per clump as the value of mean difference is significant at the 0.05 level. The negative sign in control showed that the height and girth increment and number of culms per clump were inferior to the other treated plots. In other words, different spacing treatments affect significantly the clump formation in bamboo.

Table 2 : Effect of different spacing on height and girth increment and average number of culms clump^{-1} of bamboo regeneration at Rukhad (years 2007- 12)

Treatment	Annual average height in cm (2007 to 2012)						Annual average girth in cm (2007 to 2012)						Increase in height (cm) during five years	Increase in girth (cm) during five years	Average no. of culms clump^{-1} in 2012
	07	08	09	10	11	12	07	08	09	10	11	12			
S-1 (2x2m)	110	141	290	517	535	575	2.00	3.54	4.86	8.89	9.32	10.17	465	8.17	10.43
S-2 (4x4m)	101	137	310	652	680	690	2.00	3.85	5.63	9.08	10.90	12.31	589	10.31	11.67
S-3 (6x6m)	104	131	286	402	490	567	2.00	3.66	4.12	6.65	9.71	10.04	463	8.04	10.28
S-4 (8x8m)	92	148	262	346	435	530	3.60	3.50	4.00	8.20	10.40	11.27	438	7.67	10.08
S-5 (10x10m)	141	179	253	375	415	554	3.10	3.42	3.98	7.00	8.44	9.82	413	6.72	10.04
S-0 (Open)	180	103	187	361	362	369	1.30	1.46	2.00	4.80	5.15	6.23	189	4.93	6.96

Table 3 : Statistical analysis (Descriptive, ANOVA and post hoc test) for spacing experiment

Descriptive									
						95% Confidence Interval for Mean			
		N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound	Minimum	Maximum
Height increment	S1 2x2m	3	465.000	10.0000	5.77350	440.1586	489.8414	455.0	475.0
	S2 4x4m	3	589.000	14.0000	8.08290	554.2221	623.7779	575.0	603.0
	S3 6x6m	3	463.000	5.00000	2.88675	450.5793	475.4207	458.0	468.0
	S4 8x8m	3	438.000	6.00000	3.46410	423.0952	452.9048	432.0	444.0
	S5 10x10m	3	413.000	14.7309	8.50490	376.4064	449.5936	400.0	429.0
	S0 Control	3	189.000	10.53565	6.08276	162.8280	215.1720	179.0	200.0
	Total	18	426.167	123.4773	29.1038	364.7629	487.5704	179.0	603.0
Girth increment	S1 2x2m	3	8.1700	1.03058	0.59501	5.6099	10.7301	7.120	9.180
	S2 4x4m	3	10.3100	0.68432	0.39509	8.6100	12.0100	9.900	11.10
	S3 6x6m	3	8.0400	0.12000	0.06928	7.7419	8.3381	7.920	8.160
	S4 8x8m	3	7.6700	0.15716	0.09074	7.2796	8.0604	7.500	7.810
	S5 10x10m	3	6.7200	1.08130	0.62429	4.0339	9.4061	5.500	7.560
	S0 Control	3	4.9300	0.50764	0.29309	3.6689	6.1911	4.500	5.490
	Total	18	7.6400	1.77028	0.41726	6.7597	8.5203	4.500	11.10

No. of culms per clump in 2012	S1 2x2m	3	10.4300	1.10964	0.64065	7.6735	13.1865	9.150	11.12
	S2 4x4m	3	11.6700	0.43035	0.24846	10.6010	12.7390	11.25	12.11
	S3 6x6m	3	10.2800	0.52048	0.30050	8.9871	11.5729	9.950	10.88
	S4 8x8m	3	10.0800	0.08888	0.05132	9.8592	10.3008	9.980	10.15
	S5 10x10m	3	10.0400	0.99504	0.57449	7.5682	12.5118	9.050	11.04
	S0 Control	3	6.9600	0.37643	0.21733	6.0249	7.8951	6.530	7.230
	Total	18	9.9100	1.57953	0.37230	9.1245	10.6955	6.530	12.11

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Height increment	Between Groups	257822.500	5	51564.500	451.660	0.000
	Within Groups	1370.000	12	114.167		
	Total	259192.500	17			
Girth increment	Between Groups	47.284	5	9.457	18.936	0.000
	Within Groups	5.993	12	0.499		
	Total	53.276	17			
No of culms per Clump 2012	Between Groups	36.760	5	7.352	15.603	0.000
	Within Groups	5.654	12	0.471		
	Total	42.414	17			

Post Hoc Tests

Multiple Comparisons

LSD

Dependent Variable	(I) Treatment	(J) Treatment	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Height increment	S1 2x2m	S2 4x4m	-124.00000*	8.72417	0.000	-143.0083	-104.9917
		S3 6x6m	2.00000	8.72417	0.823	-17.0083	21.0083
		S4 8x8m	27.00000*	8.72417	0.009	7.9917	46.0083
		S5 "10x10m"	52.00000*	8.72417	0.000	32.9917	71.0083
		S0 Control	276.00000*	8.72417	0.000	256.9917	295.0083
	S2 4x4m	S1 2x2m	124.00000*	8.72417	0.000	104.9917	143.0083
		S3 6x6m	126.00000*	8.72417	0.000	106.9917	145.0083
		S4 8x8m	151.00000*	8.72417	0.000	131.9917	170.0083
		S5 "10x10m"	176.00000*	8.72417	0.000	156.9917	195.0083
		S0 Control	400.00000*	8.72417	0.000	380.9917	419.0083
	S3 6x6m	S1 2x2m	-2.00000	8.72417	0.823	-21.0083	17.0083
		S2 4x4m	-126.00000*	8.72417	0.000	-145.0083	-106.9917
		S4 8x8m	25.00000*	8.72417	0.014	5.9917	44.0083
		S5 "10x10m"	50.00000*	8.72417	0.000	30.9917	69.0083
		S0 Control	274.00000*	8.72417	0.000	254.9917	293.0083
	S4 8x8m	S1 2x2m	-27.00000*	8.72417	0.009	-46.0083	-7.9917
		S2 4x4m	-151.00000*	8.72417	0.000	-170.0083	-131.9917
		S3 6x6m	-25.00000*	8.72417	0.014	-44.0083	-5.9917
		S5 "10x10m"	25.00000*	8.72417	0.014	5.9917	44.0083
		S0 Control	249.00000*	8.72417	0.000	229.9917	268.0083
	S5 "10x10m"	S1 2x2m	-52.00000*	8.72417	0.000	-71.0083	-32.9917
		S2 4x4m	-176.00000*	8.72417	0.000	-195.0083	-156.9917
		S3 6x6m	-50.00000*	8.72417	0.000	-69.0083	-30.9917
		S4 8x8m	-25.00000*	8.72417	0.014	-44.0083	-5.9917
		S0 Control	224.00000*	8.72417	0.000	204.9917	243.0083
	S0 Control	S1 2x2m	-276.00000*	8.72417	0.000	-295.0083	-256.9917
		S2 4x4m	-400.00000*	8.72417	0.000	-419.0083	-380.9917
		S3 6x6m	-274.00000*	8.72417	0.000	-293.0083	-254.9917

		S4 8x8m	-249.00000*	8.72417	0.000	-268.0083	-229.9917
		S5 "10x10m"	-224.00000*	8.72417	0.000	-243.0083	-204.9917
Girth increment	S1 2x2m	S2 4x4m	-2.14000*	.57700	0.003	-3.3972	-0.8828
		S3 6x6m	.13000	.57700	0.826	-1.1272	1.3872
		S4 8x8m	.50000	.57700	0.403	-0.7572	1.7572
		S5 "10x10m"	1.45000*	.57700	0.027	0.1928	2.7072
		S0 Control	3.24000*	.57700	0.000	1.9828	4.4972
	S2 4x4m	S1 2x2m	2.14000*	.57700	0.003	0.8828	3.3972
		S3 6x6m	2.27000*	.57700	0.002	1.0128	3.5272
		S4 8x8m	2.64000*	.57700	0.001	1.3828	3.8972
		S5 "10x10m"	3.59000*	.57700	0.000	2.3328	4.8472
		S0 Control	5.38000*	.57700	0.000	4.1228	6.6372
	S3 6x6m	S1 2x2m	-.13000	.57700	0.826	-1.3872	1.1272
		S2 4x4m	-2.27000*	.57700	0.002	-3.5272	-1.0128
		S4 8x8m	.37000	.57700	0.533	-0.8872	1.6272
		S5 "10x10m"	1.32000*	.57700	0.041	0.0628	2.5772
		S0 Control	3.11000*	.57700	0.000	1.8528	4.3672
	S4 8x8m	S1 2x2m	-.50000	.57700	0.403	-1.7572	0.7572
		S2 4x4m	-2.64000*	.57700	0.001	-3.8972	-1.3828
		S3 6x6m	-.37000	.57700	0.533	-1.6272	0.8872
		S5 "10x10m"	.95000	.57700	0.126	-0.3072	2.2072
		S0 Control	2.74000*	.57700	0.000	1.4828	3.9972
	S5 "10x10m"	S1 2x2m	-1.45000*	.57700	0.027	-2.7072	-0.1928
		S2 4x4m	-3.59000*	.57700	0.000	-4.8472	-2.3328
		S3 6x6m	-1.32000*	.57700	0.041	-2.5772	-0.0628
		S4 8x8m	-.95000	.57700	0.126	-2.2072	0.3072
		S0 Control	1.79000*	.57700	0.009	0.5328	3.0472
	S0 Control	S1 2x2m	-3.24000*	.57700	0.000	-4.4972	-1.9828
		S2 4x4m	-5.38000*	.57700	0.000	-6.6372	-4.1228
		S3 6x6m	-3.11000*	.57700	0.000	-4.3672	-1.8528
		S4 8x8m	-2.74000*	.57700	0.000	-3.9972	-1.4828
		S5 "10x10m"	-1.79000*	.57700	0.009	-3.0472	-0.5328
No. of culms per clump in 2012	S1 2x2m	S2 4x4m	-1.24000*	.56047	0.047	-2.4612	-.0188
		S3 6x6m	.15000	.56047	0.794	-1.0712	1.3712
		S4 8x8m	.35000	.56047	0.544	-0.8712	1.5712
		S5 "10x10m"	.39000	.56047	0.500	-0.8312	1.6112
		S0 Control	3.47000*	.56047	0.000	2.2488	4.6912
	S2 4x4m	S1 2x2m	1.24000*	.56047	0.047	0.0188	2.4612
		S3 6x6m	1.39000*	.56047	0.029	0.1688	2.6112
		S4 8x8m	1.59000*	.56047	0.015	0.3688	2.8112
		S5 "10x10m"	1.63000*	.56047	0.013	0.4088	2.8512
		S0 Control	4.71000*	.56047	0.000	3.4888	5.9312
	S3 6x6m	S1 2x2m	-.15000	.56047	0.794	-1.3712	1.0712
		S2 4x4m	-1.39000*	.56047	0.029	-2.6112	-.1688
		S4 8x8m	.20000	.56047	0.727	-1.0212	1.4212
		S5 "10x10m"	.24000	.56047	0.676	-.9812	1.4612
		S0 Control	3.32000*	.56047	0.000	2.0988	4.5412
	S4 8x8m	S1 2x2m	-.35000	.56047	0.544	-1.5712	.8712
		S2 4x4m	-1.59000*	.56047	0.015	-2.8112	-.3688
		S3 6x6m	-.20000	.56047	0.727	-1.4212	1.0212
		S5 "10x10m"	.04000	.56047	0.944	-1.1812	1.2612
		S0 Control	3.12000*	.56047	0.000	1.8988	4.3412

	S5 "10x10m"	S1 2x2m	-.39000	.56047	0.500	-1.6112	.8312
		S2 4x4m	-1.63000*	.56047	0.013	-2.8512	-.4088
		S3 6x6m	-.24000	.56047	0.676	-1.4612	.9812
		S4 8x8m	-.04000	.56047	0.944	-1.2612	1.1812
		S0 Control	3.08000*	.56047	0.000	1.8588	4.3012
	S0 Control	S1 2x2m	-3.47000*	.56047	0.000	-4.6912	-2.2488
		S2 4x4m	-4.71000*	.56047	0.000	-5.9312	-3.4888
		S3 6x6m	-3.32000*	.56047	0.000	-4.5412	-2.0988
		S4 8x8m	-3.12000*	.56047	0.000	-4.3412	-1.8988
		S5 "10x10m"	-3.08000*	.56047	0.000	-4.3012	-1.8588

**. The mean difference is significant at the 0.05 level.*

IV. Discussion

Without silvicultural intervention of flowered areas, the profuse uniformly dense mat of bamboo regeneration prevents the formation of bamboo clumps. In the state of Madhya Pradesh, the Kundam project (Jabalpur forest division) was started in 1976 as a constituent unit of the Madhya Pradesh State Forest Development Corporation with the objectives of raising commercial plantations of teak and bamboo. Consequent to gregarious bamboo flowering, bamboo regeneration was seen everywhere, but due to unchecked grazing and frequent fires, the bamboo regeneration was suppressed. Opening of the canopy (100 to 120 trees ha^{-1}) and protection measures adopted had resulted in promoting the luxuriant growth of bamboo. In order to promote the growth of bamboo regeneration, the approximate spacing of bamboo plants kept at 4mx4m interval along with weeding and soil working treatments. The increase in average height was recorded to be 96, 25, 46 and 179 cm from compartment no. 160, 162,163 and 164 respectively in the first season (Hakeem, 1985). In north Betul forest division, the gregarious flowering of bamboo occurred in Gawasen range in 1976-1977 in 10277 ha area and has remained unproductive over a period of 10 years due to lack of cultural operations/post flowering treatments to rehabilitate the flowered areas. The post flowering treatment consisted of *elite* selection at spacing of about 4mx4m and then digging of all rhizomes in one meter diameter around the elite. The flowered areas were strictly protected from fire and grazing. The observations/measurement of post flowering treatments on morphology of bamboo clumps was recorded in 2007-12 (Chaubey, 2012). The treated areas have converted into good bamboo forest comprising all aged bamboo culms in the clumps formed. The proper spacing and soil working around elite selection proved effective in forming clumps of bamboo with all aged culms. In Shahdol district including Bandhavgarh national park area of Madhya Pradesh, the gregarious flowering in bamboo (*Dendrocalamus strictus*) occupied an area of about 42500 ha during 1984-87 (Dwivedi, 1988). Even after 4 years, the height growth in seedlings was found between 100-170 cm. The dense carpet of bamboo regeneration at many places has suppressed the growth of all other species. The average number of bamboo seedlings per hectare was recorded to be seven times more than the number of grass seedlings. The rampant natural regeneration of *Dendrocalamus strictus* hampered development of the other species and thus, proved harmful for biodiversity of the region. The utilization pattern of *cheetal*, *sambhar* and *elephant* had been changed to a great extent due to thickets of bamboo regeneration as it prevents the germination of other perennial and annual forage/browse species in the area. The only possible operation that can be done in park areas is to adopt elite selection in such regenerated areas by creating spacing of 5mx5m by careful cutting and digging of the area to save the diversity of the habitat (Rajesh Gopal, 1989). In north Mandla forest division, the gregarious flowering occurred in 1971-73. In subsequent years, the fallen seeds germinated profusely. Under the programme of rehabilitation, the areas in patches of 50-100 hectares were closed by digging cattle-proof trenches in 1981. Cutback operations and soil working along with protection measures of fire and grazing were adopted under post-flowering treatments after 10 years of flowering. After five years of protection, 8293 established seedling and saplings of bamboo and other species were observed in protected areas against 3944 seedlings and saplings of bamboo and other tree species in unprotected areas (Prasad, 1985). The gregarious flowering of bamboo in Barela and Katni ranges of Jabalpur forest circle occurred between 1965 and 1974, resulting into reduction in bamboo resources in many areas. The cleaning and soil working was carried out in 1993. After the post-flowering treatments, mean recruitment of “Karlas” (current year's bamboo) in treated clumps was recorded to be 68% (Prasad and Parihar, 1994).

In the state of Maharashtra, the major bamboo species are *Dendrocalamus strictus*, *Bambusa arundinacea* and *Oxytenanthera ritcheyi*. Prabhu and Dabral (1989) reported that out of 48 forest divisions of the state, gregarious flowering of the *Dendrocalamus strictus* recorded in 16 divisions at 40 to 43 years of

physiological cycle. After gregarious flowering, the natural regeneration of bamboo form carpet on the forest floor. Even after 25 years, the sporadic clumps formed in the area were not fit for harvesting (Prabhu and Dabral, 1989). These facts call for a serious, patient and concerted post flowering efforts for establishment and rehabilitation of bamboo regeneration. In various working plans of Maharashtra, tending operation is prescribed for establishing bamboo regeneration.

There is no scientific record available on historical occurrence of gregarious bamboo flowering in Northeast India. In Sikkim 29 bamboo species are reported. During 2006, 4 bamboo species viz., *Dendrocalamus hamiltomii, Dendrocalamus hookeri, Sinarundinaria intermedia, Arundinaria racemosa*, flowered gregariously. Under post flowering treatment strict protection from grazing and fire is followed in the area. As the flowering appears in the area, about 70% of the clumps is harvested and balance 30% clumps is retained for production of seeds and to provide a light shade for successful natural regeneration after seed fall. In Assam, about 30 species of bamboo are reported to be gregariously flowered, but till now no action is reported to be implemented (Goyal and Kishwan, 2004; Kishwan and Goyal, 2006; Prasad and Pattanaik, 2002).

V. Conclusion

Whereas bamboo is found occurring widely in different tropical forests of the country which apart from being a source of livelihood of forest dependent population and industry its ecological role in Sustainable Forest Management requires greater attention. Based on experimental findings and literature review, the following conclusions are drawn:-

1. Apart from establishment of *ex-situ* rhizome banks, establishment of *in-situ* rhizome banks should be encouraged.
2. The rehabilitation activities to promote clump formation should be initiated after 2-3 years of flowering period while elite formation get started.
3. Spacing of selected healthy seedlings/ elites is recommended to be 4mx4m in forests with open canopy (density 0.4 and below). Forests with moderate canopy (density 0.4-0.5) should have spacing of selected healthy seedlings by 5m x 5m. All the interwoven rhizomes/ seedlings must be dug out in all the spacing prescribed. The treatment area must be protected from all the biotic factors for 5 years period after initiation of treatments.
4. In wild life areas, unproductive whippy stage dense carpet of bamboo suppressed growth and diversity of other species, and habitat of wild life reduced to a great extent. In these areas, past review recommended the elites selection at 5mx5m spacing, and cutting down of other bamboo regeneration as and when required.
5. The complete grazing closure for at least five years period is recommended to stimulate growth of bamboo seedlings and formation of clumps.
6. The intermast periods of bamboos are not as rigid as they are made out. In *Bambusa bambos* and *Dendrocalamus strictus,* there are many cohorts differing in their intermast periods. Therefore, selection for long intermast period for raising planting stock will be very useful.
7. Most tropical forests are amenable to assisted natural regeneration (ANR) treatments. Therefore, while bamboo plantation may be a desirable forestry practice, ANR is the most desirable silvicultural intervention which is comparatively inexpensive, easy and reliable method of rehabilitation of flowered bamboo areas. Joint Forest Management Committees should be actively engaged in management decision making and implementation of ANR activities on care and share basis.
8. Digitized maps of bamboo flowered areas should be prepared, with separate action plan to rehabilitate the area apart from the existing working plan treatment schedule. This digitized map of flowered area, action plan of rehabilitation and action taken report should be appended in the working plan.

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Global Journal of Science Frontier Research
Agriculture and Veterinary
Volume 13 Issue 13 Version 1.0 Year 2013
Type : Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4626 & Print ISSN: 0975-5896

Stochastic Analysis of Land Degradation on Edo State Agricultural System

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Abstract- Edo state, like many other states in Niger-Delta and Nigeria as a nation has resultant land and water degradation problems such as persistent oil spillage, erosion of arable land, sedimentation of dam and reservoirs. This research study investigates the effects of land degradation in all the local government areas in Edo state. The results of the findings indicated that 28% corresponding to 634,416.3 ha of arable land had totally been affected by soil erosion. Highest erodibility index of 0.75 was obtained at Estako west (Auchi), while least value of 0.1 was found at Akoko-Edo local government area respectively. Between 1976 and 1997, 1,820,410.50 barrels of crude oil spilled with maximum spill value 600,511.02 barrels in 1984 and minimum spill of 5,956 barrels in 1989. Reduction of cassava production was estimated and analyzed. The result showed that the reduction is highly significant at 95% confidence interval. Etasko –west had the highest reduction from 7.26 MT/HA in 1993 to 1.1 MT/HA in 2002. In addition, analysis of erosion and land degradation control expenditures showed that little attention has been paid to controlling land degradation in the state. Erosion control expenditure was increased from 4.1% in 1990 to 10% in 2002. This increase is not significant at 0.01 and 0.05 levels of significance. All these constraints affect agricultural production, human well-being, social and economic growth of the people in Edo state.

Keywords: degradation, land, erosion, spillage, index, state, hectare, expenditure.

GJSFR-D Classification : FOR Code: 300999p

Strictly as per the compliance and regulations of :

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Olotu Yahaya [α], Diamond Blessing [σ], Dagona A.G [ρ] & Morakinyo T.A [ω]

Abstract- Edo state, like many other states in Niger-Delta and Nigeria as a nation has resultant land and water degradation problems such as persistent oil spillage, erosion of arable land, sedimentation of dam and reservoirs. This research study investigates the effects of land degradation in all the local government areas in Edo state. The results of the findings indicated that 28% corresponding to 634,416.3 ha of arable land had totally been affected by soil erosion. Highest erodibility index of 0.75 was obtained at Estako west (Auchi), while least value of 0.1 was found at Akoko-Edo local government area respectively. Between 1976 and 1997, 1,820,410.50 barrels of crude oil spilled with maximum spill value 600,511.02 barrels in 1984 and minimum spill of 5,956 barrels in 1989. Reduction of cassava production was estimated and analyzed. The result showed that the reduction is highly significant at 95% confidence interval. Etasko -west had the highest reduction from 7.26 MT/HA in 1993 to 1.1 MT/HA in 2002. In addition, analysis of erosion and land degradation control expenditures showed that little attention has been paid to controlling land degradation in the state. Erosion control expenditure was increased from 4.1% in 1990 to 10% in 2002. This increase is not significant at 0.01 and 0.05 levels of significance. All these constraints affect agricultural production, human well-being, social and economic growth of the people in Edo state.

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I. Introduction

Edo state is in the comparatively enviable position of having a large percentage of its land arable, and much of that not yet under cultivation. Approximately 75 percent of the state's land is relatively fertile and receives sufficient rainfall for rainfed cropping or pasture. Only around 30 percent of the arable land is currently under cultivation (Pake et al,. 1999). The agricultural population is relatively concentrated in Eastern, Southern and Western Region, and zones within those areas have less relative population densities. In several regions, important signs of soil degradation trends are apparent including declining yields and a switch to crops that demand fewer nutrients. Indeed, food production has not kept up with the state's population growth despite an expansion of area under crops. Per capita food production hit a low in 1990, and even with recent increases it has not reached the levels of the 1970's (NEMA, 2001).

Land degradation is a universal problem. We must not be misled into thinking it is restricted to agricultural land or agricultural livelihoods, although it is in these areas that the effects of land degradation are immediately apparent and most dramatic. In the developing world, land degradation is a symptom of under-development. It results from a combination of social and economic factors, such as poverty and inequitable distribution of the land resources, inappropriate land use systems and farming methods. In the dry areas, these factors are exacerbated by climate and the fragility of ecosystems (UNEP, 1986). Because agriculture in the poorer countries is the principal employer of labour and generator of income, the effects of land degradation are often disastrous and lead to famine and political turmoil (UNEP, 1986).

As land is cleared for development, agriculture, and livestock grazing, unprotected areas are eroded, soil nutrients are depleted, and stalinization looms. Destroyed forests and degrade water resources imperil biodiversity, induce climate change, and disturb the hydrologic cycle. The livelihoods of more than 900 million people in some 100 countries are now directly and adversely affected by land degradation (UNDP, 1994). Unless the current rate of land degradation is slowed and reversed, the food security of humanity will be threatened and the ability of poor nations to increase their wealth through improved productivity will be impeded. Land degradation can be observed in all agro-climatic regions on all continents. Although climatic condition, such as drought and floods, contribute to degradation, the main causes are human activities. Destroyed forests and degrade water resources imperil biodiversity, induce climate change, and disturb the hydrologic cycle. The livelihoods of more than 900 million people in some 100 countries are now directly and adversely affected by land degradation (UNDP, 1994).

The most significant landscape function affected by land degradation is the hydrologic balance of catchments. Unfavorable soil-surface characteristics of degraded lands and a lack of adequate plan cover lead to reduced surface retention and infiltration, and to

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higher surface runoff. This results not only in reduced soil moisture content in the soil profile, but also increased rate of soil erosion (Chan, 1998).

Land degradation takes different forms and manifestations in different regions and land-use systems. It is the result of complex causes and processes, and oversimplification of the environment, climate and land-use factors involved can mislead to the conclusion that rehabilitation of degraded land is easy and simple. Typical forms of degradation, predominant under certain conditions, can be identified as follows:

1. In the more humid areas, rainfall can occur in erosive showers. Especially in the sloping areas of the tropics and subtropics, these may cause serious soil erosion by runoff. High rainfall can also lead to high rates of nutrient leaching and to soil acidification in many tropical regions.
2. In the environments, vegetation cover is sparse on large areas of land. In these areas, strong seasonal winds can cause serious wind erosion, especially where the terrain is flat and the lack of standing plants or residues-due to overgrazing-leaves the soil vulnerable to wind.
3. In irrigated agriculture, inappropriate soil and water management practices, irrigation and drainage methods, and the use of marginal quality waters without proper management lead to the accumulation of salts in the soil. Plant growth is affected by this soil stalinizations, which has disastrous effects on the productivity of the land in areas where irrigation is essential for crop production.

Land degradation will remain an important global issue for the 21st century because of its adverse impact on agronomic productivity, the environment and its effect on food security and the quality of life. Productivity impacts of land degradation are due to a decline in land quality on site where degradation occurs (e.g. erosion) and off site where sediments are deposited. However, the on-site impacts of land degradation on productivity are easily masked due to use of additional inputs and adoption if improved technology.

II. Materials and Methods

a) *The study area*

Edo State was created on August 27th, 1991. Edo State was one of the two states carved out of the defunct Bendel state of Nigeria. There are at present Eighteen (18) local Government Areas in Edo state as shown in Table1. Edo state has approximately between latitude 05° 44'N and 07° 34'N of the Equator and between latitude 06° o4°'E and 06° 43°'E. It is bounded in the south by delta state in the West by Ondo state in the North and North East by kogi state and in the East by Anambra state (Segynola, 1993). Edo State covers an area of 19,744km^2 and has a total population of 2,159,848 and population density of 109 (based on the 1991 census figure). The major relief regions in the State include the swamps/Creeks, the Esan plateau, the valley and the dissected uplands of AKoko-Edo local Government area which ranges from183 to 305 meters above sea level. The soil type in the state is generally the reddish yellow land which varies from one to area in the state. The vegetative also vary from rain forest type in Benin low land to Savanna in the Akoko-Edo upland (Segynola, 1993). The two distinct seasons are the wet and dry seasons. Fig. 2 shows the map that indicates every local government areas in Edo State.

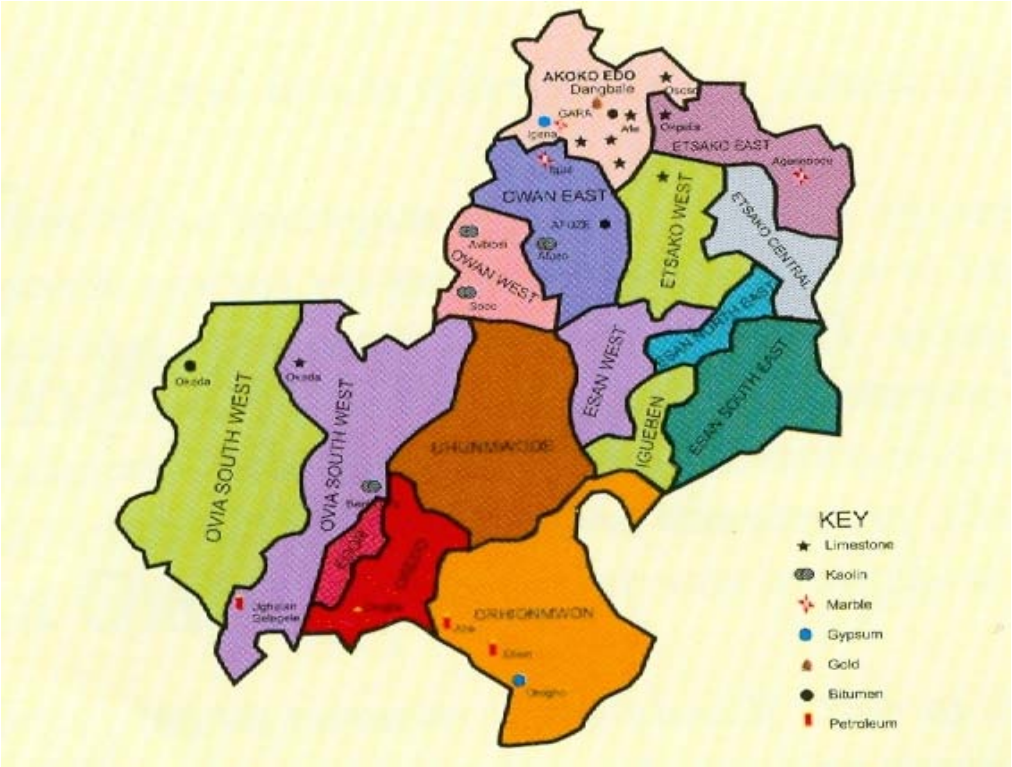

Fig 2 : Map of Edo-State, 2008

The data for this research came from both secondary and primary sources. The secondary sources include literature materials from the government ministries, agencies and previous research studies conducted by different authors. While the primary data sources were from questionnaires and structured interviews carried out in the field during the study. A total of 300 questionnaires were randomly distributed to some respondents across all the local government areas in the state. Out of the number that was distributed, 255 completed questionnaires were returned (representing 85 percent). Structured questionnaires were distributed to capture the following information:

1. The rate of oil spillage;
2. Degree of Agricultural soil lost to erosion;
3. Soil and yield loss in arable land in all the local government areas in Edo State; and
4. Quantities of waste generated in all the local government areas in Edo State. The data were sourced from the field study, ministries and some journals.

b) Data analysis

Obtained data were subjected to statistical analysis using tools such as ANOVA, T-test, SSPS and correlation regression models.

III. Results and Discussion

a) Reduction in cassava production.

The decreasing trend in the production of cassava can be observed in Table 1 from 1993 to 2002. The yield per hectare is 8.21mt/hectare and decreased to 3.21 mt/ha in the year 2002. The province of Etsako-West reflected the highest decrease from 7.26 mt/ha in 1993 and 1994 to 1.10 mt/ha in 2002.The results of the T-test carried out on the yield of cassava in Table 2 and 3 showed that the reduction in the yield of cassava is significant at 95% confidence interval in all the selected local government areas in Edo State. The computed T value of 9.077 is greater than the critical t- values of 4.0730 and 6.7770 respectively. The reason for this sharp reduction of cassava yield is due to the effect of land degradation of arable soil. From the elementary statistics at 0.05 level of significance, it showed that arable land/agricultural soil in the selected areas had been lost to soil erosion. In addition, the agricultural soil of the remaining arable soil has been eroded, thus leaves the soil infertile.

Table 1 : Average yield per hectare of cassava (MT/HA) in Edo-State

S/N	Year	Akoko Edo	Esan North East	Etsako West	Ovia North East	Owan East	Owan West
1	1993	8.21	10.10	7.26	8.10	6.87	6.25
2	1994	8.01	8.19	6.10	7.30	6.04	6.00
3	1995	7.03	7.22	5.11	6.90	5.77	5.77
4	1996	6.51	6.82	4.20	6.01	5.09	5.01
5	1997	5.20	6.01	3.94	5.89	4.87	4.66
6	1998	4.87	5.50	3.02	5.00	4.10	4.00
7	1999	4.01	4.81	2.98	4.78	3.90	3.61
8	2000	3.72	3.84	2.05	3.86	3.01	3.28
9	2001	3.48	3.02	1.82	3.01	2.81	2.70
10	2002	3.21	2.50	1.10	2.60	2.40	2.39

Source : Field study, 2010

Table 2 : One-sample statistics

	N	Mean	Std. Deviation	Std. Error Mean
Year	10	1997.5000	3.02765	.95743
Akoko-Edo	10	5.4250	1.89000	.59767
Esan N/E	10	5.8010	2.37658	.75154
Etsako West	10	3.7580	1.96337	.62087
Ovia N/E	10	5.3450	1.83182	.57927
Owan East	10	4.4860	1.49409	.47247
Owan West	10	4.3670	1.38471	.43788

Source : Field study, 2010

Table 3 : One-sample test

	Test Value = 0					
	T	Df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
	Lower	Upper	Lower	Upper	Lower	Upper
Year	2086.321	9	.000	1997.50000	1995.3341	1999.6659
Akoko-Edo	9.077	9	.000	5.42500	4.0730	6.7770
Esan N/E	7.719	9	.000	5.80100	4.1009	7.5011
Etsako West	6.053	9	.000	3.75800	2.3535	5.1625
Ovia N/E	9.227	9	.000	5.34500	4.0346	6.6554
Owan East	9.495	9	.000	4.48600	3.4172	5.5548
Owan West	9.973	9	.000	4.36700	3.3764	5.3576

Source: Field study, 2010

b) Soil loss and land degradation

Table 2 shows the effect of soil erosion of arable land in all the local government areas in Edo State. Highest arable land loss of 75% corresponded to 30,384.8ha was estimated to have been affected by soil erosion at Etsako-West. However, Akoko Edo recorded the least value of 10% land degradation corresponded to 9,324.6ha. Fig 1 shows the total arable land affected by land degradation in Edo –State. In Etsako –West, the main reasons for land degradation are as follows: steep slope, deforestation, poor farming and vulnerable soil. This situation has generally reduced the nutrient in agricultural soil and thereby, leads to food shortage. Degraded land has numerous bad ripple effects to the environment. Plant and animals die due to poor or little nutrient and food supply. Thus, there is loss of biodiversity, people (Farmer) fail to produce enough to eat, people become prone to various diseases, rivers and dams dry up due to siltation. This, results in the death of aquatic life and disruption of food chain. In the long run, the whole ecological processes in terms of water cycle, mineral cycle, plant succession and energy flow is disrupted with the subsequent occurrence of floods, droughts, pest and diseases outbreaks and complete breakdown of human social fabric. This has a negative impact on the state Gross Domestic Product (GDP).

Table 2: Soil and yield loss of arable in all the local government areas in Edo-State

S/N	Agricultural development Areas	Population	Total Areas (HA)	Arable Land (HA)	Indicator of soil loss (%)	Arable land loss to soil erosion (HA)
1	Akoko Edo	124,366	126,025	93,246	10	9,324.6
2	Esan Central	66,169	22,500	16,132	25	4,033
3	Igueben	62,342	21,085	15,340	23	3,528.2
4	Esan North East	88,358	34,4240.5	18,100	30	5,430.0
5	Esan South East	89,486	137,048	100,131	30	30,039.3
6	Esan West	91,748	64,999.5	31,109	30	9,332.7
7	Etsako East	143,903	141,827.6	111,062	30	33,318.6
8	Etsako Central	143,263	35,980.1	20,603	65	13,391.0
9	Etsako West	87,663	99,982.4	40,513	75	30,384.8
10	Oredo	305,230	121,521.2	41,234	40	16,493.6
11	Egor	212,485	121,521.2	110,141	40	44,056.4
12	Ikpoba Okha	263,261	121,521.2	87,531	40	35,012.4
13	Ovia North East	122,107	184,986.0	125,271	30	37,581.3
14	Ovia South West	81,020	337,909.7	301,052	30	90,315.6
15	Owan East	78,136	122,990.5	75,421	30	22,626.3
16	Owan West	72,963	81,567.4	59,441	30	17,832.3
17	Orhionmwon	118,054	238,896.1	200,162	40	80,064.8
18	Uhunmwode	109,294	206,97.7	169,325	40	67,730
	Total			1,615,814		634,416.3

Source : Field study, 2010

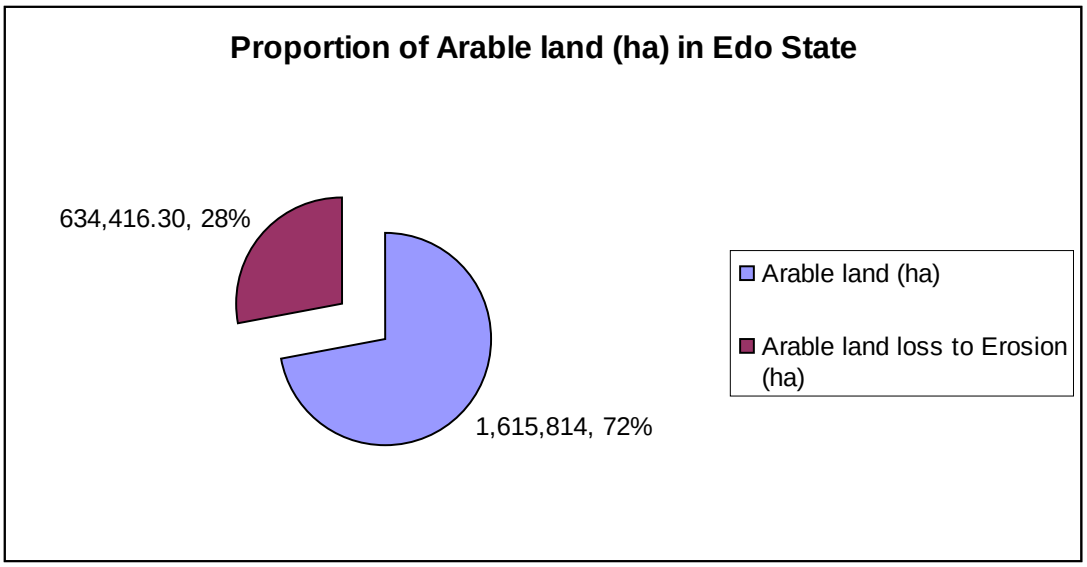

Fig 1: Proportion of Arable land (ha) in Edo State

Source: Field study, 2010

c) Oil spillage and food production

Between 1976 and 1997, 4,647 cases of oil spillage were recorded, which sum up to total net loss of 1,820,410.50 barrels of crude oil as shown in Table 3. Fig 2 shows oil spillage curve which is indicated that maximum spillage of 600, 511.02 barrels of crude oil was spilled in 1984 and least spillage of 5,956 barrels in 1989. This trend continued and it has resulted to adverse effect on agricultural production in Edo and other Niger-Delta States. It is estimated that the second main cause of land degradation to soil erosion is oil spillage (Olotu et al., 2005). From the elementary statistics at 0.05 (5%) level of significance, it showed that about 30% of arable land in Niger-Delta region has been degraded by the action of oil spillage (Olotu et al., 2005). This has resulted to a sharp drop in food production. More than 45% of nutrient in the soil has been lost to chemical decomposition. Millions of fishes and fingerlings have been killed and made the environment highly unfavourable for the production of economic aquatic life (fishes) etc. This development contributed to significant reduction in food production and increase in poverty level in Edo and other Niger-Delta States.

Table 3 : Oil Spills in Nigeria (1976 – 1996)

Year	Number of Spills	Quantity Spilled (barrels)	Quantity Recovered (barrels)	Net loss to the Environment (barrels)
1976	128	26157.00	7135.00	19021.50
1977	104	32879.25	1703.01	31176.75
1978	154	489294.75	391445.00	97849.75
1979	157	64117.13	63481.20	630635.95
1980	241	600511.02	42416.83	558094.19
1981	238	42722.50	5470.20	37252.30
1982	257	42841.00	2171.40	40669.60
1983	173	48351.30	6355.90	41995.40
1984	151	40.209.00	1644.80	38564.20
1985	187	11876.60	1719.30	10157.30
1986	155	12905.00	552.00	12358.00
1987	129	31866.00	6109.00	25358.00
1988	108	9172.00	1955.00	7207.00
1989	118	5956.00	2153.00	3830.00
1990	166	14150.35	2092.55	12057.80

1991	258	108367.01	2785.96	105912.05
1992	378	51187.90	1476.70	49711.20
1993	453	8105.32	2937.08	6632.11
1994	495	35123.71	2335.93	32787.78
1995	417	63677.17	3110.02	60568.15
1996	158	399036.67	11838.07	387198.60
Total	4,647	2,369,470.04	549,060.38	1,820,410.50

Source : Department of Petroleum Resources, 1997.

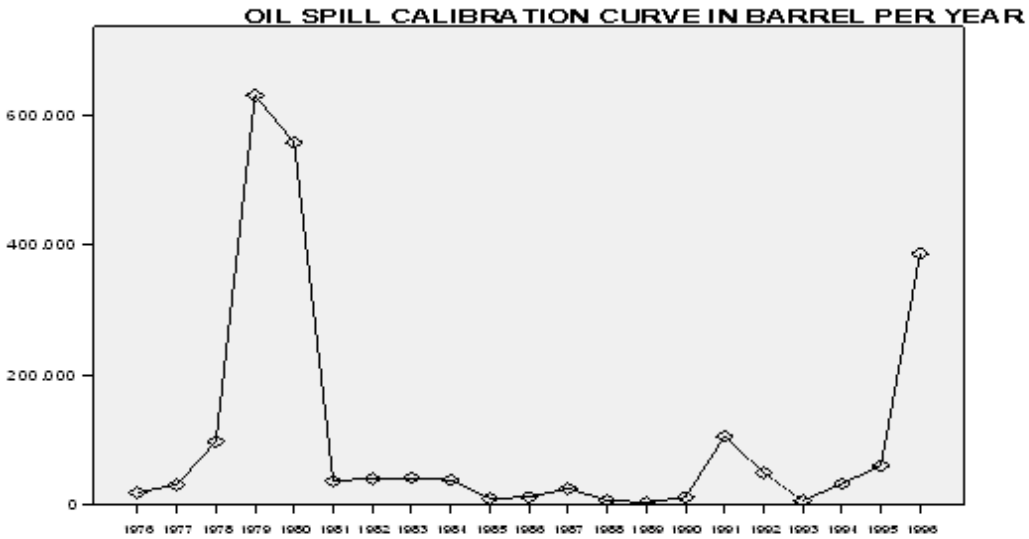

Fig 2 : Spillage curve

Source : Field study, 2010

d) Wastes generation in Edo State

Wastes are often dumped at the edge of most towns in Edo state. This causes pollution of the soil surface and ground water. Table 4 shows the solid waste generated in Edo state between 1990-2002. It is observed from the result that the volume of water increased annually. The situation with respect to waste disposal is very serious because of its direct effect on the quality of the environment is tremendous.

The main sources of hazardous waste includes: heavy metal, oxides of nitrogen sulphur, and petroleum hydrocarbons as reflected in Table 3. Most of these come from the chemical industries, although, other industries such as primary and fabricated metal and petroleum industries produce significant quantities of hazardous substances. Effluents are discharged into rivers, lakes, or estuaries, some of which are sources of drinking and irrigation water, also they are dumped with ordinary domestic garbage and thus cause soil and ground water contamination. This development has seriously affected agricultural production and brings about health complication in the state.

Table 4 : Quantity of solid waste generated in Edo- State

S/N	Year	Quantity(tons)
1	1990	149,633
2	1991	176,752
3	1992	205,689
4	1993	267,273
5	1994	288,468
6	1995	301,629

7	1996	324,327
8	1997	357,296
9	1998	401,752
10	1999	421,279
11	2000	428,526
12	2001	465,652
13	2002	482,629

Source : Edo State Ministry of Environment, 2009

IV. Expenditure on Erosion and Land Degradation

Soil loss and erosion control in Edo State is being handled by the Ministry of Environment. Table 4 shows the financial expenditure of the State Government in combating the menace of land degradation and soil erosion in the State between 1990 to 2002. In 1990, the financial allocation for the ministry was 4.1%, while in 2002 the allocation rose to 10%. The allocation to the Ministry continued to increase annually, but the increase is not significant because more land continued to be affected by soil erosion as presented in Table 2. In order to drastically reduced the impact of soil erosion, the state Government is expected to jack up the allocation for the ministry so that they can increase the state of their ecological programmes by electing the a good number of hydrological structures such as drainage, culverts e.t.c.

Table 4 : Erosion and land degradation control expenditure in Edo-State

S/N	Year	Expenditure (Millions ₦)	% of Expenditure
1	1990	206,673	4.1
2	1991	256,852	5.1
3	1992	287,779	5.7
4	1993	309,873	6.1
5	1994	357,469	7.0
6	1995	401,729	7.9
7	1996	423,827	8.3
8	1997	429,196	8.4
9	1998	455,852	9.0
10	1999	469,479	9.2
11	2000	484,026	9.5
12	2001	499,652	9.8
13	2002	508,629	10.0

Source : Field study, 2009

V. Conclusion

Despite the fact that Edo State has a large percentage of arable land, soil degradation is a substantial problem in the State. Generally, it is calculated that 3 to 17 percent of Gross Domestic Product in the State is lost to the effect of land degradation from the environmental degradation, 61% of these, from soil erosion; nutrient lost and changes in crop. The worst affected areas are: Etsako West, Etsako central, Orhionmwon, Uhunwode, Ikpoba –Okha, Egor, and Oredo respectively. There has been little national scale analysis of the cause of land degradation to national economy, but the extent of the problem is well established in this research study which shows clearly on agriculture land, reduction of agriculture yield or production, sedimentation of hydraulic structure such as dams and reservoir causing acute shortage for domestic water supply and irrigation. In addition, oil spillage causes high level of degradation to soil and water in Edo State and other Niger Delta States.

The results of the investigation reveal that little attention is given to the menace and danger of land degradation to the health, economy, and physical development of Edo State.

VI. Recommendations

Based on the result of the research study, the following recommendations are drawn:

1. The State and the Local Government should take a serious measure to contain the problem of land degradation by investigating in construction and maintenance of soil conservation structures across the State;
2. Environmental protection laws must be enacted so that an average person in the State plant tree and cover crops in his premises; and

3. Farmers should be well trained on the new methodology of farming, which will discourage soil erosion/land degradation caused by poor farming system.

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Global Journal of Science Frontier Research (D) Volume XIII Issue XIII Version I Year 2013
48

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Global Journal of Science Frontier Research
Agriculture and Veterinary
Volume 13 Issue 13 Version 1.0 Year 2013
Type : Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4626 & Print ISSN: 0975-5896

Ruminal Solubility and Effect of Calcite Powder Supplementation on Dairy Animal Performance

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Abstract- Ruminal Solubility of Certain Calcium Sources such as calcium carbonate, calcite, dolomite, lime stone powder and dicalcium phosphate (DCP) powder was investigated. Solubility of these calcium sources was low at pH 7 and ranged from 1.74 ± 1.36 in Dolomite to 2.94 ± 0.95 percent in Dicalcium phosphate (DCP). Reducing the pH of the ruminal buffer at 6 increased their solubility and the pattern was almost similar to that recorded at pH 7. Further reduction of pH of ruminal buffer to 2.5, increased their solubility significantly (up to 72.63%), however, Ca solubility of calcium carbonate and dolomite was lower than the other calcium supplements. It was concluded that calcite and lime stone powders may be good source of Ca under the conditions when ruminal pH is towards lower side.

GJSFR-D Classification : *FOR Code: 860199, 670105*

Strictly as per the compliance and regulations of :

Ruminal Solubility and Effect of Calcite Powder Supplementation on Dairy Animal Performance

B. Abegaze [α] & R.C. Chopra [σ]

Abstract- Ruminal Solubility of Certain Calcium Sources such as calcium carbonate, calcite, dolomite, lime stone powder and dicalcium phosphate (DCP) powder was investigated. Solubility of these calcium sources was low at pH 7 and ranged from 1.74 ± 1.36 in Dolomite to 2.94 ± 0.95 percent in Dicalcium phosphate (DCP). Reducing the pH of the ruminal buffer at 6 increased their solubility and the pattern was almost similar to that recorded at pH 7. Further reduction of pH of ruminal buffer to 2.5, increased their solubility significantly (up to 72.63%), however, Ca solubility of calcium carbonate and dolomite was lower than the other calcium supplements. It was concluded that calcite and lime stone powders may be good source of Ca under the conditions when ruminal pH is towards lower side.

The daily dry matter consumption of calves in group I to III was 7.12±0.22, 6.52±0.29 and 6.95±0.33 kg respectively indicating that the treatment rations were acceptable to the animals and there was no significant difference (P>0.05) in the treatment groups, with respect to DMI of the animals. The results of this study showed that neither the different sources of calcium used in group I and group II nor the levels of calcite powder used in group II and III had any significant effect on digestibility, gain in body weight of calves or in the efficiency of conversion of diet to body weight gain of calves. Moreover The results suggested that neither the $CaCO_3$ nor the calcite powder had any adverse effect on the palatability of diet.

I. Introduction

In animal production nutrition plays an important role in the farm economics, as more than 50% of the farm expenditure goes towards feeding of animals. Dietary nutrients promote programming and expression of the metabolic pathways that enables the animal to achieve its genetic potential with respect to production and reproduction. Minerals may constitute a small fraction of the total ration but perform vital role in the body. Mineral elements exist in the cells and tissues of the animal body and their characteristic concentrations vary with the element and tissue. The concentrations of essential elements must usually be maintained within the narrow limits, if the functional and structural integrity of the tissues is to be safeguarded and the optimum growth,

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Continued ingestion of diets that are deficient or excessive in a mineral, induce changes in the form of concentration of that mineral in the body tissues. In such circumstances, physiological functions are adversely affected which vary with the element, the degree and duration of dietary deficiency (Chesters and Arthur, 1988). Ultimate prevention of the changes requires that the animal be supplied with none toxic and palatable diet that contains the required minerals in adequate amounts and available forms.

On tracing the history of Ca supplements for use in mineral mixture, it appears that use of different sources remained changing, during the past century. In the 1960s, the use of bone meal, chalk powder and di-calcium phosphate as a source of Ca and P in mineral mixture was recommended. In 1982, ISI recommended the use of ground limestone in the list of ingredients for use in the formulation of mineral mixture. In 1992 specifications for Mg and S were laid down (BIS, 1992).

McDowell et al (1993) reported that various mineral supplements differ in their bio-availability and it is necessary to comparatively scan them for availability of useful elements aimed at ensuring the absence of toxic levels of incriminating minerals. Unfortunately here is no literature on the availability/ utilization of Ca from calcite powder in livestock although; calcite has been used as a buffer in high milk producing cows (Keyser *et al.,* 1985). This being the case, the objective of this research project was to study the ruminal solubility and effect of Calcite Powder supplementation on animal performance

II. Materials and Methods

a) *In vitro* Ruminal Solubility

In vitro experiments were conducted to study the ruminal solubility of Ca from dolomite, dicalcium phosphate, lime stone powder and calcite powder in comparison with pure calcium carbonate at different pH using the procedure of Witt and Owens (1983) with slight modification. Each of the Ca supplements was weighed into 250 ml conical flask. Hundred ml of the mixture of strained ruminal liquor (SRL) and McDougall's buffer was added to each flask containing the Ca supplements. The contents were well mixed and the pH was adjusted to 2.5, 6, and 7, using 0.1 N HCl. Finally the supernatant obtained after centrifugation was diluted

to 100 ml and used for the estimation of Ca by AAS. Ca solubility was estimated according to Yano *et al.* 1979, employing the following formula.

$$\text{Ca solubility in SRL (\%)} = \frac{\text{Amount of Ca present in the supplement obtained from 25 ml of ruminal buffer (Aliquot I) - Blank}}{\text{Amount of Ca presen tin 25 ml of uncentrifuged ruminal buffer (Aliquot II) - blank}}$$

III. Feeding Trials

a) Experimental Treatment Ration Formulation

Three different mineral mixtures/ experimental treatments i.e. commercial grade calcium carbonate (T_1), calcite powder (T_2) and 1.5% extra calcite powder than the second mineral mixture (T_3) were prepared, as shown in Table 1. Diammonium phosphate was used as source of phosphorus and the supply of other mineral elements was met by addition of pure salts. The mineral mixture was added to the concentrates mixture shown in Table 2 to supply 396, 396 and 1013 g of Ca/100 kg of the concentrate in treatment 1, 2 and 3 respectively.

Table 1 : Calcium and phosphorus supply from mineral supplements used in preparation of mineral mixtures* for each 100 kg of concentrate mixture

Groups	Mineral supplement sources used	Ca supply (g/ 100 kg concentrate mixture)	P supply (g/ 100 kg concentrate mixture)
T1	Calcium carbonate 1.0113 kg Diamonium phosphate 0.70 kg	396.43	1.21 161.00
T2	Calcite powder 0.9779 kg Diamonium phosphate 0.58 kg	399.96 -	10.76 133.40
T3	Calcite powder 2.04779 kg Diammonium phosphate 0.58 kg	1013.46 -	27.76 133.40

* In addition to the Ca and P source used the following ingredients were used per 100 kg of concentrate mixture for the preparation of complete mineral mixture sodium chloride 0.900 kg, trace mineral mixture 0.1185 kg containing magnesium carbonate 90 gm, ferrous sulphate 15 g, copper sulphate 2.1 gm, cobalt chloride 1.5 gm, potassium iodide 0.3 gm, zinc sulphate 7.5 gm and manganese dioxide 2.1 gm.

Table 2 : Composition of concentrate mixtures (kg/100kg)

Ingredients	Groups I	Group II	Group III
Maize	20.0000	20.0000	18.5000
Barley	20.5402	20.6486	20.6436
Groundnut cake	10.0000	10.0000	10.0000
Wheat bran	34.0000	34.0000	34.0000
Mustard cake	12.0000	12.0000	12.0000
Urea	0.7300	0.7550	0.7700
Calcium carbonate	1.0113	--	--
Calcite powder	--	0.9770	2.4779
Diamonium phosphate	0.7000	0.5800	0.5900
Sodium chloride	0.9000	0.9000	0.9000
Trace M. Mixture*	0.1185	0.1185	0.1185
CP%	19.95	19.94	19.79
Ca%	1.2	1.2	1.7
P%	0.65	0.64	0.62
TDN%	73.75	74.04	72.75

*contained magnesium carbonate 90 gm, ferrous sulphate 15gm,copper sulphate 2.1gm, cobalt chloride 1.5gm, potassium iodide 0.3gm, zinc sulphate 7.5gm and manganese dioxide 2.1gm.

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IV. Management of the Experimental Animals

Eighteen crossbred (Karan Fries) male calves of 14-16 months of age weighing 205.22 ±6.85kg taken from the Institute (NDRI) herd were dewormed and housed in individual pens with adequate space, plastic painted walls and easy access to sunshine. The animals were tied individually and washed daily with clean water. Finally the experimental animals were randomly allocated to the experimental treatment in completely randomized design with 6 replications for experimental period of 24 weeks as shown in Table 3.

The experimental animals were offered concentrate mixture and wheat straw in the morning at 9.00 am. Body weight was recorded at weekly intervals. Feed conversion efficiency was calculated from body weight gain per kg of feed consumed. The growth rate was calculated by regression analysis of the cumulative weight gain during 24 weeks period as 'b' value, as shown below

$$b\ \text{value (kg/ week)} = \frac{\sum xy - \frac{\sum x.\ \sum y}{n}}{\sum X^2 - \left(\frac{\sum x}{n}\right)^2}$$

Samples of feed offered and residue left, if any, were taken each morning for dry matter and chemical analysis. After the completion of 24 weeks of growth study , a metabolic trial of 7 days collection period was conducted on all the eighteen calves in the metabolic shed. The quantity of faeces and urine voided by individual animal were recorded every morning (24 hr collection) for 7 days, and representative sample were drawn for further analysis.

Table 3 : Allocation of the treatments to the experimental animals

S. No.	Animal No.	Initial body weight (kg)	Date of Birth
Group-I			
1	KF-3871	135	10.11.2004
14	KF-3885	200	22.12.2004
17	KF-3877	211	3.12.2004
18	KF-6880	216	11.12.2004
6	KF-6861	230	25.09.2004
16	KF-6873	240	23.10.2004
	Average	205.33±15.20	
Group-II			
7	KF-6895	158	18.01-2005
15	KF-6888	185	24.12.2004
4	KF-6877	205	23.10.2004
13	KF-6869	220	02.11.2004
11	KF-6868	226	15.11.2004
12	KF-6866	240	18.10.2004
	Average	205.67±12.24	
Group-III			
2	KF-6896	164	23.11.2005
9	KF-6859	197	14.09.2004
5	KF-6887	196	24.12.2004
3	KF-6881	228	13.12.2004
10	KF-6874	224	14.11.2004
8	KF-6886	219	22.12.2004
	Average	204.67±9.85	

Samples of feed and faeces were analyzed for proximate principles, dry matter, total ash, acid insoluble ash and nitrogen content as per AOAC (2000). Mineral content of feeds, faeces and urine samples was estimated using AAS and balances were calculated.

V. Statistical Analysis

Data in different parameters were subjected to analysis of variance

VI. Result and Discussions

a) Ruminal Solubility of Calcite Powder (In Vitro)

Many mineral elements do not have similar solubility in different part of gastrointestinal tract. Solubility of any mineral element in the gastrointestinal tract is an important criterion to assess its availability to the animal (Chicco *et al.,* 1965). Ammerman *et al.* (1957) observed that ferrous sulphate and ferric chloride had higher biological availability to sheep than ferrous carbonate and ferric oxide as the latter two compounds were less soluble sources of iron. Similarly, Rahnema and Fontenot (1983) reported that Mg from MgO is more utilized by sheep than Mg from dolomite limestone because Mg from former source is more soluble, thus any other mineral which is less soluble is supposed to be less available to ruminants.

Solubility of any mineral in the gastrointestinal tract is related to the prevailing pH at that part of the gut. Storry, (1961) found that Ca and Mg present in the abdominal contents of sheep were in a soluble form. Bremner (1970) studied the changes in concentration and solubility of Zn, Mn and Cu in the different parts of alimentary tract of sheep and found that a relationship existed between the solubility of the metal and pH values of the gut content. This pattern of changes could be reproduced in *in- vitro* by adjusting the pH of rumen and abdominal samples.

The solubility data of the different Ca supplements studied in the current experiment presented in Table 4. and Fig. 1. It was observed that at any pH studied, Ca solubility from different chemical forms of supplements was essentially not-similar. At pH 6.0 Ca from calcite powder showed better solubility 11.15±4.65% while dolomite showed the least than others. At pH 2.5 calcium carbonate, limestone powder and calcite powder showed higher solubility i.e.72.74±5.47, 72.63±6.12%and72.39±12.34 respectively. The data (Table 4) further revealed that Ca solubility from dicalcium phosphate, dolomite, lime stone powder, calcite powder and calcium carbonate was not similar even at neutral pH of 7. At neutral pH 7 of the buffer the solubility ranged from 1.74 % (dolomite) to 2.94% DCP. By scaling down the pH of the ruminal buffer the Ca solubility was seen to increase in all the cases which are in concurrence with the findings of Lall (1987). In case of CaCo3 it reached to 72.74%, whereas in case of dolomite and calcite it was 47.84 and 72.39% respectively. Lall (1987) reported the solubility of $CaCl_2$ to the extent of 98.8% in ruminal buffer at pH 4.0. It was further evident as pH approached that of abdominal fluid, the solubility of all forms of Ca studied (Table 4) increased.

Table 4 : Ca solubility from different Ca supplements in relation to ruminal pH

	Predominant chemical form	Ca solubility %		
		PH		
		7	6	2.5
Calcium Carbonate	$CaCO_3$	2.81 ±1.8	5.77±0.64	72.74 ±5.46
Calcite	$CaCO_3$	2.05 ± 0.25	11.15±4.65	72.39 ±12.34
Dolomite	Ca Mg $(CO_3)_2$	1.74 ±1.36	3.71±0.25	47.84±13.16
LSP	Ca CO_3	2.81±1.8	5.33±0.87	72.63±6.12
DCP	$CaHPO_4$	2.94 ±0.95	7.18 ±2.93	61.06±7.86

The calcium solubility at pH 6 and 2.5 increased in all the calcium sources under study. Storry *I.* 1961) have reported all the Ca and Mg present in abdominal content of sheep were in a soluble form where the pH was in the range of 2-3. Bremner (1970) suggested that pH of gut influenced solubility and availability of certain trace elements. He studied the changes in the concentration and solubility of Zn, Mn and Cu in the different parts of the alimentary tract of sheep and found that a relationship existed between the solubility of the metal and pH of the gut contents

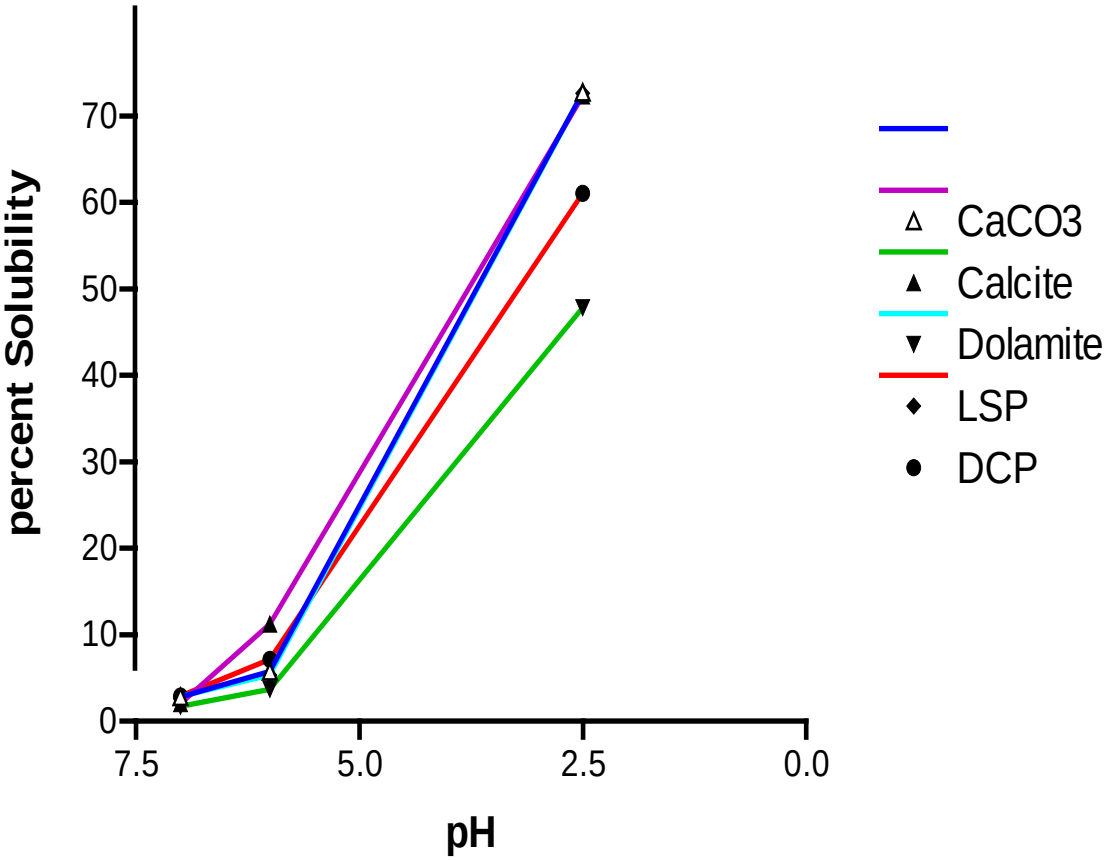

Fig. 1: In vitro ruminal calcium solubility at different pH

If reaction of the gut influenced the solubility of Ca from different Ca supplement sources to such a great extent, It may be anticipated that the distribution of Ca into soluble and particulate phases in the rumen and flow rates of the two phases from the rumen may influence the rate at which Ca could be made available at the absorption sites lower down the gut. Therefore, different sources of Ca supplements may not be of similar value. Evidently, there is need to modify the quantitative proportion of alternate sources of Ca in a mineral mixture not only on the basis of composition but also on the basis of Solubility and net availability

VII. Effect of Calcite Powder Supplementation on Animal Performance

a) Feed Intake

The daily dry matter consumption of calves in group I to III was 7.12±0.22, 6.52±0.29 and 6.95±0.33 kg respectively. Figures for dry matter intake per 100 kg body weight were 2.44, 2.06 and 2.18 kg in the respective groups. The present observations are in concurrence with the findings of Udeybir *et al.* (2000) who reported that voluntary dry matter intake in growing cattle weighing 320 kg was 2.08±0.09 percent of the body weight. The figures of present study further suggested that the rations were acceptable to the animals and there was no significant difference ($P>0.05$) in the treatment groups, with respect to DMI of the animals.

Ricketts et. al (1970) fed diets containing three Ca/ P ratio (1:1, 4:1 and 8:1) and observed the performance of Holstein steers and reported that different Ca and P ratio had no effect on average daily feed intake in total experimental period of 168 days. They further observed that during the first 14 weeks of experiment the ad lib fed steers receiving 8:1 Ca/ P ratio diets consumed significantly less DM than did the steers, receiving 1:1 or 4:1 Ca/ P ratio diets. After 14 weeks the average feed intake of steers fed 8:1 Ca to P ratio diets did not differ from those receiving from 1:1 or 4:1 Ca to P ratio diets. Analysis of variance for feed intake/ B.W. $^{0.75}$ was the same as for average daily feed intake. This indicated that animals in different weight groups consumed the same amount of feed per unit metabolic body weight (B.W. $^{0.75}$).

Sharma *et al.* (2004) fed diets containing varying levels of Ca with different levels of minerals to lambs and reported that the average value of daily DM intake was similar among the treatments. Wise *et al. (*1963) fed diet containing 0.4 : 1 to 14.3:1 ratios of Ca/ P to Herford calves and observed that daily feed intake of calves varied from 2.7 to 3.63 kg per animal and the differences among group being non significant. Combs and Wallace (1962) fed diets containing varying level of Ca i.e. (0.4 and 0.88%) to pigs through various sources of Ca such as $CaCO_3$, ground lime stone and Oyster

shell and observed that neither the levels of Ca nor the sources of Ca had any effect on DM intake. Lall (1987) reported that different sources of Ca had no effect on DM intake in growing calves. Our present findings are in agreement with the present study, the ratio of Ca/ P in the diets varied between 1.95:1 to 2:1 with different sources i.e. $CaCO_3$ and calcite powder (group I and II and 2:1 to 2.64:1 with different levels of the one source (calcite) powder (group II and III) and had no effect on daily DMI. In contrast to above findings Clark *et al.* (1989) observed that addition of 1.4% $CaCO_3$ to basal diets of cows reduced the DMI which they speculated as might be due to increased ash content of 1.4% lime stone added diet. Similar observations were also recorded by Rogers *et al.* (1982).

VIII. Digestibility

The digestibility coefficients of DM, CP, CF, EE and NFE are presented in Table 4.13. The corresponding values in the three groups were 60.12 ±0.92, 63.01±1.72 and 59.71±0.75 for DM 55.63±1.89, 57.10±2.19 and 55.97±3.57 for CF, 81.25±2.47, 82.51±2.38 and 80.35±1.91 for EE, and 69.37±0.73, 73.51±1.67 and 70.64±1.28 for NFE, respectively. These values of digestible coefficient for DM, CP, CF, EE and NFE did not show any significant difference among the experimental treatments.

The digestibility data showed that neither the sources of Ca i.e. calcium carbonate/ calcite powder nor the addition of additional calcite powder had any effect on the digestibility's of organic nutrients. indicating that compositional characteristics of calcite powder had no influence on utilization of dietary organic nutrients and is comparable to calcium carbonate when used as Ca source (Group I). The f additional 1.5% calcite powder in group III as compared to group II also did not show any significant effect on the digestibility of organic nutrients (Table 4.13).

Lall (1987) showed that inclusion of rock phosphate or super phosphate as a source of Ca/ P had no effect on the intake and utilization of organic nutrients in calves, compared with Dicalcium phosphate. Combs and Wallace (1962) compared the effect of 0.4 and 0.88% Ca on nutrient digestibility and observed that 0.88% Ca in the diet significantly reduced the digestibility of EE and CF, while DM and CP digestibility was significantly lowered when gypsum rather than ground lime stone or oyster shell was used as supplement Ca source. The same authors reported that the sources of calcium did not significantly affect the apparent digestibility of ether extract, but digestibility of CP was significantly influenced by the level of calcium. Feeding of calcium carbonate in the diet is reported to improve apparent total tract digestibility (Wheeler *et al.,* 1976; 1977), which is just contrary to the observation made by other workers, (Fernandez *et al.,* 1982; Nocek *et al.,* 1983; and Rogers *et al.,* 1985) who demonstrated that supplementation of calcium carbonate to the diet of dairy cows did not improve starch digestibility.

Keyser *et al.* (1985) showed that the effect of calcium carbonate on starch digestibility was dependent on its particle size and rate of reactivity. Clark *et al.* (1989) demonstrated that supplementation of calcium carbonate in the diet of cows did not influence the apparent total tract digestibility of DM, OM, CP, EE. The apparent digestibility of starch was increased ($P<0.01$) by supplementation of calcium carbonate to the control ration, A similar increase in starch digestibility was also reported by Rogers *et al.* (1982). In subsequent experiment Rogers *et al.* (1985) fed cow basal diet (0.6% Ca) and basal diet with 1.4% lime stone (Ca 1.1% P 0.52%) and observed that digestibility of DM and CP were similar in all the groups, which are in concurrence with the findings of the present experiment.

Lall (1987) fed different sources of Ca and P (DCP, rock phosphate and super phosphate) in the diet of calves and observed that there was no difference in the digestibility of organic nutrients (OM, ADF and CP).Amrutkar (2006) added 0, 5 and 10% lime stone powder in the concentrate mixture of three different groups of calves. (Dietary Ca: P ratio 1.9:1, 3.7:1 and 6.4:1) and observed that there was no significant difference in the digestibility of organic nutrients.

IX. Growth Rate and Feed Conversion Efficiency

The data pertaining to initial and final body weights, feed efficiency and average daily gain are presented in table 4.26. The mean average daily gains in calves of group I, II and III were 448.39±19.78, 463.00±13.26 and 515.89±29.15 gm respectively, which were statistically non significant. Feed conversion ratios (DMI/ kg gain) in group I, II and III were 12.72±0.80, 12.46±0.63 and 11.36±0.6 which were also statistically similar in all the groups (Table 6). These results indicated that neither the different sources of calcium used in group I and group II nor the levels of calcite powder used in group II and III had any significant effect on gain in body weight of calves or in the efficiency of conversion of diet to body weight gain of calves. Huffman *et al.* (1933) observed satisfactory growth among dairy calves fed rations containing Ca and P ratio between 4:1 and 5:1.

Table 6 : Growth and feed conversion efficiency of calves in different groups

	Groups I	Group II	Group III
Initial body weight (kg)	223.67±15.60	226.83±12.64	225.83±11.49
Final body weight in24 week(kg)	299.0±13.51	304.67±11.48	312.5±14.99
Mean weight gain	75.33±3.23	77.84±1.58	86.67±4.90
Average daily gain (gm)	448.39±19.18	463.30±13.26	515.89±29.15
Growth rate 'b' value (kg/ week)	3.61±0.15	3.77±0.15	3.62±0.02
Feed to gain ratio(feed intake/ Kg bodyweight)	12.72±0.80	12.46±0.63	11.36±0.60

Table 7 : Cumulative body weight (kg) of calves in different groups

Weeks	Group I	Group II	Group III
1	223.67	226.83	225.83
2	229.00	229.50	228.83
3	223.33	228.00	226.67
4	233.67	235.00	237.17
5	235.33	241.00	241.17
6	244.00	248.17	248.33
7	247.50	248.00	252.00
8	247.00	250.67	253.83
9	251.33	252.83	256.50
10	251.50	255.50	258.50
11	259.33	264.50	264.33
12	262.50	266.50	265.50
13	262.33	272.33	272.83
Weeks	Group I	Group II	Group III
14	270.17	272.00	272.17
15	274.00	277.83	279.17
16	277.00	283.50	282.83
17	281.00	289.50	289.00
18	290.67	294.17	301.00
19	291.33	293.67	300.33
20	293.17	300.17	305.67
21	297.00	304.17	312.50
22	297.67	303.50	308.83
23	300.17	304.83	311.17
24	299.00	304.67	312.50

Theiler *et al.* (1937) stated that a Ca P ratio of 4:1 did not significantly affect performance of growing beef heifers and steer when an adequate amount of P was supplemented in the ration. In contrast, Ricketts *et al.* (1970) observed that steers receiving 8:1 Ca/ P diet gained significantly ($P<0.01$) less weight than the steers receiving either 1:1 of 4:1 Ca/ P diet

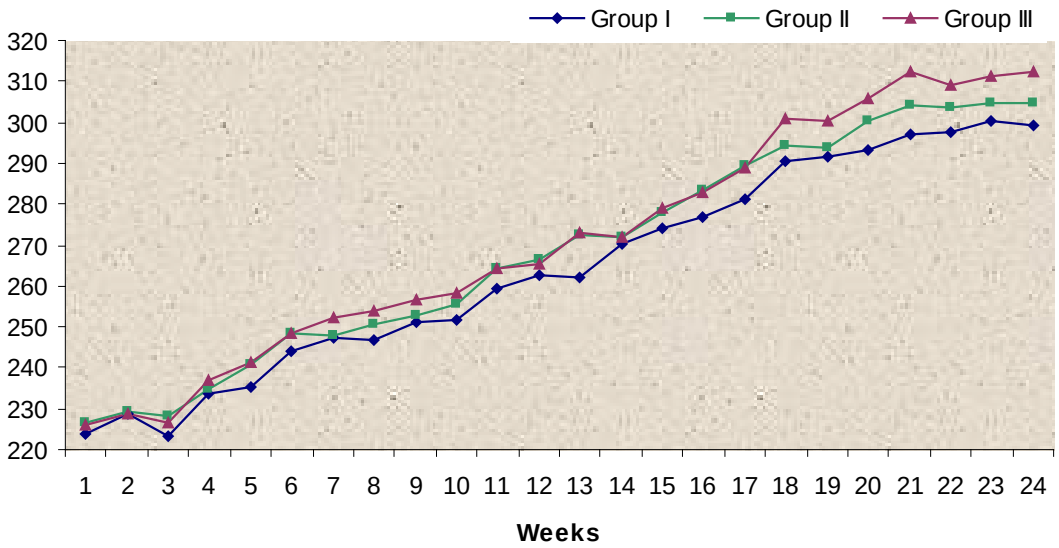

Fig. 4.3 : Cumulative body weight (kg) of calves under different treatment groups

Wise *et al.* (1963) fed 45 Herford calves in a factorial experiment with three levels of Ca (0.27, 0.81 and 2.43% of diet) and P (0.17, 0.34 and 0.68% of diet). Nine resulting, levels and ratios 0.4:1 to 14.3:1 of Ca and P were obtained by addition of varying amounts of calcium carbonate, defluorinated rock phosphate and dibasic sodium phosphate to a semi purified diet, They reported that performance and nutrient conversion were markedly decreased with Ca: P ratios lower than 1:1 ratios and between the ratios 1:1 and7:1 gave similar and satisfactory results. Ca: p ratios while above 7:1 resulted in decreased performance and nutrient conversion, but adverse effects were not marked with the ratio below 1:1.

Lall (1987) reported that there was no difference in growth rate, feed and mineral utilization in calves fed various sources of Ca and P in the diet. Similarly, many other workers (Aflaro *et al.,* 1988; Amrutkar, 2006) have observed that average daily gain, average feed intakes, feed efficiency and general health of calves were not affected (P>0.05) by wide range of Ca: P ratio, the result in the present study are in agreement with those reported above.

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It is vital, that authors take care in submitting a manuscript that is written in simple language and adheres to published guidelines.

Format

Language: The language of publication is UK English. Authors, for whom English is a second language, must have their manuscript efficiently edited by an English-speaking person before submission to make sure that, the English is of high excellence. It is preferable, that manuscripts should be professionally edited.

Standard Usage, Abbreviations, and Units: Spelling and hyphenation should be conventional to The Concise Oxford English Dictionary. Statistics and measurements should at all times be given in figures, e.g. 16 min, except for when the number begins a sentence. When the number does not refer to a unit of measurement it should be spelt in full unless, it is 160 or greater.

Abbreviations supposed to be used carefully. The abbreviated name or expression is supposed to be cited in full at first usage, followed by the conventional abbreviation in parentheses.

Metric SI units are supposed to generally be used excluding where they conflict with current practice or are confusing. For illustration, 1.4 l rather than 1.4 × 10-3 m3, or 4 mm somewhat than 4 × 10-3 m. Chemical formula and solutions must identify the form used, e.g. anhydrous or hydrated, and the concentration must be in clearly defined units. Common species names should be followed by underlines at the first mention. For following use the generic name should be constricted to a single letter, if it is clear.

Structure

All manuscripts submitted to Global Journals Inc. (US), ought to include:

Title: The title page must carry an instructive title that reflects the content, a running title (less than 45 characters together with spaces), names of the authors and co-authors, and the place(s) wherever the work was carried out. The full postal address in addition with the e-mail address of related author must be given. Up to eleven keywords or very brief phrases have to be given to help data retrieval, mining and indexing.

Abstract, used in Original Papers and Reviews:

Optimizing Abstract for Search Engines

Many researchers searching for information online will use search engines such as Google, Yahoo or similar. By optimizing your paper for search engines, you will amplify the chance of someone finding it. This in turn will make it more likely to be viewed and/or cited in a further work. Global Journals Inc. (US) have compiled these guidelines to facilitate you to maximize the web-friendliness of the most public part of your paper.

Key Words

A major linchpin in research work for the writing research paper is the keyword search, which one will employ to find both library and Internet resources.

One must be persistent and creative in using keywords. An effective keyword search requires a strategy and planning a list of possible keywords and phrases to try.

Search engines for most searches, use Boolean searching, which is somewhat different from Internet searches. The Boolean search uses "operators," words (and, or, not, and near) that enable you to expand or narrow your affords. Tips for research paper while preparing research paper are very helpful guideline of research paper.

Choice of key words is first tool of tips to write research paper. Research paper writing is an art.A few tips for deciding as strategically as possible about keyword search:

- One should start brainstorming lists of possible keywords before even begin searching. Think about the most important concepts related to research work. Ask, "What words would a source have to include to be truly valuable in research paper?" Then consider synonyms for the important words.
- It may take the discovery of only one relevant paper to let steer in the right keyword direction because in most databases, the keywords under which a research paper is abstracted are listed with the paper.
- One should avoid outdated words.

Keywords are the key that opens a door to research work sources. Keyword searching is an art in which researcher's skills are bound to improve with experience and time.

Numerical Methods: Numerical methods used should be clear and, where appropriate, supported by references.

Acknowledgements: Please make these as concise as possible.

References

References follow the Harvard scheme of referencing. References in the text should cite the authors' names followed by the time of their publication, unless there are three or more authors when simply the first author's name is quoted followed by et al. unpublished work has to only be cited where necessary, and only in the text. Copies of references in press in other journals have to be supplied with submitted typescripts. It is necessary that all citations and references be carefully checked before submission, as mistakes or omissions will cause delays.

References to information on the World Wide Web can be given, but only if the information is available without charge to readers on an official site. Wikipedia and Similar websites are not allowed where anyone can change the information. Authors will be asked to make available electronic copies of the cited information for inclusion on the Global Journals Inc. (US) homepage at the judgment of the Editorial Board.

The Editorial Board and Global Journals Inc. (US) recommend that, citation of online-published papers and other material should be done via a DOI (digital object identifier). If an author cites anything, which does not have a DOI, they run the risk of the cited material not being noticeable.

The Editorial Board and Global Journals Inc. (US) recommend the use of a tool such as Reference Manager for reference management and formatting.

Tables, Figures and Figure Legends

Tables: Tables should be few in number, cautiously designed, uncrowned, and include only essential data. Each must have an Arabic number, e.g. Table 4, a self-explanatory caption and be on a separate sheet. Vertical lines should not be used.

Figures: Figures are supposed to be submitted as separate files. Always take in a citation in the text for each figure using Arabic numbers, e.g. Fig. 4. Artwork must be submitted online in electronic form by e-mailing them.

Preparation of Electronic Figures for Publication

Even though low quality images are sufficient for review purposes, print publication requires high quality images to prevent the final product being blurred or fuzzy. Submit (or e-mail) EPS (line art) or TIFF (halftone/photographs) files only. MS PowerPoint and Word Graphics are unsuitable for printed pictures. Do not use pixel-oriented software. Scans (TIFF only) should have a resolution of at least 350 dpi (halftone) or 700 to 1100 dpi (line drawings) in relation to the imitation size. Please give the data for figures in black and white or submit a Color Work Agreement Form. EPS files must be saved with fonts embedded (and with a TIFF preview, if possible).

For scanned images, the scanning resolution (at final image size) ought to be as follows to ensure good reproduction: line art: >650 dpi; halftones (including gel photographs) : >350 dpi; figures containing both halftone and line images: >650 dpi.

Color Charges: It is the rule of the Global Journals Inc. (US) for authors to pay the full cost for the reproduction of their color artwork. Hence, please note that, if there is color artwork in your manuscript when it is accepted for publication, we would require you to complete and return a color work agreement form before your paper can be published.

Figure Legends: Self-explanatory legends of all figures should be incorporated separately under the heading 'Legends to Figures'. In the full-text online edition of the journal, figure legends may possibly be truncated in abbreviated links to the full screen version. Therefore, the first 100 characters of any legend should notify the reader, about the key aspects of the figure.

6. AFTER ACCEPTANCE

Upon approval of a paper for publication, the manuscript will be forwarded to the dean, who is responsible for the publication of the Global Journals Inc. (US).

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The corresponding author will receive an e-mail alert containing a link to a website or will be attached. A working e-mail address must therefore be provided for the related author.

Acrobat Reader will be required in order to read this file. This software can be downloaded

(Free of charge) from the following website:

www.adobe.com/products/acrobat/readstep2.html. This will facilitate the file to be opened, read on screen, and printed out in order for any corrections to be added. Further instructions will be sent with the proof.

Proofs must be returned to the dean at dean@globaljournals.org within three days of receipt.

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Before start writing a good quality Computer Science Research Paper, let us first understand what is Computer Science Research Paper? So, Computer Science Research Paper is the paper which is written by professionals or scientists who are associated to Computer Science and Information Technology, or doing research study in these areas. If you are novel to this field then you can consult about this field from your supervisor or guide.

TECHNIQUES FOR WRITING A GOOD QUALITY RESEARCH PAPER:

1. Choosing the topic: In most cases, the topic is searched by the interest of author but it can be also suggested by the guides. You can have several topics and then you can judge that in which topic or subject you are finding yourself most comfortable. This can be done by asking several questions to yourself, like Will I be able to carry our search in this area? Will I find all necessary recourses to accomplish the search? Will I be able to find all information in this field area? If the answer of these types of questions will be "Yes" then you can choose that topic. In most of the cases, you may have to conduct the surveys and have to visit several places because this field is related to Computer Science and Information Technology. Also, you may have to do a lot of work to find all rise and falls regarding the various data of that subject. Sometimes, detailed information plays a vital role, instead of short information.

2. Evaluators are human: First thing to remember that evaluators are also human being. They are not only meant for rejecting a paper. They are here to evaluate your paper. So, present your Best.

3. Think Like Evaluators: If you are in a confusion or getting demotivated that your paper will be accepted by evaluators or not, then think and try to evaluate your paper like an Evaluator. Try to understand that what an evaluator wants in your research paper and automatically you will have your answer.

4. Make blueprints of paper: The outline is the plan or framework that will help you to arrange your thoughts. It will make your paper logical. But remember that all points of your outline must be related to the topic you have chosen.

5. Ask your Guides: If you are having any difficulty in your research, then do not hesitate to share your difficulty to your guide (if you have any). They will surely help you out and resolve your doubts. If you can't clarify what exactly you require for your work then ask the supervisor to help you with the alternative. He might also provide you the list of essential readings.

6. Use of computer is recommended: As you are doing research in the field of Computer Science, then this point is quite obvious.

7. Use right software: Always use good quality software packages. If you are not capable to judge good software then you can lose quality of your paper unknowingly. There are various software programs available to help you, which you can get through Internet.

8. Use the Internet for help: An excellent start for your paper can be by using the Google. It is an excellent search engine, where you can have your doubts resolved. You may also read some answers for the frequent question how to write my research paper or find model research paper. From the internet library you can download books. If you have all required books make important reading selecting and analyzing the specified information. Then put together research paper sketch out.

9. Use and get big pictures: Always use encyclopedias, Wikipedia to get pictures so that you can go into the depth.

10. Bookmarks are useful: When you read any book or magazine, you generally use bookmarks, right! It is a good habit, which helps to not to lose your continuity. You should always use bookmarks while searching on Internet also, which will make your search easier.

11. Revise what you wrote: When you write anything, always read it, summarize it and then finalize it.

12. Make all efforts: Make all efforts to mention what you are going to write in your paper. That means always have a good start. Try to mention everything in introduction, that what is the need of a particular research paper. Polish your work by good skill of writing and always give an evaluator, what he wants.

13. Have backups: When you are going to do any important thing like making research paper, you should always have backup copies of it either in your computer or in paper. This will help you to not to lose any of your important.

14. Produce good diagrams of your own: Always try to include good charts or diagrams in your paper to improve quality. Using several and unnecessary diagrams will degrade the quality of your paper by creating "hotchpotch." So always, try to make and include those diagrams, which are made by your own to improve readability and understandability of your paper.

15. Use of direct quotes: When you do research relevant to literature, history or current affairs then use of quotes become essential but if study is relevant to science then use of quotes is not preferable.

16. Use proper verb tense: Use proper verb tenses in your paper. Use past tense, to present those events that happened. Use present tense to indicate events that are going on. Use future tense to indicate future happening events. Use of improper and wrong tenses will confuse the evaluator. Avoid the sentences that are incomplete.

17. Never use online paper: If you are getting any paper on Internet, then never use it as your research paper because it might be possible that evaluator has already seen it or maybe it is outdated version.

18. Pick a good study spot: To do your research studies always try to pick a spot, which is quiet. Every spot is not for studies. Spot that suits you choose it and proceed further.

19. Know what you know: Always try to know, what you know by making objectives. Else, you will be confused and cannot achieve your target.

20. Use good quality grammar: Always use a good quality grammar and use words that will throw positive impact on evaluator. Use of good quality grammar does not mean to use tough words, that for each word the evaluator has to go through dictionary. Do not start sentence with a conjunction. Do not fragment sentences. Eliminate one-word sentences. Ignore passive voice. Do not ever use a big word when a diminutive one would suffice. Verbs have to be in agreement with their subjects. Prepositions are not expressions to finish sentences with. It is incorrect to ever divide an infinitive. Avoid clichés like the disease. Also, always shun irritating alliteration. Use language that is simple and straight forward. put together a neat summary.

21. Arrangement of information: Each section of the main body should start with an opening sentence and there should be a changeover at the end of the section. Give only valid and powerful arguments to your topic. You may also maintain your arguments with records.

22. Never start in last minute: Always start at right time and give enough time to research work. Leaving everything to the last minute will degrade your paper and spoil your work.

23. Multitasking in research is not good: Doing several things at the same time proves bad habit in case of research activity. Research is an area, where everything has a particular time slot. Divide your research work in parts and do particular part in particular time slot.

24. Never copy others' work: Never copy others' work and give it your name because if evaluator has seen it anywhere you will be in trouble.

25. Take proper rest and food: No matter how many hours you spend for your research activity, if you are not taking care of your health then all your efforts will be in vain. For a quality research, study is must, and this can be done by taking proper rest and food.

26. Go for seminars: Attend seminars if the topic is relevant to your research area. Utilize all your resources.

27. Refresh your mind after intervals: Try to give rest to your mind by listening to soft music or by sleeping in intervals. This will also improve your memory.

28. Make colleagues: Always try to make colleagues. No matter how sharper or intelligent you are, if you make colleagues you can have several ideas, which will be helpful for your research.

29. Think technically: Always think technically. If anything happens, then search its reasons, its benefits, and demerits.

30. Think and then print: When you will go to print your paper, notice that tables are not be split, headings are not detached from their descriptions, and page sequence is maintained.

31. Adding unnecessary information: Do not add unnecessary information, like, I have used MS Excel to draw graph. Do not add irrelevant and inappropriate material. These all will create superfluous. Foreign terminology and phrases are not apropos. One should NEVER take a broad view. Analogy in script is like feathers on a snake. Not at all use a large word when a very small one would be sufficient. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Amplification is a billion times of inferior quality than sarcasm.

32. Never oversimplify everything: To add material in your research paper, never go for oversimplification. This will definitely irritate the evaluator. Be more or less specific. Also too, by no means, ever use rhythmic redundancies. Contractions aren't essential and shouldn't be there used. Comparisons are as terrible as clichés. Give up ampersands and abbreviations, and so on. Remove commas, that are, not necessary. Parenthetical words however should be together with this in commas. Understatement is all the time the complete best way to put onward earth-shaking thoughts. Give a detailed literary review.

33. Report concluded results: Use concluded results. From raw data, filter the results and then conclude your studies based on measurements and observations taken. Significant figures and appropriate number of decimal places should be used. Parenthetical remarks are prohibitive. Proofread carefully at final stage. In the end give outline to your arguments. Spot out perspectives of further study of this subject. Justify your conclusion by at the bottom of them with sufficient justifications and examples.

34. After conclusion: Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium though which your research is going to be in print to the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects in your research.

Informal Guidelines of Research Paper Writing

Key points to remember:

- Submit all work in its final form.
- Write your paper in the form, which is presented in the guidelines using the template.
- Please note the criterion for grading the final paper by peer-reviewers.

Final Points:

A purpose of organizing a research paper is to let people to interpret your effort selectively. The journal requires the following sections, submitted in the order listed, each section to start on a new page.

The introduction will be compiled from reference matter and will reflect the design processes or outline of basis that direct you to make study. As you will carry out the process of study, the method and process section will be constructed as like that. The result segment will show related statistics in nearly sequential order and will direct the reviewers next to the similar intellectual paths throughout the data that you took to carry out your study. The discussion section will provide understanding of the data and projections as to the implication of the results. The use of good quality references all through the paper will give the effort trustworthiness by representing an alertness of prior workings.

Writing a research paper is not an easy job no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record keeping are the only means to make straightforward the progression.

General style:

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear

· Adhere to recommended page limits

Mistakes to evade

- Insertion a title at the foot of a page with the subsequent text on the next page
- Separating a table/chart or figure - impound each figure/table to a single page
- Submitting a manuscript with pages out of sequence

In every sections of your document

· Use standard writing style including articles ("a", "the," etc.)

· Keep on paying attention on the research topic of the paper

· Use paragraphs to split each significant point (excluding for the abstract)

· Align the primary line of each section

· Present your points in sound order

· Use present tense to report well accepted

· Use past tense to describe specific results

· Shun familiar wording, don't address the reviewer directly, and don't use slang, slang language, or superlatives

· Shun use of extra pictures - include only those figures essential to presenting results

Title Page:

Choose a revealing title. It should be short. It should not have non-standard acronyms or abbreviations. It should not exceed two printed lines. It should include the name(s) and address (es) of all authors.

Abstract:

The summary should be two hundred words or less. It should briefly and clearly explain the key findings reported in the manuscript--must have precise statistics. It should not have abnormal acronyms or abbreviations. It should be logical in itself. Shun citing references at this point.

An abstract is a brief distinct paragraph summary of finished work or work in development. In a minute or less a reviewer can be taught the foundation behind the study, common approach to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Yet, use comprehensive sentences and do not let go readability for briefness. You can maintain it succinct by phrasing sentences so that they provide more than lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study, with the subsequent elements in any summary. Try to maintain the initial two items to no more than one ruling each.

- Reason of the study - theory, overall issue, purpose
- Fundamental goal
- To the point depiction of the research
- Consequences, including definite statistics - if the consequences are quantitative in nature, account quantitative data; results of any numerical analysis should be reported
- Significant conclusions or questions that track from the research(es)

Approach:

- Single section, and succinct
- As a outline of job done, it is always written in past tense
- A conceptual should situate on its own, and not submit to any other part of the paper such as a form or table
- Center on shortening results - bound background information to a verdict or two, if completely necessary
- What you account in an conceptual must be regular with what you reported in the manuscript
- Exact spelling, clearness of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else

Introduction:

The **Introduction** should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable to comprehend and calculate the purpose of your study without having to submit to other works. The basis for the study should be offered. Give most important references but shun difficult to make a comprehensive appraisal of the topic. In the introduction, describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will have no attention in your result. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here. Following approach can create a valuable beginning:

- Explain the value (significance) of the study
- Shield the model - why did you employ this particular system or method? What is its compensation? You strength remark on its appropriateness from a abstract point of vision as well as point out sensible reasons for using it.
- Present a justification. Status your particular theory (es) or aim(s), and describe the logic that led you to choose them.
- Very for a short time explain the tentative propose and how it skilled the declared objectives.

Approach:

- Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done.
- Sort out your thoughts; manufacture one key point with every section. If you make the four points listed above, you will need a least of four paragraphs.

- Present surroundings information only as desirable in order hold up a situation. The reviewer does not desire to read the whole thing you know about a topic.
- Shape the theory/purpose specifically - do not take a broad view.
- As always, give awareness to spelling, simplicity and correctness of sentences and phrases.

Procedures (Methods and Materials):

This part is supposed to be the easiest to carve if you have good skills. A sound written Procedures segment allows a capable scientist to replacement your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt for the least amount of information that would permit another capable scientist to spare your outcome but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section. When a technique is used that has been well described in another object, mention the specific item describing a way but draw the basic principle while stating the situation. The purpose is to text all particular resources and broad procedures, so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step by step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

- Explain materials individually only if the study is so complex that it saves liberty this way.
- Embrace particular materials, and any tools or provisions that are not frequently found in laboratories.
- Do not take in frequently found.
- If use of a definite type of tools.
- Materials may be reported in a part section or else they may be recognized along with your measures.

Methods:

- Report the method (not particulars of each process that engaged the same methodology)
- Describe the method entirely
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures
- Simplify - details how procedures were completed not how they were exclusively performed on a particular day.
- If well known procedures were used, account the procedure by name, possibly with reference, and that's all.

Approach:

- It is embarrassed or not possible to use vigorous voice when documenting methods with no using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result when script up the methods most authors use third person passive voice.
- Use standard style in this and in every other part of the paper - avoid familiar lists, and use full sentences.

What to keep away from

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings - save it for the argument.
- Leave out information that is immaterial to a third party.

Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part a entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Carry on to be to the point, by means of statistics and tables, if suitable, to present consequences most efficiently.You must obviously differentiate material that would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matter should not be submitted at all except requested by the instructor.

Content

- Sum up your conclusion in text and demonstrate them, if suitable, with figures and tables.
- In manuscript, explain each of your consequences, point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation an exacting study.
- Explain results of control experiments and comprise remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or in manuscript form.

What to stay away from

- Do not discuss or infer your outcome, report surroundings information, or try to explain anything.
- Not at all, take in raw data or intermediate calculations in a research manuscript.
- Do not present the similar data more than once.
- Manuscript should complement any figures or tables, not duplicate the identical information.
- Never confuse figures with tables - there is a difference.

Approach

- As forever, use past tense when you submit to your results, and put the whole thing in a reasonable order.
- Put figures and tables, appropriately numbered, in order at the end of the report
- If you desire, you may place your figures and tables properly within the text of your results part.

Figures and tables

- If you put figures and tables at the end of the details, make certain that they are visibly distinguished from any attach appendix materials, such as raw facts
- Despite of position, each figure must be numbered one after the other and complete with subtitle
- In spite of position, each table must be titled, numbered one after the other and complete with heading
- All figure and table must be adequately complete that it could situate on its own, divide from text

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The Discussion is expected the trickiest segment to write and describe. A lot of papers submitted for journal are discarded based on problems with the Discussion. There is no head of state for how long a argument should be. Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implication of the study. The purpose here is to offer an understanding of your results and hold up for all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of result should be visibly described. Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved with prospect, and let it drop at that.

- Make a decision if each premise is supported, discarded, or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."
- Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work
- You may propose future guidelines, such as how the experiment might be personalized to accomplish a new idea.
- Give details all of your remarks as much as possible, focus on mechanisms.
- Make a decision if the tentative design sufficiently addressed the theory, and whether or not it was correctly restricted.
- Try to present substitute explanations if sensible alternatives be present.
- One research will not counter an overall question, so maintain the large picture in mind, where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

- When you refer to information, differentiate data generated by your own studies from available information
- Submit to work done by specific persons (including you) in past tense.
- Submit to generally acknowledged facts and main beliefs in present tense.

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- Do not give permission to anyone else to "PROOFREAD" your manuscript.

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- To guard yourself and others from possible illegal use please do not permit anyone right to use to your paper and files.

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Topics	Grades		
	A-B	**C-D**	**E-F**
Abstract	Clear and concise with appropriate content, Correct format. 200 words or below	Unclear summary and no specific data, Incorrect form Above 200 words	No specific data with ambiguous information Above 250 words
Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

INDEX

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ISSN 9755896