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VOLUME 19 ISSUE 6 VERSION 1.0



GLOBAL JOURNAL OF SCIENCE FRONTIER RESEARCH: D
AGRICULTURE & VETERINARY



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AGRICULTURE & VETERINARY

VOLUME 19 ISSUE 6 (VER. 1.0)

OPEN ASSOCIATION OF RESEARCH SOCIETY

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GLOBAL JOURNAL OF SCIENCE FRONTIER RESEARCH: D
AGRICULTURE AND VETERINARY
Volume 19 Issue 6 Version 1.0 Year 2019
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals
Online ISSN: 2249-4626 & Print ISSN: 0975-5896

Experimental and Theoretical Expansion of Access to Credit among Rural Farmers: Case Studies in Boanedistrict, Mozambique

By Euclides Alfredo Matusse

Maringa Estadual University

Abstract- The aim of study is to establish relationship between loan accessibility, repayment capacity, credit terms, and farmers' socioeconomic characteristics using of metrics to extract an indicator for targeting credit financing to rural households.

Design/methodology/approach: The goal question metric GQM paradigm is used to select a sample of 30 settings in the Boane district. The paper adopted validation research on how to perform controlled experiments with small adaptations and involved descriptive, correlation, regression analysis approaches. Data were analyzed using the R, and SPSS statistical model, and Pearson correlation where used to examine the nature of the relationship between the variables.

Keywords: *loans, credit, accessibility, metrics, indicators, credit terms, repayment.*

GJSFR-D Classification: *FOR Code: 070199*



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Experimental and Theoretical Expansion of Access to Credit among Rural Farmers: Case Studies in Boane District, Mozambique

Euclides Alfredo Matusse

Abstract- The aim of study is to establish relationship between loan accessibility, repayment capacity, credit terms, and farmers' socioeconomic characteristics using of metrics to extract an indicator for targeting credit financing to rural households.

Design/methodology/approach: The goal question metric GQM paradigm is used to select a sample of 30 settings in the Boane district. The paper adopted validation research on how to perform controlled experiments with small adaptations and involved descriptive, correlation, regression analysis approaches. Data were analyzed using the R, and SPSS statistical model, and Pearson correlation where used to examine the nature of the relationship between the variables.

Findings: Results indicated that there was a significant positive correlation ($r=0.79389$) between the credit terms and loan accessibility metrics, while the relationship between credit terms and repayment capacity reveals a strong positive correlation and statistically significant ($r=0.51525$). Conclusions between loan accessibility and repayment capacity metrics indicate that there is a weak and statistically significant positive correlation ($r=0.30795$). The multiple regression analysis shows that the credit terms and farmers' socioeconomic characteristics predicted a variance of 61.7% and 60.8%, respectively, in loan access.

Practical implications: The study is relevant because several donors, practitioners, consultants, loan officers, and microfinance institutions can revisit the borrowing decision, determine the efficiency and feasibility of providing useful information on the business's ability to sustain and performance of microcredit institutions.

Originality/value: The research seeks to establish relationships of four determinants of access to credit to extract an indicator with emphasis on repayment capacity, credit terms, loan accessibility, and farmers' socioeconomic characteristics among agribusiness cooperatives and microcredit institutions in Mozambique.

Keywords: loans, credit, accessibility, metrics, indicators, credit terms, repayment.

I. INTRODUCTION

Microfinance institutions (MFIs) play a vital role in supporting the agricultural and rural sector in Boane district Maputo province, as well as rural development and its contribution to poverty reduction

through lending as it enables farmers to reap economies of scale, and venture into production fields. Microfinance is a product of providing financial services to make loans, deposit, insurance service, cash transfer for customers Conroy, (2002). In Mozambique, these MFIs include not only agricultural credit, rural credit, but also savings, transfer of funds, and credit unions to provide quality self-sufficiency services through the mobilization and management of their financial activities (BdeM)¹. According to Mosca and Nova (2019) there are at least three agriculture in the agricultural sector: (1) the international agribusiness that relies on extractivism and concentrates accumulation abroad, with dominance of value chains in Mozambique; (2) small and medium-sized national capital agribusiness, mainly focused on the urban internal market; and (3) a large, highly differentiated family sector that produces mainly food, is not well integrated in the market and has multiple (mostly informal) income-earning activities.

In this study, the approach focuses on small and medium scale agribusiness as a source of livelihood for rural households and rapid population growth. In this context, credit is a factor in accelerating sustainable agricultural development and increasing incomes among farmers (Ololade and Olagunju, 2013; Yara et al. 2019), and the inadequate flow of this financing becomes critical against incremental food production. However, the dynamic nature of agricultural credit financing poses several challenges caused by the high-interest rate, amount granted, repayment period, default, distance from loan, and critical constraints on access to loans by farmers from formal sources Abiodun et al. (2009).

Faced with these challenges, to support agricultural credit financing, the research seeks to establish relationships of determinants of access to credit considering loan accessibility, repayment capacity, credit terms, and socioeconomic characteristics of farmers to find out if they these are relevant indicators in targeting financing to rural households.

This analysis must quantitatively be supported by metrics. For this reason, this article seeks to answer the following questions.

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¹ Bank of Mozambique. Annual report. Volume 24. Annualreport No. 26



1. What are the determinants of access to agricultural loans from formal and informal sources among farmers?
2. How does repayment capacity affect farmers' loan accessibility in the Boane district?
3. What is the distance from the farmers' place (arable land) to the sources of loan?
4. How do the credit terms influence the loan and repayment capacity of farmers?

a) *Objective of the Studies*

Based on the gaps identified in Euclides Matusse (2019) systematic review work, the overall objective of this study is to propose a model to extract an indicator, and to support credit managers in assertive decision-making through metrics. In this context, the research attempts to achieve the following main objectives:

- i. Investigate the socioeconomic characteristics and restrictions faced by rural farmers in acquiring credit;
- ii. Analyze the correlation between credit terms and loan accessibility by rural farmers;
- iii. Analyze the correlation between credit terms and repayment capacity of rural farmers; and
- iv. Establishing (co) relationships to demonstrate how repayment capacity affects loan affordability to rural farmers.

The paper organized as follows: Section 2 presents the concept of access to agricultural credit financing for rural households; section 3 describes the methodology and its use in the present study. Section 4, analyzes the material and method: the metrics identified from the current literature; section 5 presents the results and discussion to evaluate the approach, comparing their characteristics. Section 6, the conclusions, contributions, recommendations, and finally, the bibliographic references.

II. THEORETICAL EXPANSION FRAMEWORK

a) *Concept of Access to the Financing of Agricultural Credit*

Access to credit is one of the main components of rural development and catalyst that activates other production factors and underutilizes functional capacities for the rapid, sustainable growth of agriculture (Ijere 1998). To boost productivity, and production, farmers have to use improved agricultural technologies, buying inputs such as fertilizers, pesticides, insecticides, tools, implements, and herbicides.

It is a remarkable interest shown by agribusiness managers, agricultural economists, and policy makers on the need to pay more attention to the financing of credit to farmers in Mozambique. This well-

deserved attention calls for the conviction that agriculture and production provide greater food security, poverty reduction, and guaranteed supply of raw materials for the development of industry, employment, and higher incomes (Mosca and Nova, 2019).

Agricultural credit remains a challenge categorized into four determinants; credit terms or negotiated terms (offered by a microfinance institution to a borrower) that control the total or monthly credit value Amitava Basu(2017), characteristic of borrowers are attributes that borrowers must have if they are to benefit or access services of microcredit institutions Fred Nimohet al. (2012), loan access Dzadze, et al. (2012) and repaying ability to get back the borrowed investment Adu, et al. (2019).

Figure 1 illustrates the model of the credit application process through formal determinants and the relationship between demand and lending decision, considering the spatial distance between farmers' location and loan sources (Abiodun et al. 2009;Njoku, 2016).

The spiral approach implements the concept of greatest need; it analyzes the terms of lending, credit access, repayment capacity, and the borrower's socioeconomic characteristics in the credit department subcommittee. Each committee prepares an assessment of all steps in the process except the credit demand that must be adopted by some loan and portfolio agents.



Figure 1: Determinants of access to credit. Source: Author's summary

In this context, the evaluation committee follows a period of three to four days, within which credit analysts must complete and deliver each loan decision process. An alternative to the given delivery period involves the planning and borrower data that should be reassessed as much as possible at the beginning of the process.

This divides the analysis into smaller sub deliveries and providing a detailed decision of prompt

delivery. At the end of each review, the remaining processes must reset, considering the borrower's feedback.

III. METHODOLOGY

The goal question metric GQM paradigm was created by researcher Basili and Rombach (1988) which bases on the conviction that for an organization to measure efficiently is necessary, first, to specify the objectives that must achieved, to relate these objectives with data the obtained through measurements, and finally, interpretation of these data according to the proposed.

The GQM approach must be characterized by goal setting: sets objectives relevant to the organization; questions: generates a set of questions that defines objectives through qualitative aspects so that they must measure; and metrics: specifies a set of actions that need to be collected to answer the questions generated (Ribu 2001). Following the approach, the objectives to be achieved in experimental validation must be initially established considering the metrics of the terms of credit Bob Sekiziyivu et.al, (2018), socioeconomic characteristics of farmers Fred Nimoh et.al, (2012), accessibility of the Loan (Abiodun, et al. 2009;EuclidesMatusse, 2019) and capacity in the repayment (Adu, et al. 2019; Nawaiet al. 2010;Mohd Noor Mohd Shariff, 2010; Euclides Matusse, 2019).

The methodology described in this section aims to support the understanding of the preparation of the research to be applied and defines the guideline for the use of the strategy that allows evaluation of each process, such as described in figure 2, steps of the design process meta activity of the experiment.

The description of the elements that make up the research methodology described as follows: definition of objectives (OE) represent the objectives of

the experiment should achieve, based on the determining factors of access to credit; determinants in access to credit (DAC) is a set of credit factors that describe quantitative data and need to be obtained and analyzed. These factors must be divided according to the problem (or problems) that you select and generally use some parameters to determine the priority and relevance in access to credit. Selection of metrics (MS) is the set of metrics selected from the current literature according to elements that compose it; therefore, management questions (QGM) are assumptions that must be answered according to the management perspectives of credit, to support the definition for quantitative analysis.

Metrics (DM) is an estimate of data to intended and support credit targeting among rural farmers. The experimental validation mechanism (MVE) must be considered an integral part of the activities in directing credit to rural families and has three distinct phases: planning, data collection, analysis, and documentation. In data collection and data analysis/documentation (CDA) illustrated in figure 2, the actions (rectangles) represent the phases of metrics analysis to evaluate the correlation to extract indicators that serve as elements for strategy while decisions (lozenge), represent the pre and after condition of each phase.

Initially, the credit manager should initiate the evaluation aspects of the experiment, as well as instrumentation and define the artifacts needed for empirical study. Then, experimental data must be collected to analyze and validated in the analysis and interpretation phase. Finally, the results must be presented and packaged during the documentation phase. The negligence of any of these phases leads to erroneous and needs changes in the strategy already made, which is sometimes impossible to accomplish.

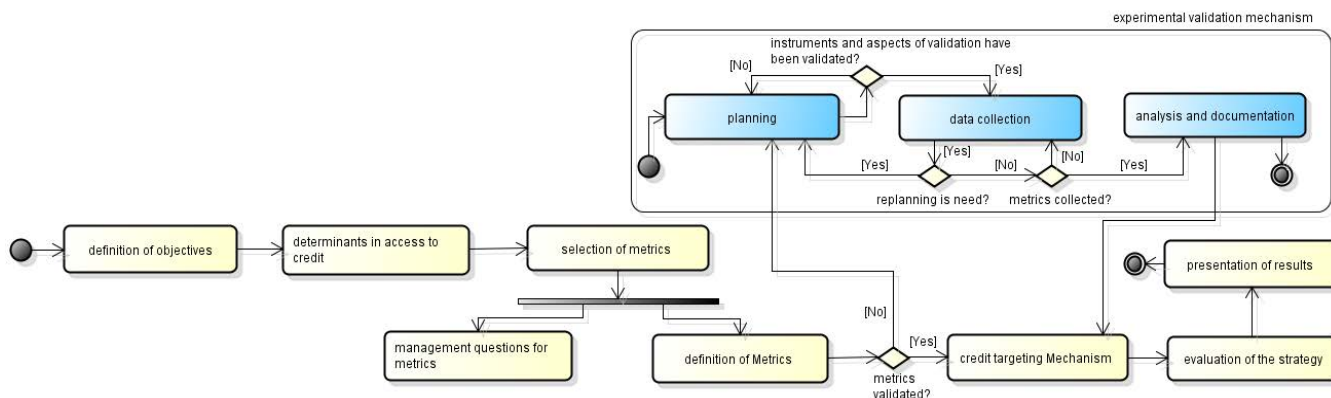


Figure 2: MPAE-Design process meta activity. Source: Author's summary

The Credit targeting Mechanism (MDC) represent the elements for strategy elaboration; these elements aim to integrate metrics with the implementation of the GQM method as an initiative of best practices to support credit managers in the decision-making conform with indicators. Evaluation of the strategy (ES) must be carried out through the elements that compose them derived from the experimental study, and the presentation of results (AR) allows presentation of the results of the strategy to the credit manager and portfolio for making more assertive decision-making in financing credit to rural farmers.

IV. MATERIAL AND METHOD

The study was conducted in the Boane District. The district is located southwest of Maputo province, being bordered to the north by Moamba district, to the south and east by Namaacha district, and west by the city of Matola and Mautuine district, located 30 km from Maputo city and lies between longitude 32° 23' 20" East and latitudes 26° 1' 44" South. With an area² of 815 km² and population density of 101 in habitants/km², the population is young 42% down 15 years of age, mostly female (masculinity rate of 47%) and urban and semi-urban matrix (urbanization rate 68%).

The waterways of Boane district belong to the watersheds of the Umbeluzi, Tembe, and Matola rivers. The Umbeluzi valley has soils with good agricultural and livestock potential, which must be exploited by a vast fabric of private and family farming. Agriculture is the basis of the incomes rural families, with cultures like vegetables, corn, cassava, beans, bananas, and citrus as main crops. The primary data was collected directly from 30 farmers to compose different configurations by the use of structured questionnaires, interviews, and standard analytical testing methods were used to determine the properties of the data applied in the selected metrics from the current literature.

Secondary data were also collected from published data from DPIC³, Boane, these included the use of descriptive statistics to examine the level of socioeconomic characteristics associated with loans, linear model is adopted for the hypothesis test to analyze factors that influence access to formal and informal agricultural credit.

The R correlation model analysis is performed to establish relationships between the study variables. This method generates a measure of the magnitude and direction of credit financing to the rural family. The multiple regression model illustrated the Pearson correlation formulain equation 1 presents explicitly specified as follows:

$$r = \frac{\sum (x - m_x)(y - m_y)}{\sqrt{\sum (x - m_x)^2 \sum (y - m_y)^2}} \quad (1)$$

Where m_x and m_y are the means of x and y variables.

The corresponding p-value is determined using t distribution table for $df = n - 2$.

According to Abiodun et al. (2009), the calibration for access to the loan for each farmer must be obtained from the historical basis of the determining factors of the loan of microfinance institutions. Thus, calculation model to analyze factors that influence access to credit, can receive notes ranging from 1 to 4, value 1 indicating that this item is low complexity; the value 2 moderate, medium influence; the value 3 complex; and the item 4 n-complex. The determinant factor of the loan (DEF) must be obtained through the Equation Eq. 2.

$$DEF = N \times TFator \quad (2)$$

Where: DEF –The factor of determining loans, TFator - is the sum between the weight and the rating awarded of each loan determinant, N - is the total number of farmers; and the technical estimate to capture the agricultural loan accessibility metric per farmer must calculate in the Equation Eq.3.

$$TAEA(agric) = LOS + LR + RPP + LOG \quad (3)$$

Where: -TAEA(agric) - is the estimate of the technique for capturing the metric accessibility of agricultural lending per farmer, LOS - refers to the amount granted of the loan (amount-MTN), LR is loan rate (percentage-%), RPP is the reimbursement period (months), LOG - represents the loan guarantee (Amount-MTN).

The statistical formula adapted from the work of Euclides Matusse(2019) to calculate the estimate accessibility of agricultural lending by farmer must describe below for extracting the Equation Eq.4.

$$AEmp_{(agric)} = \frac{(TAEA(agric) \times DEF)}{(N^2 - N)} \quad (4)$$

Where: AEmp(agric) - accessibility of agricultural lending by the farmer from formal and informal sources, TAEA(agric) - is the estimation of the technique to capture the metric of agricultural lending by a farmer, DEF –the factor of determining loans, and N - is the total number of farmers.

The terms of credit must be understood as terms negotiated involving collateral, payment periods and interest rate (Atieno, 2001). Thus, the technical estimate for capturing the terms credit for the agricultural loan must be calculated in the Equation Eq.5.

² Direcção Nacional de Terras (<http://www.dnageca.gov.mz/dnt>)

³ Direcção Provincial da Industria e Comércio (<https://www.pmaputo.gov.mz/>)

$$TERM_{(cred)} = LR + RPP + LOG \quad (5)$$

Where: $-TERM_{(cred)}$ - is the estimate of the technique for capturing the terms of credit of the agricultural loan, LR is loan rate (percentage-%), RPP is the repayment period (months), LOG - represents the loan guarantee (amount-MTN).

The formula for calculating the terms credit or negotiated terms (offered by a microfinance institution to a farmer) must be described below for extracting the Equation Eq.6.

$$TCRED_{(agric)} = \frac{(TERM_{(cred)} \times DEF)}{(N^2 - N)} \quad (6)$$

Where: $TCRED_{(agric)}$ - is the credit terms estimate of the agricultural loan by the farmer from formal and informal sources, $TERM_{(cred)}$ - is the estimate of the technique to capture the credit terms, DEF - a factor of determinant loans and N - is the total number of agricultures.

The repayment capacity process depends on inherent characteristics of farmers and their businesses that make it unlikely that the loan must be repaid as loan size, repayment period, loan fee, distance between the farmers' site (arable land) in relation to loan sources (Goodluck, Moshi 2012; Adu, Owualah and Babajide 2019; Ndiege et. al, 2016).

Thus, the statistical formula adapted from the work of Onyeagoacha et al. (2012) to calculate reimbursement capacity, and slightly modified to suit this study to capture all measurable variables described in the Equation Eq.7.

$$RPC = LOS + LR + RPP \quad (7)$$

Where: RPC is repayment capacity, LOS - refers to the size of the loan (amount-MTN), LR is loan rate (percentage - %), RPP is the repayment period (months).

The formulation for measuring geographic (spatial) dispersion respecting the relationships of precedence's and resources (O'Leary and Cummings, 2007) described in the Equation Eq.8.

$$SDI = \sum_{i-j}^k \frac{(KM_{ij} \times N_i \times N_j)}{(N^2 - N) / 2} \quad (8)$$

Where: SDI - is the spatial distance index, KM_{ij} - refers to the deadline is the distance between places i and j in kilometers, N_i and N_j - represent the number of people on-site, k - is the total number spaces that changes in relation to the farmer's decision, N - is the total number of farmers.

The statistical formula adapted from the work of Euclides Matusse (2019) to calculate the estimate of the repayment capacity defined as an object to answer the research question must be describe below for extracting the Equation Eq.9.

$$RPC_{(agric)} = \frac{(RPC \times SDI)}{(N^2 - N)} \quad (9)$$

Where: $RPC_{(agric)}$ - reimbursement capacity per farmer, RPC - is reimbursement capacity, SDI - refers to the spatial distance index, and N - is the total number of farmers.

V. RESULTS AND DISCUSSION

We summed up the demographic data of the study participants collected for the 30 resolutions generated as well as evaluating the classification of such metrics.

As table 1 shows, about 20% of farmers fell in the age group of 30 and 39 years, implying young and active individuals, while 56.67% of farmers fit the age category of 50 years above. This shows that agribusiness cooperatives are predominantly populated by seniors active in the study area. Of the 23.33% who were aged 40 and 49 years, 20% are adult and active individuals.

Table 1: Distribution of the Rural Family (Years)

Age (in years)	Frequency	Percentage(%)
20-29	0	0.00
30-39	6	20.00
40-49	7	23.33
50-59	17	56.67
Total	30	100.00

Data on the educational level in table 2 show that 40% of farmers did not have formal education. Those with primary education represented 35%, while 25% received high school.

Table 2: Distribution of the Rural Family (Education)

EducationLevel (in years)	Frequency	Percentage(%)
0 (no formal education)	10	40.00
1-6 (primary school)	11	35.00
7-12 (secondary school)	9	25.00
13-18 (university)	0	0.00
Total	30	100.00

Data on agricultural experience, as shown in table 3 that about 20% of farmers have experience ranging from 6 to 10 years, while only 56.67% have been in the production business for more than 16 years. Of the 23.33% of the interviewees, 10% had experience of

cultivation of 11-15 years and another 13.33% range from 1-5 years.

Table 3: Distribution of the Rural Family (Experience)

Agricultural Experience (in years)	Frequency	Percentage (%)
1-5	4	13.33
6-10	6	20.00
11-15	3	10.00
16 – forward	17	56.67
Total	30	100.00

As shown in table 4, about 90% of farmers have arable land less than 5 hectares in size, while about 10% have arable land with an average size of 7 hectares. The results imply that agribusiness cooperatives are predominantly small farmers, probably due to the limited availability of agricultural land.

Table 4: Distribution of the rural family (land size)

Land size (hectares)	Frequency	Percentage (%)
0.10-4.99	27	90.00
5.0-8.99	3	10.00
9.00-12.99	0	0.00
13.00 – forward	0	0.00
Total	30	100.00

Data on household size in table 5 showed that most farmers have approximately 56.67% of the household size of between 7 and 9 people. Approximately 23.33% maintained the household size of 4-6 people. Of the 20% of respondents, 10% were household sizes of between 1 and 3 people, and another 10% range from 10-12 people per household.

Table 5: Distribution of the Rural Family (Household)

Household (in years)	Frequency	Percentage (%)
1-3	3	10.00
4-6	7	23.33
7-9	17	56.67
10-12	3	10.00
Total	30	100.00

The distribution of farmers by marital status, as represented by table 6, showed that 43.33% were married, while 56.67% segmented into different categories of individuals, such as singles (divorced, separated, widowed).

Table 6: Distribution of the Rural Family (Marital Status)

Marital status	Frequency	Percentage (%)
Married	13	43.33
Single	17	56.67
Total	20	100.00

The distribution of farmers by the distance between their loans sources as shown in table 7. Of the result, 100% cover between 1 and 2 kilometers, since microfinance services have be concentrated around agribusiness cooperatives. This distance carries additional costs such as transportation and cost overhead, which shows less propensity to obtain the loan.

Table 7: Distribution of the Rural Family (Distance)

Distance (in kilometers)	Frequency	Percentage (%)
1-2	30	100.00
3-4	0	0.00
4-5	0	0.00
5-6	0	0.00
Total	30	100.00

Income distribution among rural farmers in the study area, as shown in table 8, that about 30% of farmers have an income ranging from 5.000,00-20.000,00 MTN, with the vast majority gaining between 66.000,00 and 80.000,00 MTN per farm season. Of the 23.33% of the interviewees, 16.66% had, income of 46.000,00 and 60.000,00 MTN, and another 6.67% range from 21.000,00 and 45.000,00 MTN. This demonstrate that rural families in the area are generally low-cost employees and low agricultural incomes.

Table 8: Distribution of the Rural Family (Incomes)

Income (in MTN meticais)	Frequency	Percentage (%)
5.000,00-20.000,00	9	30.00
21.000,00-45.000,00	2	6.67
46.000,00-60.000,00	5	16.66
66.000,00-80.000,00	14	46.67
Total	30	100.00

The distribution of the amount granted to each farmer by the amount is shown in table 9. About 56.67% of them are around 61.000,00 and 90.000,00 MTN, and this represents the majority. Due to the scarcity of the loan amount, it should be deduced that rural households are not concerned with strengthening their production because they consider problematic and flexible credit terms and conditions to suit farmers' reality

Table 9: Distribution of the Rural Family (Granted Amount)

Amount (in MTN meticais)	Frequency	Percentage (%)
10.000,00-30.000,00	4	13.33
31.000,00-60.000,00	2	6.67
61.000,00-90.000,00	17	56.67
91.000,00-100.000,00	7	23.33
Total	30	100.00

The distribution of farmers by sex is shown in table 10 indicates that the population of men (56.67%) is dominant in the agribusiness cooperative in the area of study.

Table 10: Distribution of the Rural Family (Sex)

Sex	Frequency	Percentage (%)
Male	17	56.67
Female	13	43.33
Total	30	100.00

To establish the relationship between the socioeconomic characteristics of farmers, terms of credit, and loan accessibility, the multiple regression model is performed. The regression analysis summarized in table 11 indicates that the terms of credit (TCRED) (beta = 1,158, p <.01) and socioeconomic characteristics (CarSoc) (beta = -.264, p <.01) of farmers have a statistically significant positive on access to a loan. This demonstrated that IMFs lend at an affordable rate depending on farm size, education and loan period. The regression model was well achieved and specified for TCRED (F = 47,732, p <.01) and CarSoc (F = 0.327, p <.01) about loan access, implying that both socioeconomic characteristics and credit terms were appropriate and borrowers have the freedom to negotiate the duration of the loan period. Thus, the expected independent variables range from up to 61.7% TCRED and CarSoc 60.8%, respectively, in access to the loan.

Table 11: Análise De Regressão

Model Summary ^c										
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.794 ^a	.630	.617	2.38377	.630	47.732	1	28	.000	
2	.793 ^b	.635	.608	2.41294	.004	.327	1	27	.572	1.382

a. Predictors: (Constant), TCRED
 b. Predictors: (Constant), TCRED, CarSoc
 c. Dependent Variable: AEmp

Coefficients ^a								
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error				Beta	Tolerance
1	(Constant)	2.859	2.324		1.230	.229		
	TCRED	1.158	.168	.794	6.909	.000	1.000	1.000
2	(Constant)	3.199	2.426		1.318	.198		
	TCRED	1.240	.222	.850	5.575	.000	.582	1.719
	CarSoc	-.264	.461	-.087	-.572	.572	.582	1.719

a. Dependent Variable: AEmp

The figure 3 presents the residual statistical values observed from the variables independent, of the credit terms metric, socioeconomic characteristics of farmers on the dependent variable forecast value loan accessibility for a sample of N (30) with a minimum value 14,140, maximum value 25,657, mean (μ) 18.632 and standard deviation (σ) 3,068.

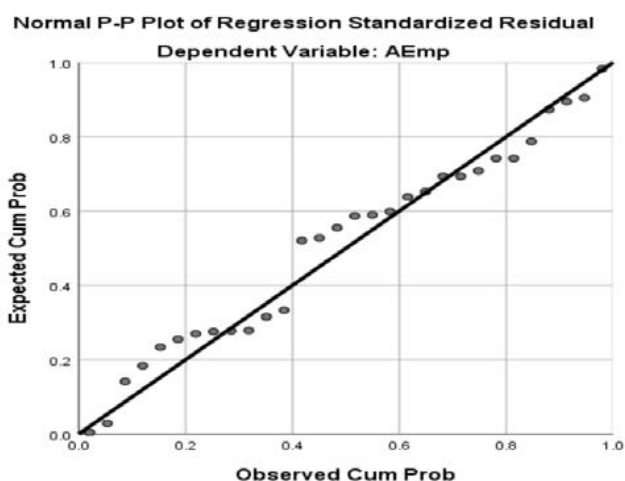


Figure 3: The plot of regression standardized residual

Pearson's Correlation analysis

Correlation analysis in table 12, have to be conducted to establish the relationships between the study variables. This method allows you to determine whether there is a correlation between the two datasets.

Table 12: Correlation Analysis

	Variables	AEmp	TCRED	CarSoc
Pearson's Correlation	AEmp	1.000	.794	.463
	TCRED	.794	1.000	.647
	CarSoc	.463	.647	1.000
Sig. (1-tailed)	AEmp	.		.005
	TCRED	.000	.	.000
	CarSoc	.005	.000	.

a) Experimental validation of metrics

We follow the suggestions provided by Perry et al. (2000) and Wohlin et al. (2000) on how to conduct controlled experiments with small adaptations. Thirty farmers participated in the study, nine of them in secondary education, and eleven primary schools. As a short sample level has be considered, variations with the participants' agricultural experience were reduced. For the study in question, the following hypotheses were proposed:

Hypothesis formulation: hypotheses proposed for the study

Null Hypothesis ($H_{(0)}$): there is no significant correlation between the metric $TCRED_{(agric)}$ and the metric $AEmp_{(agric)}$;

Alternative Hypothesis ($H_{(1)}$): there is a significant correlation between the metric $TCRED_{(agric)}$ and the metric $AEmp_{(agric)}$.

Null Hypothesis ($H_{(0)}$): there is no significant correlation between the metric $TCRED_{(agric)}$ and the metric $RPC_{(agric)}$;

Alternative Hypothesis ($H_{(1)}$): there is a significant correlation between the metric $TCRED_{(agric)}$ and the metric $RPC_{(agric)}$.

Null Hypothesis ($H_{(0)}$): there is no significant correlation between the metric $AEmp_{(agric)}$ and the metric $RPC_{(agric)}$;

Alternative Hypothesis ($H_{(1)}$): there is a significant correlation between the metric $AEmp_{(agric)}$ and the metric $RPC_{(agric)}$.

The study characterized and validated metrics and the feasibility of using them to target credit financing to rural farmers. Thus, the analysis mechanisms used were:

- Descriptive statistical analyses about the metrics collected from the settings generated by each participant, combined with descriptive statistical analyses, scatter charts, as they provide information with observed values on total values of a measure, arithmetic media, standard deviation, minimum value, maximum, amplitude and sample (N) of metrics, and
- trade-off analyses with the objective of prioritizing elements that makeup metrics. The scale to measure the correlation coefficient illustrated according to figure 4.

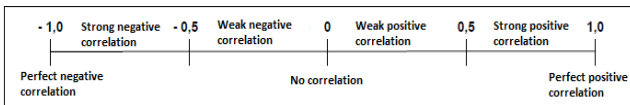


Figure 4: The correlation ranking scale

b) *Normality test and the correlation between credit terms and loan accessibility*

Figure 5 shows the observed values and the following hypotheses were proposed for tests concerning the metric $TCRED_{(agric)}$:

- Null Hypothesis ($H_{(0)}$): the distribution of observed values is normal;
- Alternative Hypothesis ($H_{(1)}$): the distribution of observed values in question is not normal

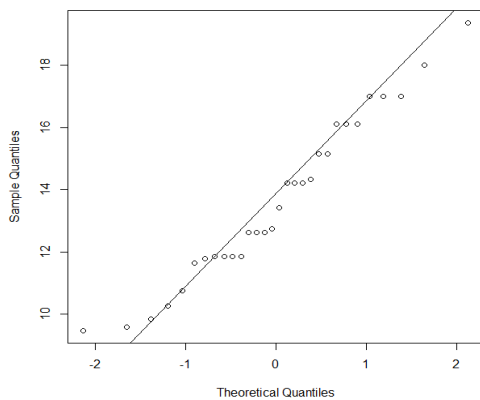


Figure 5: Shapiro and Wilk normality test for metric $TCRED_{(agric)}$

We can observe that the distribution of values is normal. Despite this, normality tests Shapiro and Wilk [21] were performed to make sure of this.

Normality tests for the metric $TCRED_{(agric)}$ as can be seen in Figure 5 for a sample of N (30) with minimum value 9.47, maximum value 19.36, amplitude 9.89, mean (μ) 13.622, and standard deviation (σ) 2.641. Based on the Shapiro and Wilk tests [21], for a sample size of 30 with 95 % safety ($\alpha = 0.05$), the significance value (p) is 0.364 ($p < 0.05$) and the calculated value of $W = 0.9628$ the alternative hypothesis ($H_{(1)}$) should be rejected. Thus, there is evidence to reject the alternative hypothesis ($H_{(1)}$) by metric $TCRED_{(agric)}$, considering the distribution of the observed normal values.

Analysis correlation R model: as metric distribution $TCRED_{(agric)}$ and $AEmp_{(agric)}$ is normal expressed in section (V-D), applied whether the R model correlation, to support the interpretation of the data. This method allows you to determine whether there is a correlation between the two datasets. Equation 10 represents an analysis of the R linear regression model to verify that there is a correlation between the metrics.

$$y = ax + b \tag{10}$$

Where: y is loan accessibility, x - credit terms, a - angular coefficient, b interpolator and r correlation coefficient.

The conclusions reveal that there is a hard and statistically significant positive correlation ($r = 0.79389$) according to the ranking of correlation figure 4. This demonstrate that the terms of credit, interest rates, loan period, and the guarantee requirement are flexible, so farmers tend to pay their parcels regularly in compliance with contractual standards.

c) *Normality test and the correlation between credit terms and repayment capacity*

The figure 6, shows the observed values, and the following hypotheses where proposed for tests concerning the metric $RPC_{(agric)}$:

- Null Hypothesis ($H_{(0)}$): The distribution of observed values is normal;
- Alternative Hypothesis ($H_{(1)}$): The distribution of observed values in question is not normal

We can observe that the distribution of values is non-normal. Despite this, normality tests Shapiro and Wilk [21] were performed to make sure this.

Normality tests for the metric $RPC_{(agric)}$: as can be seen in figure 6 for a sample of N (30) with minimum value 0.45, maximum value 0.74, amplitude 0.29, mean (μ) 0.657, and standard deviation (σ) 0.063. Based on the Shapiro and Wilk tests [21], for a sample size of 30 with 95 % safety ($\alpha = 0.05$), the significance value (p) is 0.0007 (p

< 0.05) and the calculated value of $W = 0.8518$ the null hypothesis ($H_{(0)}$) should be rejected

Thus, there is evidence to reject the null hypothesis ($H_{(0)}$) by the metric $RPC_{(agric)}$.

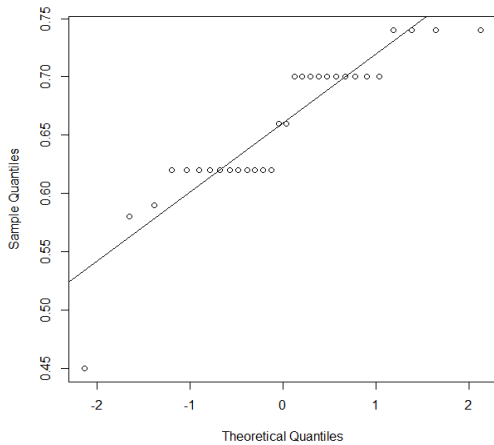


Figure 6: Shapiro and Wilk normality test for metric $RPC_{(agric)}$

Analyze correlation R model: as normal metric distribution $TCRED_{(agric)}$ and $RPC_{(agric)}$ is not normal, applied whether the R model correlation to support the interpretation of the data. This method allows you to determine whether there is a correlation between the two datasets. Equation 11 represents an analysis of the R linear regression model to verify that there is a correlation between the metrics.

$$y = ax + b \quad (11)$$

Where: y is loan accessibility, x - credit terms, a - angular coefficient, b interpolator and r correlation coefficient.

The conclusions reveal that there is a hard and statistically significant positive correlation ($r = 0.51525$) according to the ranking of correlation figure 4. This demonstrate that the more flexible the terms where granting credit, the easier it is for rural families to honor their loans. One of the threats to validity the completion is the sample size (N) that must be increased in future repetitions.

d) Normality test and the correlation between loan accessibility metric and repayment capacity

The figure 7, presents the observed values, and the following hypotheses were proposed for tests concerning the metric $AEmp_{(agric)}$:

- Null Hypothesis ($H_{(0)}$): the distribution of observed values is normal;
- Alternative Hypothesis ($H_{(1)}$): the distribution of observed values in question is not normal

We can observe that the distribution of values is normal. Despite this, normality tests Shapiro and Wilk [21] were performed to make sure of this.

Normality tests for the metric $AEmp_{(agric)}$: as can be seen in figure 6 for a sample of size N (30) with minimum value 12.16, maximum value 26.53, amplitude 14.37, mean (μ) 18,632, and standard deviation (σ) 3,852.

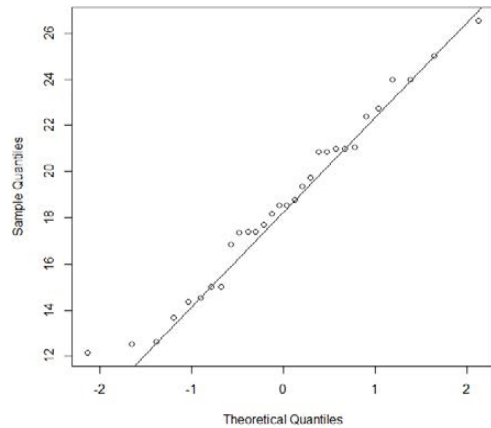


Figure 7: Shapiro and Wilk normality test for metric $AEmp_{(agric)}$

Based on the Shapiro and Wilk tests [21], for a sample size of 30 with 95% safety ($\alpha = 0.05$), the significance value (p) is 0.6637 ($p > 0.05$) and the calculated value of $W = 0.9743$ the alternative hypothesis ($H_{(1)}$) should be rejected.

Thus, there is evidence to reject the alternative hypothesis ($H_{(1)}$) by metric $AEmp_{(agric)}$.

Analysis correlation R model: as distribution of metric $AEmp_{(agric)}$ is normal and $RPC_{(agric)}$ is not normal; the R model correlation was applied to support the interpretation of the data. This method allows you to determine whether there is a correlation between the two datasets. Equation 12 represents an analysis of the R linear regression model to verify that there is a correlation between the metrics.

$$y = ax + b \quad (12)$$

Where: y is loan accessibility, x - credit terms, a - angular coefficient, b interpolator and r correlation coefficient.

The conclusions reveal that there is a weak and statistically significant positive correlation ($r = 0.30795$) according to figure 4 correlation ranking. This demonstrate that the level of flexibility of loan access was directly associated with the loan repayment level. The point to be highlighted, is a threat to the validity of

the study on the distance from the place of farmers (arable land) about loan sources presented in less than 2 km, since microfinance services were concentrated around the agribusiness cooperatives.

VI. CONCLUSION

In this research, experimental validation of factors that affect access to formal credit among farmers of agribusiness cooperatives in the Boane district is presented, and reveal emerging realities. The results of the study showed that there is a positive and statistically significant correlation between loan accessibility, repayment capacity, credit terms, and socioeconomic characteristics of farmers through metrics and provides evidence that indicator can be used to target credit financing to rural families.

Contributions

The contributions of this study have been located in two main dimensions: for theory and the market:

- The empirical evaluation of the study showed the importance of credit terms as determinants of repayment of loans between rural families in the Boane district, so credit managers, portfolio, and policymakers need to pay attention guarantees required to farmers before lending.
- The result of statistical model R indicated that there was a significant positive correlation ($r=0.79389$) between the credit terms and loan accessibility metrics, while the (co) relationship between credit terms and repayment capacity reveal correlation positive and statistically significant ($r=0.51525$). The conclusions reveal that there is a weak and statistically significant positive correlation ($r=0.30795$) between the loan accessibility metrics and repayment capacity. Therefore the regression analysis shows that the characteristics farmers predicted a variance of 61.7% TCRED and CarSoc 60.8% respectively in access to the loan.

Recommendations

From the finding of the study, the guarantee requirement weighs heavily on the perspective of borrowers since land, agricultural production is the only guarantor for obtaining loans, so microcredit institutions should relax their conditions of provisions of the terms of credit, especially collateral guarantee, to increase reimbursement capacity.

The Bank of Mozambique (BdeM), in addition to monitoring loan rates, needs to establish structures to avoid undercapitalization, fraudulent practices, and unjustified interference in the consistent injection of funds into agriculture by members of the council of microfinance institutions.

The Government, and regulatory institutions should reorient stable, long-term and effective policies to tailor the reality of the needs of agribusiness cooperatives in Mozambique.

ACKNOWLEDGEMENTS

The author appreciates the financial support of Nhacutse microcredit under process 190504/2019-7.

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GLOBAL JOURNAL OF SCIENCE FRONTIER RESEARCH: D
AGRICULTURE AND VETERINARY
Volume 19 Issue 6 Version 1.0 Year 2019
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals
Online ISSN: 2249-4626 & Print ISSN: 0975-5896

Effect of Nitrogen and Variety on Agronomic Performance of Rhodes Grass (*Chloris gayana* Kunth) in the Sudan

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Abstract- An experiment was conducted in Shambat (2016-2017) in the demonstration farm of the College of Agricultural Studies, Sudan University for Science and Technology, to study the effect of variety and nitrogen fertilization on the agronomic performance of Rhodes grass. Two Rhodess grass varieties (Fine cut and Reclaimer) and 2 nitrogen doses plus control were studied across seven cuts. The treatments were replicated four times in split plot experiment with fertilizer doses assigned to the main plots and the varieties to the sub-plots. The data collected included forage yield, plant height and days to 50% flowering.

Keywords: *fine cut, reclaimer, tetraploid, diploid.*

GJSFR-D Classification: FOR Code: 070302



EFFECT OF NITROGEN AND VARIETY ON AGRONOMIC PERFORMANCE OF RHODES GRASS CHLORIS GAYANA KUNTH IN THE SUDAN

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Effect of Nitrogen and Variety on Agronomic Performance of Rhodes Grass (*Chloris gayana* Kunth) in the Sudan

Hussein H. A. M^α, Dagash Y. M. I^σ & Maarouf I. Mohammed^ρ

Abstract- An experiment was conducted in Shambat (2016-2017) in the demonstration farm of the College of Agricultural Studies, Sudan University for Science and Technology, to study the effect of variety and nitrogen fertilization on the agronomic performance of Rhodes grass. Two Rhodess grass varieties (Fine cut and Reclaimer) and 2 nitrogen doses plus control were studied across seven cuts. The treatments were replicated four times in split plot experiment with fertilizer doses assigned to the main plots and the varieties to the sub-plots. The data collected included forage yield, plant height and days to 50% flowering.

Differences between varieties and their interaction with cuts were not significant for forage yield. Differences between fertilizer doses for forage yield and their interaction with cuts were highly significant. The nitrogen dose 120kgN/ha significantly increased for age yield and plant height over 60kgN/ha and the control with yield increment of 118%. The dose 60kgN/ha failed to give significant increase in yield over the control. The highest forage yield was obtained in the first cut after establishment then started to decrease. The nitrogen dose 120kgN/ha maintained comparatively high yield throughout the subsequent cuts.

It was concluded that nitrogen application has significant positive impact on productivity of Rhodes grass. Future research should focus on optimizing management of nitrogen dose across cuts. Lack of differences between Rhodes grass varieties in forage yield was attributed to the narrow genetic base of the diploid group. More attention should be given to Tetraploid varieties (Callide, Samford) to enhance productivity of the dairy farms.

Keywords: fine cut, reclaimer, tetraploid, diploid.

I. INTRODUCTION

Rhodes grass (*Chlorisgayana*) is an important forage crop originated in East Africa. It had been widely cultivated in the tropical and sub-tropical regions of the world (Ubei *et al.*, 2001). Rhodes grass is a perennial plant primarily used as forage. It can be grazed, cut for hay or used as deferred feed, with moderate to high feed quality. Many Rhodes cultivars have been developed to suit specific conditions or end-uses (Cook *et al.*, 2005). The crop is grown in a wide

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range of soils; from clays to sandy loam. It does not do well on very heavy clays. The crop responds well to irrigation, moderately tolerant to flooding and has good salt tolerance (Loch *et al.*, 2004).

Based on seed importation record kept by the National Seed Administration of Sudan in 2018, the area cropped to Rhodes grass increased steadily from few hectares in 2012 to about 32000 ha by 2017. The crop is essentially grown for export to the Gulf States where it can fetch high prices justifying the huge initial costs incurred by the fully mechanized pivot irrigation system. Another low cost production system employing surface (Border) irrigation has also been attempted under the problematic low permeable soils.

Sudan is endowed with huge animal wealth ranking first in the Arab World and second in Africa (Mohammed and Zakaria, 2014). Rhodes grass may contribute effectively in alleviating fodder bottlenecks as it allows production of huge quantities of fodder under irrigation throughout the year. Research works carried on Rhodes grass are not coping with its growing importance in the Sudan. Some works on the husbandry practices (Abuswar, 2005; Abdelrahman, 2007; Elnazier, 2010) and variety performance (Maarouf, 2008) have been made. However, research works following the wide adoption of Rhodes cultivation in the Sudan (i.e. 2012 onwards) are very few or lacking. The Sudan Soils are known to be inherently low in nitrogen. The requirement of Rhodes grass to nitrogen fertilization is known to increase under irrigation (Fair, 1989; Dannhauser, 1991). The objectives of this study were to study the effect of variety, nitrogen fertilization and their interaction on the agronomic performance of irrigated Rhodes grass in Sudan.

II. MATERIALS AND METHODS

a) The field experiment

The experimental site: The experiment was conducted at Shambat, during (2016-2017) in the demonstration farm of the College of Agricultural Studies, Sudan University for Science and Technology, latitude 15°39' N, Longitude 32°3'E, 280 meter above sea level. The location is in the semi-arid tropical region with very hot summer and short rainy season between July and September. Temperature, rain fall and relative humidity

of the growing season are presented in Appendix I. The soil of the site is moderately clay, non-saline, non-sodic with pH of 7.8. The chemical and physical properties of the experimental site are presented in Appendices II and III.

Management and Cultural practices: The seeds of the Rhodes grass were sown in the 28th of August 2016. The individual plot size was two ridge 7m long spaced at 0.75m. The seeds were drilled manually in furrows opened in one side of the ridge using seed rate of 20 kg/ha Phosphate fertilizer (TSP) was added before sowing at a rate of 50 Kg P₂O₅/ha. The first irrigation was given immediately after sowing; irrigation water was applied after that at intervals of 7-10 days. However, the experiment was sporadically subjected to shortage of irrigation water leading to partial infestation with termite. Weeds were kept at minimum using hand tools. The zero cut (cut of the seed-crop) commenced after 65 days from sowing, a time at which all entries in each plot were in 25% to 50% bloom. Thereafter, succeeding cuttings throughout the age of the experiment were approximately maintained at intervals of 35 to 40 days or when 10%-25% of plants in each plot have flowered. Forage yield continued to be taken up to the ninth cut after which the experiment was terminated. However, the data of cut 8 and cut 9 will not be reported due to severe termite infestation.

b) *Treatments and experimental design*

Two Rhodes grass (*Chlorisgayana* Kunth) cultivars were used in this study, namely: Fine cut and Reclaimer. The seeds were received from Selected Seed Co. of Australia via a local agent in the Sudan. Three levels of nitrogen fertilizer in a form of urea were studied viz.: 60kg N /ha, 120kg N /ha and 0.0kg N /ha (Control). Randomized Complete Block design in split plot experiment was used with fertilizer treatments assigned to the main plots and the varieties to the sub-plots. The treatments were replicated four times, however, due to termite damage, the data of one of the replicates was deemed unreliable

c) *Data collection*

Green matter yield (GMY) (t/ha): Estimated from the center of the plot excluding one meter from each side of the two ridges. Plants were cut at a height of 6 cm and the green matter yield (GMY) was immediately recorded using spring balance.

Dry matter yield (DMY) (t/ha): Estimated from a sample of one kg randomly taken from each harvested plot and oven dried at 80°C for 48 hours

Plant height (cm): Five Plants from the whole plot were randomly chosen and the height was measured from the soil surface to the tip of the plant.

d) *Statistical analysis*

The data collected for forage yield and plant height were subjected to analysis of variance (ANOVA)

following the standard procedure of analyzing split plot in RCB design (Cochran and Cox, 1957). The Least Significant Difference (LSD) procedure was used to separate the means. The statistical package GenStat (2009) was used to run the analysis

III. RESULTS

Variation among treatments: Table 1 shows mean squares of Rhodes grass cultivars and nitrogen treatments evaluated for forage yield across 7 cuts. Differences between varieties were not significant for forage yield. Interaction of varieties with cuts was also insignificant. Differences between fertilizer doses for dry yield and their interaction with variety were highly significant. Variation among cuts and their interaction with nitrogen doses were also highly significant. The greatest magnitude of mean squares for forage yield was obtained by the nitrogen dose, cut and their interaction.

Forage yield and related traits: The effect of variety on forage yield and related traits was depicted in Table 2. Reclaimer and Fine cut gave comparable yields of 3.62 and 3.60 t/ha, respectively. Comparable GMYs have been also obtained with respective yields of 14.4 and 14.3 t/ha. Both varieties showed comparable performance for plant height and days to flower averaging 88 cm and 32.1 day, respectively.

Effect of nitrogen dose on forage yield and some related traits are presented in Table 3. The nitrogen dose 120kgN/ha significantly increased the dry (DMY) and green (GMY) matter yields over 60kgN/ha and the control. The dose 60kgN/ha gave higher DMY and GMY than the control but the difference in yield was not statistically significant. The plant height obtained by the nitrogen dose 120kgN/ha (92 cm) was significantly higher than that of 60kgN/ha (83 cm). It was also higher than that of the control (88 cm) but the difference was not statistically significant.

Table 4 shows that the nitrogen dose 120kg/ha has increased DMY and GMY by 118.5% and 96.7%, respectively, whereas the respective increases for the dose 60kg/ha were 16.3% and 15.1%.

Interaction effects: The effects of dose x variety interaction on forage yield are depicted in Fig. 1. The highest yields were obtained when using the dose 120kgN/ha with Reclaimer (DMY = 6.23 t/ha) whereas the lowest ones were obtained by the control with Reclaimer (DMY = 2.62 t/ha). Fine cut gave the highest yields under the dose 60kgN/ha (DMY = 3.26 t/ha).

The effect of dose x cut interaction on dry forage yield was shown by Fig. 2. For all doses, forage yield was the highest in the first cut then started to decrease. The dry matter yield obtained by 60kgN/ha decreased from 6.59 to 0.81 t/ha in the first and the 7th cut, respectively. Similar trend was observed for the

control treatment. However, the dose 120kgN/ha, that gave 9.27 t/ha in the first cut, maintained comparatively high DMY in the subsequent cuts (i.e. cut6 = 7.15, cut5 = 6.18 t/ha) before decreasing sharply to .81 t/ha in cut7. The total DMY from 7 cuts was 38.3, 22.0 and 18.9 for 120kgN/ha, 60kgN/ha and the control, respectively.

Fig. 3 shows the effect of dose x variety x cut interaction on dry (DMY) matter yields. The highest yield (10.14 t/ha) was obtained by the interaction of cut1, variety Reclaimer and the dose 120kgN/ha, whereas the lowest DMY (0.80 t/ha) was shown by the interaction of cut7 with both varieties and doses. Similar trend was kept by GMY (data not shown) where the highest yield (35.4 t/ha) was shown by the interaction of cut1, variety Reclaimer and the dose 120kgN/ha. The lowest GMY (4.0 t/ha) was shown by the interaction of cut7, variety Reclaimer and the dose 60kgN/ha. The total DMY from 7 cuts across variety and nitrogen dose ranged from 18.4 t/h (Reclaimer with control) to 43.6 t/ha (Reclaimer with 120kgN/ha)

The effect of cut x dose interaction on plant height is depicted in Fig. 4. The tallest plant stature (104 cm) was obtained by cut1 with 120kgN/ha whereas the shortest one (52 cm) was shown by cut7 with 60kgN/ha. Generally plant heights obtained by 120kgN/ha are taller across different cuts than those shown by 60kgN/ha and the control.

IV. DISCUSSION

Variation among treatments: Most of the variability observed for agronomic performance in this study could be attributed to the effect of fertilizer doses, cuts and their interaction. The effect of variety seems to have little or no contribution to the variability observed specially for forage yield. The genotypic difference between varieties for forage yield might have been curtailed by the uncontrolled variations as evident by the high error mean square (residual) which was 50 times greater than the variety mean squares (Table 1). This might also explain the high coefficient of variations noticed for forage yield. The difficulties encountered in irrigation water coupled with termite infestation were some of the reasons behind the uncontrolled variations. However, lack of differences between Rhodes grass varieties may also be attributed to the narrow genetic base of the varieties used in this study as both of them selected from the diploid Katambora variety (Loch *et al.*, 2004). Insignificant differences among Katambora types has been reported (Maarouf, 2008).

Forage yield and related traits: The study revealed that nitrogen fertilization increased Rhodes grass yield irrespective of the variety effect. Yield increment amounting to 118% was obtained when a dose of 120kgN/ha was used. This result substantiates the previous findings reported by many workers (Skerman

and Riveros 1990; Valenzuela and Smith 2002; Loch *et al.*, 2004; ESGPIP, 2008; Abebe *et al.*, 2015). Loch *et al.*, 2004 reported that in most situations, nitrogen is the major element limiting growth. Increment in Rhodes grass yield up to sevenfold due to nitrogen application has been reported (Henzell, 1963). Research works conducted in Sudan also pointed to the significant effect of nitrogen on Rhodes grass yield (Abuswar, 2005; Abdelrahman, 2007). However, in the present study, the lower dose of nitrogen (60kgN/ha) failed to give significant increase in yield over the control.

The present study as well as many other studies (Koul, 1997; Gasim, 2001; Adam, 2004) showed that plant height is significantly increased by nitrogen fertilizer. Increased plant height could be one of the factors contributing to increased forage yield. Other yield components contributing to forage yield include population density resulting from plant coverage via stolons. However, this feature was not monitored in the present study since high level of seed rate (20 kg/ha) has been used.

The interaction of variety and the dose of nitrogen for dry matter yield is highly significant pointing to the differential performance of variety across different fertilization levels. Similarly, a differential performance of dose across cuts exists indicating that the response of Rhodes grass yield to nitrogen dose was influenced by cutting age.

The potential of dry matter yield of Rhodes grass shown by this study (18.4 - 43.6 t/ha/year) was within the range reported in the literature which varies from 8.7-9.1 (Abebe *et al.*, 2015) to 35-60 t/ha/year (Cook *et al.*, 2005). However, the yield levels showed by this study were lower than those reported in Sudan by Maarouf (2008) who presented data showing dry yield amounting to 3.9 t/ha/year.

V. CONCLUSIONS

The present study confirmed the importance of nitrogen fertilizer in increasing forage production of Rhodes grass. However, the soils of the Sudan are inherently low in nitrogen suggesting the need for more research to optimize nitrogen requirement across cuts i.e. to what extent we can skip applying nitrogen across cuts. Most if not all of Rhodes grass varieties grown in the Sudan belong to the diploid group with little or no variation among cultivars as showed by this study. Diploid varieties suit mainly hay production largely used for export in the Sudan. New research efforts must include Tetraploide.g. Samford, Callide, Masaba, Boma etc.. Such varieties are characterized by high productivity and palatability and suitable for grazing and green chopping systems specially in dairy farms.

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Table 1: Mean squares for green (GMY), dry (DMY) matter yields and related traits of 2 Rhodes grass cultivars evaluated across 7 cuts (2016-2017)

Source of variation	df	GMY (t/h)	DMY (t/h)	Plant height(cm)	Days to flowering
Block	2	266.40	7.705	1351.1	30.77
Dose(D)	2	5282.85 *	298.361 **	1683.9 *	99.59 ns
Residual	4	359	12.188	323.6	129.70
Variety(V)	1	0.40ns	0.034 ns	94.3 n.s	25.19 **
D x V	2	63.47 n.s	5.817 **	14.2 n.s	2.04 ns
Residual	6	26.79	1.351	35.7	0.82
Cut	6	2021.13 **	200.126 **	5433.8 **	214.40 **
D x C	12	251.47 **	14.314 **	311.6 **	109.62 **
V x C	6	13.64 n.s	0.198 ns	30.8 n.s	4.37 n.s
D x V x C	12	5.32 n.s	0.605 ns	29.2 n.s	0.85 n.s
Residual	282	24.54	1.730	104.7	13.84

*. **: Significant at 5% and 1% probability level, respectively.

ns: Not significant at 5% probability level.

Table 2: Effect of variety on Rhodes grass yield and related traits

Variety	Reclaimer	Fine cut	Mean	SE±	CV%
Dry matter yield (t/h)	3.62	3.60	3.61	0.090	36.4
Green matter yield (t/h)	14.4	14.3	14.3	0.40	34.6
Plant height (cm)	87	88	88	0.5	11.7
Days to flowering	32.4	31.8	32.1	0.070	11.6

Table 3: Effect of nitrogen dose on Rhodes grass yield (t/h) and some related traits

Dose	60kgN/ha	120kgN/ha	N0 (control)	Mean	SE±	LSD (5%)	C.V(%)
Dry matter yield	3.14	5.90	2.70	3.61	0.269	1.295	36.4
Green matter yield	12.2	24	10.6	14.3	1.46	7.03	34.6
Plant height (cm)	83	92	88	88	1.4	6.7	11.7
Days to flowering	30.9	31.9	32.8	32.1	0.879	4.225	11.6

Table 4: Percent increase in Rhodes grass yield (t/ha) obtained by nitrogen dose over the control

Dose	Dry matter yield (DMY)	Green matter yield(GMY)	Increase over control (%)	
			DMY	GMY
120kgN/ha	5.90	24.0	118.5	96.7
60kgN/ha	3.14	12.2	16.3	15.1
Control	2.70	10.6	-	-

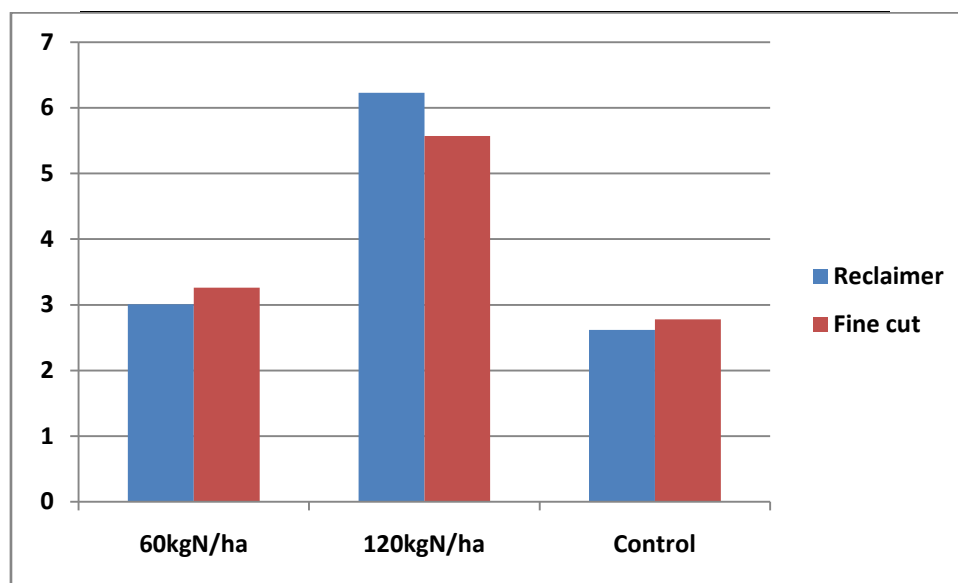


Fig. 1: Effect of dose x variety interaction on dry matter yield of Rhodes grass



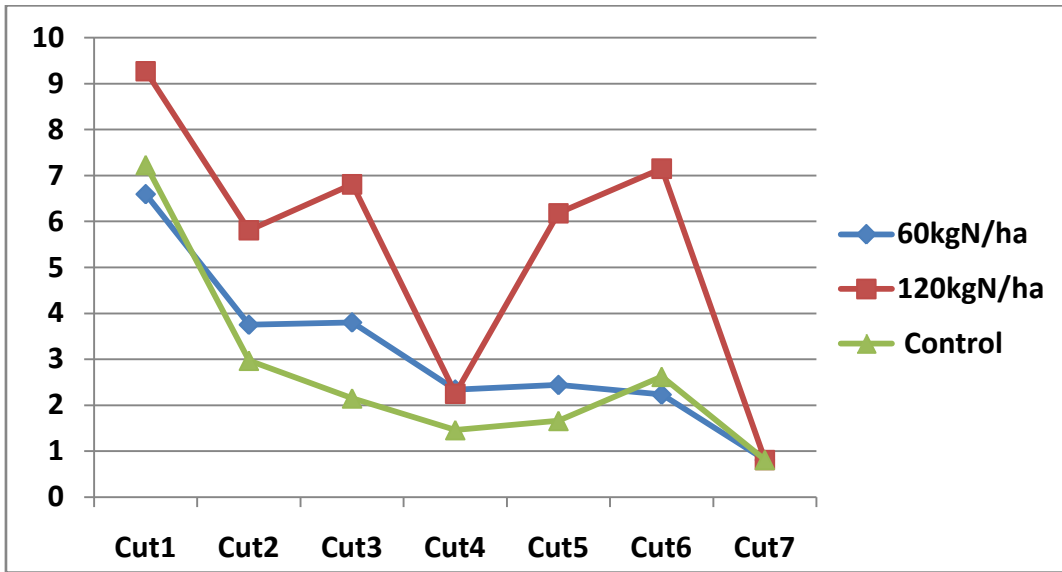


Fig. 2: Effect of dose x cut interaction on dry matter yield of Rhodes grass

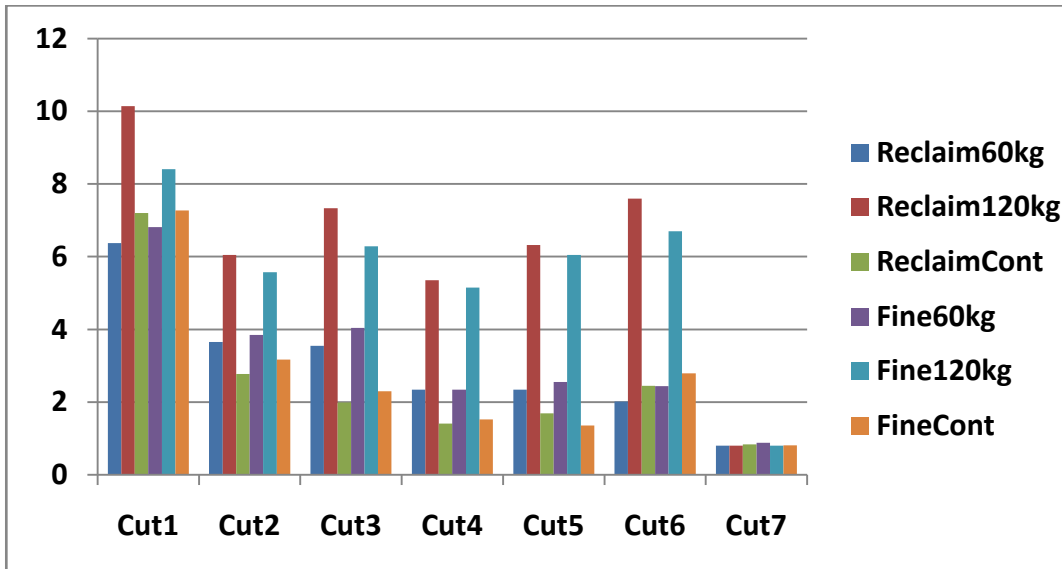


Fig. 3: Effect of dose x variety x cut interaction on dry matter yield of Rhodes grass

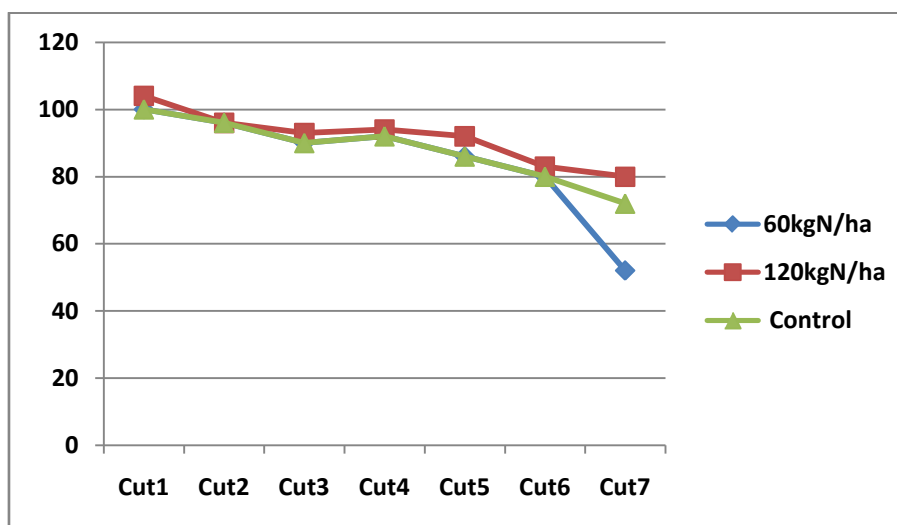


Fig. 4: Effect of cut x nitrogen dose interaction on plant height of Rhodes grass

Appendix I: Monthly average temperature of meteorological data for the experimental period at Shambat

Month	2016				2017			
	Max Temp. (°C)	Min Temp. (°C)	Rain Fall (mm)	Relative Humidity (%)	Max Temp. (°C)	Min Temp. (°C)	Rain Fall (mm)	Relative Humidity (%)
Jan	-	-	-	-	16.8	34.2	-	30
Feb	-	-	-	-	14.9	31.6	-	23
Mar	-	-	-	-	17.8	36.3	-	19
Apr	-	-	-	-	24	40.9	-	17
May	-	-	-	-	26.3	41.6	5.3	29
Jun	-	-	-	-	26.4	42.4	1.5	30
Jul	-	-	-	-	26.7	39.9	40.4	42
Aug	25.2	36.1	69.5	55	24.8	36.6	15	52
Sep	25.4	39.2	23	63	26.5	39.3	2.5	43
Oct	24.6	40.2	-	32	24.3	39.4	-	27
Nov	21.4	37	-	31	20.8	34.8	-	30
Dec	17.5	33.4	-	34	18.3	33.6	-	38

Source: Ministry of Environment, Natural Resources and Physical Development Metrological Authority.

Appendix II: Chemical and physical soil properties of the experimental site

Depth (cm)	pH	ECe (dm/m)	Ca+Mg (mmol+L)	Na (m mol+l)	SAR	CaCO ₃	Clay (%)	Silt (%)	Sand (%)
0-15	7.79	1.4	9.0	5.1	2.4	5.10	42.1	15.9	42.0
15-35	7.88	1.0	6.0	4.3	2.5	4.88	39.6	15.8	44.6
35-51	7.87	1.2	5.0	7.1	4.5	4.99	44.1	16.4	39.5
51-75	7.91	2.0	8.0	12.5	6.3	4.88	51.4	16.6	32.0
75-90	7.71	2.2	6.0	16.0	9.2	5.20	50.0	16.6	33.4

Appendix III: Soil analysis for Nitrogen (N), Phosphorus (P) and potassium (K)

Depth (cm)	N%	P (meg/kg)	K (meg/l)
0-20	0.084	0.53	0.195
0-20	0.140	0.79	0.096
0-20	0.140	0.46	0.070
Mean	0.121	0.59	0.120
20-40	0.112	0.54	0.079
20-40	0.098	0.54	0.066
20-40	0.098	0.51	0.084
Mean	0.103	0.53	0.076



GLOBAL JOURNAL OF SCIENCE FRONTIER RESEARCH: D
AGRICULTURE AND VETERINARY
Volume 19 Issue 6 Version 1.0 Year 2019
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals
Online ISSN: 2249-4626 & Print ISSN: 0975-5896

Evaluation of Irrigation Regime on Tomato (*Lycopersicon Esculentum*), at Hadero Tunto Zuria Woreda, Ethiopia

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Abstract- Effective irrigation practices, management of irrigation water, amount and time irrigation water application are constraints to improve production, minimize water use, and protect natural resources. The experiment was conducted for three consecutive years at Hadero Tunto Zuria Woreda in farmers' fields to identify the impact of irrigation regime which allow achieving optimum Tomato yield. From the study site soil was collected to determine its physical and chemical properties of the soil, daily climate data were collected from nearest meteorological station. The experiment has four levels of treatments (125% MAD, 100% MAD, 75 % MAD and farmer practice) which were arranged in RCBD with four replications. The long year's climatic data were collected and analyzed by CROPWAT8.0 software to calculation of the right amount of water needed for the irrigation. The treatment was conducted under furrow irrigation method and Parshall flumes were used to measure inflow rates at each field.. The experimental field has 16 plots and each plot size was 4m by 5m dimension.

Keywords: furrow, MAD, water use efficiency, tomato, RCBD.

GJSFR-D Classification: FOR Code: 070399



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Tamirneh Kifle

Abstract- Effective irrigation practices, management of irrigation water, amount and time irrigation water application are constraints to improve production, minimize water use, and protect natural resources. The experiment was conducted for three consecutive years at Hadero Tunto Zuria Woreda in farmers' fields to identify the impact of irrigation regime which allow achieving optimum Tomato yield. From the study site soil was collected to determine its physical and chemical properties of the soil, daily climate data were collected from nearest meteorological station. The experiment has four levels of treatments (125% MAD, 100% MAD, 75 % MAD and farmer practice) which were arranged in RCBD with four replications. The long year's climatic data were collected and analyzed by CROPWAT8.0 software to calculation of the right amount of water needed for the irrigation. The treatment was conducted under furrow irrigation method and Parshall flumes were used to measure inflow rates at each field.. The experimental field has 16 plots and each plot size was 4m by 5m dimension. Space between rows 90cm and between the plant 30cm was used. The result shows that maximum total yield (33.94 t/ha) was obtained from 100 % MAD and minimum yield (26.82t/ha) was obtained from 125 % MAD. The results of unmarketable yield has no significant difference ($P < 0.05$) between the three treatment (125% MAD, 100%MAD and 75%MAD). The highest water use efficiency (5.64kg/m³) was obtained from 100%MAD. The highest net income (288116 birr/ha) was obtained at 100 % MAD that received 495.5mm seasonal irrigation water depth. The largest MRR (2156%) was acquired at 100 % MAD. From the result applying the optimum crop water requirement (100%MAD) of tomato was significantly increase the yield, economic benefit, and water use efficiency. Therefore, Applying irrigation water to the right amount at right time was increases yield of Tomato.

Keywords: furrow, MAD, water use efficiency, tomato, RCBD.

I. INTRODUCTION

Irrigation scheduling has conventionally aimed to achieve an optimum water supply for productivity, with soil water content being maintained close to field capacity. In many ways irrigation scheduling can be regarded as a mature research field which has moved from innovative science into the realms of use, or at most the refinement, of existing practical applications. Nevertheless, in recent years there has been a wide

range of proposed novel approaches to irrigation scheduling which have not yet been widely adopted; many of these are based on sensing the plant response to water deficits rather than sensing the soil moisture status directly (Jones, 1990a).

The science of irrigation scheduling has a long and illustrious pedigree. Field monitoring of soil suction began in the 1930's with the development of the tensiometer (Richards and Neal 1936), followed by water content measurement using neutron scattering (Gardner and Kirkham 1952).

The increasing worldwide shortages of water and costs of irrigation are leading to an emphasis on developing methods of irrigation that minimize water use (maximize the water use efficiency). The advent of precision irrigation methods such as trickle irrigation has played a major role in reducing the water required in agricultural and horticultural crops, but has highlighted the need for new methods of accurate irrigation scheduling and control. In recent years it has become clear that maintenance of a slight plant water deficit can improve the partitioning of carbohydrate to reproductive structures such as fruit and also control excessive vegetative growth (Chalmers *et al.*, 1981), giving rise to what has been termed by Chalmers *et al.* (1986) as 'regulated deficit irrigation' (RDI).

Tomato (*Lycopersicon esculentum* Mill.) is one of the most widely grown vegetable crops in the world, second to potato. It originally came from tropical area from Mexico to Peru (Maerere *et al.*, 2006; FAO, 2005). Much is known about optimal irrigation for high yields and soluble solids' content of processing tomato (Hanson and May, 2005, 2006; Phene *et al.*, 1985).

As many of the low productivity areas have untapped water resources, irrigation development is being suggested as a key strategy to enhance agricultural productivity and to stimulate economic development (Bhattarai *et al.*, 2002).

In the contemporary literature, irrigated farming is recognized as central in increasing land productivity, enhancing food security, earning higher and more stable incomes and increasing prospects for multiple cropping and crop diversification (Hussain *et al.*, 2001; Smith, 2004).

Generally soil moisture readings are useful to determine how much water is available for the 4 crop,

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when to start irrigating, and how much water to apply. Soil moisture monitoring can help conserve water and energy, minimize pollution of surface and ground water, and produce optimum crop yields. Efficient scheduling of irrigation water applications gives the highest return for the least amount of water (Werner, 2002). Therefore, this study was conducted to evaluate the effect of irrigation regime on tomato yield and water use efficiency.

II. MATERIALS AND METHODS

a) Study Area Description

A field experiment was carried out in three seasons of 2016, 2017 and 2018, at Hadero Tunto Zuria

Woreda, located at an altitude ranges from 1300m and 2600m a.s.l m.a.s.l, latitude ranges between 07°10'N to 07°12'N and longitude ranges between 037°38' to 037°43'19". Hadero Tunto Zuria Woreda is bordered by Wolayta Zone in the south, Kacha Bira woreda in the east, Hadiya Zone in the north and Tembaro woreda in the west. The woreda has three distinct agro climate zones, Kolla (1%), Weynadega (87%), which was the dominant agro-climatic zone and Dega (12%). The mean annual rainfall ranges from 800mm - 1200mm and with mean annual temperature of 18°C-32°C.

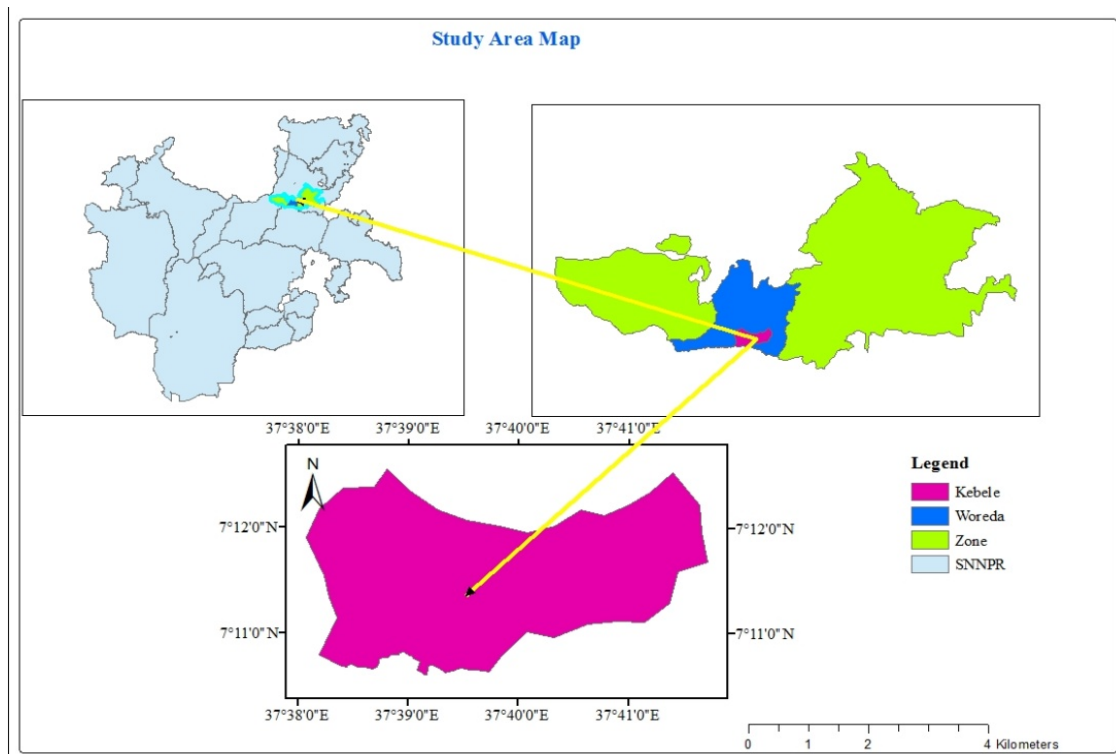


Figure 1: Map of study area

b) Experimental Design

The experiment has four treatments (125 % MAD, 100 % MAD, 75 % MAD and Farmer practice) with four replications. The experiment was laid out in randomized complete block design and the treatment was conducted under furrow irrigation method. The experimental field has 16 plots and each plot size was 4m by 5m dimension. Space between rows and the plants were 90 cm and 30 cm, respectively.

c) Crop Data

Maximum effective root zone depth (RZD) of tomato ranges between 0.7-1.5m and has allowable soil water depletion fraction (P) of 0.40(Andreas *et al.*, 2002). Tomato average Kc would be taken after adjustments have been made for initial, mid and late season stage to

be 0.6, 1.15 and 0.8, respectively (Allen *et al.*, 1998). Yield data like economical yield, unmarketable yield and total yield was measured in the field.

d) Crop Water Determination

Crop water requirement refers to the amount of water that needs to be supplied, while crop evapotranspiration refers to the amount of water that is lost through evapotranspiration (Allen *et al.*, 1998). For the determination of crop water requirement, the effect of climate on crop water requirement, which is the reference crop evapotranspiration (ET_o) and the effect of crop characteristics (K_c) are important (Doorenbos and pruit, 1977). The long term and daily climate data such as maximum and minimum air temperature, relative humidity, wind speed, sunshine hours, and rainfall data

of the study area were collected to determine reference evapotranspiration, crop data like crop coefficient, growing season and development stage, effective root depth, critical depletion factor of tomato and maximum infiltration rate and total available water of the soil was determined to calculate crop water requirement using Cropwat model.

$$ET_c = ET_o \times K_c \quad (1)$$

Where, ET_c = crop evapotranspiration, K_c = crop coefficient, ET_o = reference evapotranspiration.

e) Irrigation Water Management

The total available water (TAW), stored in a unit volume of soil was determined by the expression:

$$TAW = \frac{(F_c - PWP) * BD * Dz}{100} \quad (2)$$

The depth of irrigation supplied at any time can be obtained from the equation

$$I_{net}(mm) = ET_c(mm) - P_{eff}(mm) \quad (3)$$

Gross irrigation (IR_g) is the ratio of net irrigation to application efficiency of furrow irrigation (FAO, 2002). According to Raine and Bakker(1996), furrow irrigation application efficiencies normally vary from 45-60%. The gross irrigation requirement will be obtained from the expression:

$$I_g = \frac{I_n}{E_a} \quad (4)$$

E_a = application efficiency of the furrows (60%)

The time required to deliver the desired depth of water into each furrow will be calculated using the equation:

$$t = \frac{I_g * l * w}{6 * Q} \quad (5)$$

Where: I_g = gross depth of water applied (cm), t = application time (min), l = furrow length in (m), w = furrow spacing in (m), and Q = flow rate (discharge) (l/s)

The amount of irrigation water to be applied at each irrigation application was measured using Parshall flume.

f) Data collection

Daily climate like maximum and minimum air temperature, relative humidity, wind speed, sunshine hours and rainfall data was collected to calculate crop water requirement. Soil moisture was determined gravimetrically. Amount of applied water per each irrigation event was measured using calibrated parshall flume. During harvesting Stand count, weight of economical yield, fruit number of economical yield, unmarketable fruit weight and unmarketable fruit number were measured from the net harvested area of each plot.

g) Economic analysis

Economic evaluation of deficit irrigation is analyzing the cost that invested during growing season and benefit gained from yield produced by application of water. Marginal Rate of Return (MRR) was used for analysis following the CYMMYT method (CIMMYT, 1988). Economic water productivity was calculated based on the information obtained at the study site: the size of irrigable area, the price of water applied and the income gained from the sale of onion yield by considering the local market price. Yield and economic data was collected to evaluate the benefits of application of different manageable depletion level of the treatment. Economic data includes input cost like cost for water (water pricing), seeds, fertilizers, fuel and labor. However, the only parameter that was vary between the treatment is amount of irrigation water. The net income (NI) treatments were calculated by subtracting total cost (TC) from gross income (GI) and were computed as:

$$NI = GI - TC \quad (6)$$

The difference between net income of a treatment and its next higher variable cost treatment termed as change in net income (ΔNI). Higher net benefits may not be attractive if they require very much higher costs (CIMMYT, 1988). Hence, it is required to calculate marginal costs with the extra marginal net income. The marginal rate of return (MRR) indicates the increase of the net income, which is produced by each additional unit of expenditures and it is computed as follows:

Where, MRR = marginal rate of return, ΔNI = change in net income, ΔVC = change in variable cost

h) Statistical Analysis

The collected data were analyzed using Statistical Agricultural Software (SAS 9.0) and least significance difference (LSD) was employed to see a mean difference between treatments and the data collected was statistically analyzed following the standard procedures applicable for RCBD with single factor. The treatment means that were different at 5% levels of significance were separated using LSD test.

III. RESULTS AND DISCUSSION

a) Physical and Chemical properties of Soil

The laboratory result in the table shows that according to the USDA soil textural classification, the percent particle size determination for experimental site revealed that the soil texture could be classified as clay soil. The average soil bulk density (1.21g/cm³) is below the critical threshold level (1.4 g/cm³) and was suitable for crop root growth. The critical value of bulk density for restricting root growth varies with soil type (Hunt and Gilkes,1992) but the general bulk density greater than 1.6 g/cm³ tend to restrict root growth (McKenzie *et al.*, 2004).

Average moisture content at field capacity of the experimental site soils were 27.83% and at permanent wilting point had 17.05% through one meter soil depth. The total available water (TAW) that is the amount of water that a crop can extract from its root zone is directly related FC and PWP. The representative value of TAW was 180 mm/m and the TAW range of 190 – 260 mm/m is the characteristic for clay soil (Brouwer *et al.*, 1985). Soil pH was found to be at the optimum value (6.15) for

tomato and other crops. Tomato can be grown on a wide range of soil but a well-drained, with pH of 5 to 7 is preferred (Doorenbos *et al.*, 1979). The value of EC (1.01) ds/m) was lower considering the standard rates in literature (Landon, 1991). Generally, according to USDA soil classification, a soil with electrical conductivity of less than 2.0 dS/m at 25°C and pH less than 8.5 are classified as normal soil. Therefore, the soil of the study area was normal soils.

Table 1: Soil physical and chemical properties result

Soil properties	Bulk density (gm/cm ³)	Infiltration rate(mm/hr)	Soil texture	EC(ds/m)	pH	Fc (%)	PWP (%)	TAW (mm/M)
Average value	1.21	42	Clay	1.01	6.15	27.83	17.05	13.04

b) *Response of tomato to Irrigation regime*

As shown from (Table 2) that highest marketable yield (29 t/ha) was obtained from 100%MAD and minimum marketable yield (22.2t/ha) was obtained from 125% MAD. Maximum unmarketable yield (5.35t/ha) was achieved from 75% MAD. The experiment results show that there is a significant difference on total yield of tomato between the treatments. Maximum total yield (33.94 t/ha) was obtained from 100% MAD and

minimum yield (26.82t/ha) was obtained from 125% MAD. It is very important a shift from maximizing productivity per unit of land to maximizing productivity per unit of water consumed. The results showed that there were significant differences in water use efficiency between treatments. The highest water use efficiency (5.64 kg/m³) was obtained from 100% MAD and minimum water use efficiency (4.3kg/m³) was obtained from 125% MAD.

Table 2: Effect of irrigation regime on tomato yield and water use efficiency

TRT	MY(t/ha)	UMY(t/ha)	TY(t/ha)	WUE(kg/m ³)
125% MAD	22.2 ^b	4.6 ^{ba}	26.82 ^b	4.3 ^p
100% MAD	29 ^a	4.87 ^{ba}	33.94 ^a	5.64 ^a
75% MAD	23.9 ^b	5.35 ^a	29.32 ^b	4.81 ^{ba}
Farmer practice	22.95 ^b	4.21 ^b	27.2 ^b	5.46 ^a
Cv	23.2	24.7	18.0	27.7
Lsd	4.7	0.97	4.4	1.2

c) *Economic Analysis*

Cost benefit ratio for each treatments were analyzed and income was computed based on the current local market price of tomato at Hadero Tunto Zuria Worda. At the time of harvest the market price of tomato was 11 birr per kg. To analyze by the producer of dominance analysis, the treatments were set in their sort of increasing variable cost and their equivalent benefits were put aside. T3 and T1 showed the minimum and maximum variable cost respectively. Based on the current prices of tomato yield produced and input costs required for production, the economic analysis was

carried out. The highest net income (288116 birr/ha) was obtained at T2 (Applying at 100%MAD) that received 495.5mm seasonal irrigation water depth and the least net income (210190 birr/ha) was obtained at T1 (125% of MAD) that received 619.3 mm depth of irrigation water. However, as it is indicated in table the largest MRR (2156%) was acquired at T2. The MRR tell us that the amount of additional income obtained for every 1 birr spent. Hence, T2 (100% MAD) acquired additional 21.56 birr for every 1birr spent. The minimum acceptable marginal rate of return (MRR) should be between 50 and 100% (CIMMYT, 1988).

Table 3: Economic analysis

Trt	Ay (kg/ha)	GI (birr/ha)	FC (birr/ha)	VC (birr/ha)	TC (birr/ha)	NI (birr/ha)	MRR (%)
75% of MAD	26395.2	290347	18200	22296	40496	249851	-
Farmer practice	24458.4	269042	18200	26760	44960	224082	D
100%MAD	30549.6	336046	18200	29730	47930	288116	2156
125% of MAD	24140.7	265548	18200	37158	55358	210190	D

MAD = maximum allowable depletion, Ay = Adjusted yield, GI=Gross income, FC= Fixed cost, Trt= treatment, VC=Variable cost, TC=Total cost, NI=Net income, MRR=Marginal rate of return, D=Domination

IV. CONCLUSION AND RECOMMENDATION

Maximum total yield (33.94 t/ha) was obtained from 100% MAD and minimum yield (26.82t/ha) was obtained from 125%MAD. The highest water use efficiency (5.64kg/m³) was obtained from 100%MAD. The highest net income (288116 birr/ha) was obtained at T2 (applying at 100%MAD) that received 495.5mm seasonal irrigation water depth and the least net income (210190 birr/ha) was obtained at T1 (125%% of MAD) that received 619.3 mm depth of irrigation water. However, as it is indicated in table the largest MRR (2156%) was acquired at T2 (applying at 100%MAD). From the result applying at 100% MAD for tomato was significantly increase the yield, economic benefit and water use efficiency in the study area. Therefore, applying irrigation water too high interval and too low interval reduces tomato yield and water use efficiency.

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GLOBAL JOURNAL OF SCIENCE FRONTIER RESEARCH: D
AGRICULTURE AND VETERINARY
Volume 19 Issue 6 Version 1.0 Year 2019
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals
Online ISSN: 2249-4626 & Print ISSN: 0975-5896

Effect of Nitrogen and Variety on Quality Performance of Rhodes Grass (*Chloris gayana* kunth) in the Sudan

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Abstract- An experiment was conducted in Shambat (2016-2017) in the demonstration farm of the College of Agricultural Studies, Sudan University of Science and Technology to study the effect of variety and nitrogen fertilization on the quality performance of Rhodes grass. Two Rhodess grass varieties (Fine Cut and Reclaimer) and three nitrogen levels (60kgN/ha, 120kg N/ha and Control= 0.0kgN/ha) were investigated across seven cuts. The treatments were studied as factorial arrangement in Completely Randomized Design. Proximate analysis for Neutral Detergent Fiber (NDF), Acid Detergent Fiber (ADF) and Crude Protein(CP) was carried out.

Keywords: NDF, ADF, CP, cutting age.

GJSFR-D Classification: FOR Code: 961009



Strictly as per the compliance and regulations of:



Effect of Nitrogen and Variety on Quality Performance of Rhodes Grass (*Chloris gayana* kunth) in the Sudan

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Abstract- An experiment was conducted in Shambat (2016-2017) in the demonstration farm of the College of Agricultural Studies, Sudan University of Science and Technology to study the effect of variety and nitrogen fertilization on the quality performance of Rhodes grass. Two Rhodess grass varieties (Fine Cut and Reclaimer) and three nitrogen levels (60kgN/ha, 120kg N/ha and Control= 0.0kgN/ha) were investigated across seven cuts. The treatments were studied as factorial arrangement in Completely Randomized Design. Proximate analysis for Neutral Detergent Fiber (NDF), Acid Detergent Fiber (ADF) and Crude Protein(CP) was carried out.

Differences between varieties were not significant for Neutral Detergent Fiber (NDF) Acid Detergent Fiber (ADF) and Crude protein (CP). Nitrogen dose and cutting age have a significant effect on NDF and ADF. Crude protein was significantly affected by cutting age but not nitrogen dose. The interaction effect of nitrogen dose and cutting age was significant for NDF and ADF. The dose 60kgN/ha gave desirable ADF percentage compared to 120kgN/ha whereas the opposite is true for NDF. Cutting age at 182 and 268 days resulted in desirable ADF percentage compared to 75 day whereas the opposite is true for NDF. Crude protein was better at cutting age of 75 day than 182 day. It was concluded that cutting age and nitrogen fertilization have significant impact on Rhodes grass digestibility and intake potential. More research is needed to study the impact of nitrogen fertilization on crude protein of Rhodes grass.

Keywords: NDF, ADF, CP, cutting age.

I. INTRODUCTION

Rhodes grass (*Chloris gayana* Kunth) has become one of the major forage crops throughout the tropical and sub-tropical World. It is a perennial C4 grass originated in Africa where it was first cultivated in 1985 (Loch *et al.*, 2004; Ubei *et al.*, 2001). It can be grazed, cut for hay or used as deferred feed, with moderate to high feed quality (Cook *et al.*, 2005). Many Rhodes grass cultivars have been developed to suit different cultivation conditions or end-uses: for example cultivars with varying flowering duration, prostrate cultivars suitable for grazing or erect ones for hay

production (FAO, 2014; Quattrocchi, 2006; NSW DPI, 2004; Duke, 1983; Göhl, 1982). Rhodes grass flourish in areas with annual rainfall of 600-1600 mm. The crop is grown in a wide range of soils; from clays to sandy loam. It responds well to irrigation and moderately tolerant to flooding. The crop is palatable to animals with good nutritive value in early growth stages (Loch *et al.*, 2004).

Sudan owns one of the huge animal wealth in Africa. The national herd is greatly dependent on the natural vegetation that supports maintenance and reproduction requirements with very little contribution to animal's performance. One of the possible solutions is to encourage irrigated fodder production to support the natural pastures. Although the earliest attempt to introduce Rhodes grass to Sudan dated back to 1970s (Zaroug, 2002), its commercial cultivation is relatively new. According to the record of the National Seed Administration of Sudan, importation of Rhodes grass seed increased steadily since 2012 through 2016 pointing to the growing importance of Rhodes grass in the Sudan. Based on total seed imported up to 2017 the area cropped to Rhodes grass in Sudan could be estimated around 32000 ha.

High quality forage is a prerequisite for improved animal performance, however, the traditional system for forage production in the Sudan favors high yields at the expense of high feeding value (Mohammed and Zakaria, 2014). Research works on Rhodes grass in the Sudan, specially those dealing with forage quality, are not coping with its growing importance in the country. Some works on husbandry practices (Abuswar, 2005; Abdelrahman, 2007; Elnazier, 2010) and variety performance (Maarouf, 2008) have been made. The objectives of this study were to investigate the effect of variety, nitrogen fertilization, cutting age and their interaction on the quality performance of irrigated Rhodes grass in the Sudan.

II. MATERIALS AND METHODS

The experimental site: The experiment was conducted at Shambat during 2016-2017 in the demonstration farm of the College of Agricultural Studies, Sudan University of Science and Technology, latitude 15°39'N, Longitude 32°31'E, 280 meter above sea level. The location is in

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the semi-arid tropical region with very hot summer and a short rainy season between July and September (Appendix I). The soil of the site is moderately clay, non-saline, non-sodic, with pH of 7.8 (Appendices II and III).

Management and Cultural practices: The seeds of Rhodes grass were sown in 28- August, 2016. The plot size was two ridge 7m long spaced at 0.75m. The seeds were drilled manually in furrows opened in one side of the ridge at seed rate of 20 kg/ha. TSP fertilizer was added before sowing at a rate of 50 Kg P₂O₅/ha. The first irrigation was given immediately after sowing; irrigation water was applied after that at intervals of 7-10 days. Weeds were kept at minimum using hand tools. The experiment was affected by shortage of irrigation water and termite infestation. The zero cut (cut of the seed-crop) commenced after 65 days from sowing, a time at which all entries in each plot were in 25% to 50% bloom. Thereafter, succeeding cuttings were approximately maintained at intervals of 35 to 40 days or when 10%-25% of plants in each plot have flowered. Forage cuttings were continued to be taken up to the 9th cut after which the experiment was terminated. However, the data of cut 8 and cut 9 will not be reported due to sever termite infestation.

Treatments: Two Rhodes grass (*Chloris gayana* Kunth) and 3 levels of nitrogen fertilizer were investigated. The seeds of the cultivars: Fine cut and Reclaimer were received from Selected Seed Co. of Australia via their local agent in the Sudan. The levels of the nitrogen fertilizer (in a form of urea) were: 60kg N /ha, 120kg N /ha and 0.0kg N /ha (Control).

Data collection: Proximate analysis for the following forage quality traits was carried out on dry matter basis based on the standard procedure of A.O.A.C. (1984):

- Percentage of Neutral Detergent Fiber (NDF %),
- Percentage of Acid Detergent Fiber (ADF %),
- Percentage of Crude Protein (CP %),

The traits were studied across the two Rhodes grass varieties and the three fertilizer levels using two replicate samples taken from three cuts spread over the seven cuts, namely: cut 2, cut 5 and cut 7 which coincide with the cutting age of 75 day, 182 day and 268 day, respectively. The chemical analysis was carried out in the Laboratory of the Faculty of Animal Production, University of Khartoum, Shambat.

Experimental design and statistical analysis: The treatments were originally replicated four times in RCB design. However, due to budget limitation the treatments were studied as factorial arrangement in Completely Randomized Design. The data collected were subjected to the analysis of variance (ANOVA) procedure (Cochran and Cox, 1957). The Least Significant Difference (LSD) procedure was used to

separate the means. The statistical package Gen Stat (2009) was used to run the analysis.

III. RESULTS

Table 1 shows mean squares for neutral (NDF), acid (ADF) detergent fibers and crude protein (CP). The effects of nitrogen and cutting age were significant for NDF and ADF whereas the effect of variety for both traits was not significant. For crude protein, significant effect was only detected among cutting ages. The effect of nitrogen dose x cutting age was significant for NDF and ADF whereas the effect of dose x variety was significant only for ADF. The interaction of dose x cutting age x variety was significant for NDF and CP.

a) Main effects

The effect of nitrogen dose on nutritive value of Rhodes grass is shown in Table 2. The ADF value (42.7%) shown by the dose 60kgN/ha was the lowest (desirable) and that obtained by 120kgN/ha (46.6%) was the highest. In contrast, the NDF value (63.3%) shown by 120kgN/ha was lower (desirable) than 60kgN/ha (66.8%) and the control (68.4%). Crude protein obtained by 120kgN/ha was 8.5% and that of the other doses was 8.1%.

Table 3 shows the effect of variety on nutritive value of Rhodes grass which reflects no significant differences between cultivars. The ADF, NDF and CP averaged 44.5%, 66.7% and 8.0%, respectively.

Table 4 shows the effect of cutting age on nutritive value of Rhodes grass. Cutting at 182 and 268 day resulted in lower ADF percentage than cutting at 75 day with respective values of 41.7%, 42.9% and 48.5%. For NDF, cutting at 268 day gave the lowest value (60.8%) compared to 75 day (70.3%) and 182 day (68.7%). Crude protein was best (9.9%) when cutting was done at 75 day than 182 day (6.6%).

b) Interaction effects

Nitrogen dose x cutting age: Table 5 shows the effect of nitrogen dose x cutting age interaction on nutritive value of Rhodes grass. The nitrogen dose 60kgN/ha with cutting age 182 day gave the lowest ADF value (37%) whereas the same dose with cutting age 75 day gave the highest ADF value (50%). Similar trend was noticed when using the same cutting ages with control. Cutting at 268 day with nitrogen dose 120kgN/ha gave higher ADF value (49.3%) than with other cutting ages. For NDF, the nitrogen dose 120kgN/ha with cutting age 268 day gave the lowest value (54%) compared to other cutting ages (> 65%). Similar trend was noticed for the same cutting age with other nitrogen doses. For crude protein, the nitrogen dose 120kgN/ha with cutting age 75 day gave the highest value (11.1%) compared to other interactions. Similar trend was noticed for the same cutting age by other doses in contrast to respective interactions.

Variety x nitrogen dose interaction: Table 6 shows the effect of nitrogen x variety interaction on nutritive value of Rhodes grass. The nitrogen dose 60kgN/ha with Fine cut gave the lowest ADF value (41.5%) followed by control with Reclaimer (43.4%). The highest ADF value (48.6%) was noticed for the dose 120KgN/ha with variety Reclaimer.

Variety x cutting age interaction: The effect of cutting age x variety interaction on nutritive value of Rhodes grass was not significant. The data are presented in Table 7.

Nitrogen x cutting age x variety interaction: The effect of nitrogen dose x cutting age x variety interaction on CP and NDF of Rhodes grass are presented in Tables 8 and 9, respectively. For crude protein, the nitrogen dose 120KgN/ha at cutting age 75 day in both varieties gave the higher CP (10.9%-11.3%) than other respective interactions. For NDF (Table 9), the nitrogen dose 120KgN/ha at cutting age 268 day gave the lowest NDF in both varieties (48.7% for Reclaimer, 59.3% for Fine cut) in contrast to control at cutting age 75 day that gave the highest NDF with respective values of 71% and 74%.

IV. DISCUSSION

Lack of significant differences between Rhodes grass varieties for quality traits could be attributed to the narrow genetic base as both varieties have been developed from one variety (Katambora population). Therefore, most of the variability observed could be attributed to the effect of nitrogen fertilization and cutting age. The effect of cutting age on NDF, ADF and protein content has been reported by Keftasa (1990).

The ADF measures digestibility. The lower the ADF value the better the digestibility and energy value of the fodder. NDF predicts intake potential; the higher the NDF, the lower the intake (Steve and Marble, 1997). There was a general trend that nitrogen application will improve digestibility, however, this was not evident at the low nitrogen dose (60KgN/ha). The intake potential was found to be improved by nitrogen in this study. These findings agree with those reported by Keftasa (1990) who found that both NDF and ADF were lower in nitrogen fertilized Rhodes grass if cut early, however, he noted that higher NDF and ADF values have been obtained if cutting was done at advanced maturity stage.

The present study showed that the crude protein (CP) was not significantly increased by nitrogen fertilizer where only slight increase in CP was obtained by applying the highest dose of nitrogen (120kgN/ha). Disagreeing results were reported by Keftasa (1990) and Loch, *et al.*, (2004). However, the former stated that nitrogen fertilization at the later stages of growth decreased CP content.

The study showed that cutting age has significant effect on quality traits. CP was significantly

higher at earlier growth stage than the later ones. Similar results were obtained by Mbwire and Uden (1997). The NDF and ADF values were decreased at increased age of cutting indicating improved digestibility and potential intake. These results disagree with those reported by Mbwire and Uden (1997).

Based on the most significant factors affecting quality traits in this study (nitrogen dose x cutting age interaction) the results obtained for crude protein (6.3%-11.1%) and ADF (37.0%-50.0%) were within the range of those reported in the literature for Rhodes grass (Heuze *et al.*, 2016). The range obtained for NDF (48.7%-74%) was however, lower than that reported by Heuze *et al.*, (2016). In Sudan, Babiker, (2010) reported NDF values ranging 68.5%-70.3%, ADF 42.4%-45% and CP 10.6%-11.4%.

a) Conclusion

Nitrogen fertilization and cutting age have significant impact on Rhodes grass digestibility and intake potential. More research is needed to explain why nitrogen fertilization did not positively impacted crude protein of Rhodes grass.

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Table 1: Mean squares from ANOVA for neutral (NDF), acid (ADF) detergent fibers and crude protein (CP) of 2 Rhodes grass cultivars evaluated across 7 cuts (2016-2017)

Source of variation	Mean Squares			
	D.F.	NDF (%)	ADF (%)	CP (%)
Nitrogen dose(D)	2	543.76 **	252.51**	3.946 ns
Cutting age (C)	2	2180.52**	1160.35**	234.739 **
Variety (V).	1	239.70ns	30.91ns	21.048 ns
D x C	4	270.28*	460.43**	14.363 ns
D x V	2	135.51ns	222.12**	4.142 ns
C x V	2	33.82ns	15.47ns	1.121ns
D x C x V	4	250.11 *	55.89ns	26.210 *
Residual	237	76.49	46.50	9.129

*. **: Significant at 5% and 1% probability level, respectively.

ns: Not significant at 5% probability level.

Table 2: Effect of nitrogen dose on nutritive value of Rhodes grass

	ADF (%)	NDF (%)	CP (%)
60kgN/ha	42.7	66.8	8.1
120kgN/ha	46.6	63.3	8.5
Control	44.3	68.4	8.1
Mean	44.5	66.7	8.2
SE±	0.85	1.09	0.38
LSD (5%)	2.06	2.65	0.91
CV%	15.3	13.1	36.8

Table 3: Effect of variety on nutritive value of Rhodes grass

	ADF (%)	NDF (%)	CP (%)
Reclimaier	44.9	65.7	7.9
Fine cut	44.2	67.6	8.5
Mean	44.5	66.7	8.2
SE±	0.6	0.78	0.27
CV%	15.3	13.1	36.8

Table 4: Effect of cutting age on nutritive value of Rhodes grass

Cutting age*	ADF (%)	NDF (%)	CP (%)
75 day	48.5	70.3	9.9
182day	41.7	68.7	6.6
268 day	42.9	60.8	8
Mean	44.5	66.7	8.2
SE±	0.75	0.97	0.33
LSD (5%)	2.05	2.63	0.93
CV%	15.3	13.1	36.8

*: Number of days from zero cut

Table 5: Effect of nitrogen dose x cutting age interaction on nutritive value of Rhodes grass

Cutting age*	ADF (%)			NDF (%)			CP (%)		
	75 day	182 day	268 day	75 day	182 day	268 day	75 day	182 day	268 day
60kgN/ha	50	37	40.7	69.5	66.1	64.6	9.4	6.8	8.1
120kgN/ha	45.1	45.4	49.3	66.8	69.3	54	11.1	6.7	7.5
Control	49.6	42.2	40.6	72.5	69.6	62.4	9.4	6.3	8.3
Mean	44.5			66.7			8.2		
SE±	1.49			1.91			0.66		
LSD (5%)	3.55			4.55			1.57		
CV%	15.3			13.1			36.8		

*: Number of days from zero cut

Table 6: Effect of nitrogen x variety interaction on nutritive value of Rhodes grass

Variety Dose	ADF(%)		NDF(%)		CP(%)	
	Reclaimer	Fine cut	Reclaimer	Fine cut	Reclaimer	Fine cut
60kg N/ha	43.9	41.5	67.7	66.1	7.6	8.6
120kg N/ha	48.6	44.6	61.4	65.2	8.1	8.9
N0(Control)	43.4	45.3	67	69.7	8	8.2
Grand Mean	44.5		66.7		8.2	
SE±	1.22		1.57		0.54	
LSD (5%)	2.92		3.78		1.31	
CV%	15.3		13.1		36.8	

Table 7: Effect of cutting age x variety interaction on nutritive value of Rhodes grass

Variety Cutting age*	ADF (%)		NDF (%)		CP (%)	
	Reclaimer	Fine cut	Reclaimer	Fine cut	Reclaimer	Fine cut
75 days	48.4	48.6	68.6	71.9	9.5	10.3
182 days	42.3	41.2	67.9	69.4	6.4	6.7
268 days	43.6	42.3	60.4	61.2	7.8	8.3
Mean	44.5		66.7		8.2	
SE±	1.08		1.38		0.48	
LSD (5%)	2.92		3.74		1.29	
CV%	15.3		13.1		36.8	

*: Number of days from zero cut

Table 8: Effect of nitrogen dose x cutting age x variety interaction on crude protein(CP%) of Rhodes grass

Variety Cutting age	Reclaimer			Fine cut		
	75 day	182 day	268 day	75 day	182 day	268 day
60kg N/ha	7.4	7.8	7.8	11.4	6.0	8.4
120kg N/ha	10.9	6.2	6.9	11.3	7.2	8.0
N0(Control)	9.7	5.8	8.3	9.2	6.9	8.4
Grand Mean	8.2					
SE±	0.96					
LSD(5%)	2.25					
CV%	36.8					

Table 9: Effect of nitrogen dose x cutting age x variety interaction on neutral detergent fiber (NDF%) of Rhodes grass

Variety Cutting age	Reclaimer			Fine cut		
	75 day	182 day	268 day	75 day	182 day	268 day
60kgN/ha	68.4	66.9	67.6	70.6	65.5	62
120kgN/ha	64.5	71.7	48.7	69.3	67.2	59.3
Control	71	66.5	63	74	72.7	61.8
Grand Mean	66.7					
SE±	2.77					
LSD(5%)	6.53					
CV%	13.1					

Appendix I: Monthly average temperature of meteorological data for the experimental period at Shambat.

Month	2016				2017			
	Max Temp. (°C)	Min Temp. (°C)	Rain Fall (mm)	Relative Humidity (%)	Max Temp. (°C)	Min Temp. (°C)	Rain Fall (mm)	Relative Humidity (%)
Jan	-	-	-	-	16.8	34.2	-	30
Feb	-	-	-	-	14.9	31.6	-	23
Mar	-	-	-	-	17.8	36.3	-	19
Apr	-	-	-	-	24	40.9	-	17
May	-	-	-	-	26.3	41.6	5.3	29
Jun	-	-	-	-	26.4	42.4	1.5	30
Jul	-	-	-	-	26.7	39.9	40.4	42
Aug	25.2	36.1	69.5	55	24.8	36.6	15	52
Sep	25.4	39.2	23	63	26.5	39.3	2.5	43
Oct	24.6	40.2	-	32	24.3	39.4	-	27
Nov	21.4	37	-	31	20.8	34.8	-	30
Dec	17.5	33.4	-	34	18.3	33.6	-	38

Source: Ministry of Environment, Natural Resources and Physical Development Metrological Authority.

Appendix II: Chemical and physical soil properties of the experimental site

Depth (cm)	pH	ECe (dm/m)	Ca+Mg (mmol+L)	Na (mmol+l)	SAR	CaCO ₃	Clay (%)	Silt (%)	Sand (%)
0-15	7.79	1.4	9.0	5.1	2.4	5.10	42.1	15.9	42.0
15-35	7.88	1.0	6.0	4.3	2.5	4.88	39.6	15.8	44.6
35-51	7.87	1.2	5.0	7.1	4.5	4.99	44.1	16.4	39.5
51-75	7.91	2.0	8.0	12.5	6.3	4.88	51.4	16.6	32.0
75-90	7.71	2.2	6.0	16.0	9.2	5.20	50.0	16.6	33.4

Appendix III: Soil analysis for Nitrogen (N), Phosphorus (P) and potassium (K)

Depth (cm)	N%	P (meg/kg)	K (meq/l)
0-20	0.084	0.53	0.195
0-20	0.140	0.79	0.096
0-20	0.140	0.46	0.070
Mean	0.121	0.59	0.120
20-40	0.112	0.54	0.079
20-40	0.098	0.54	0.066
20-40	0.098	0.51	0.084
Mean	0.103	0.53	0.076



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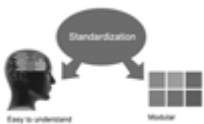
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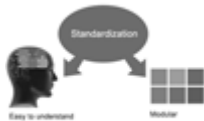


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The recommended size of an original research paper is under 15,000 words and review papers under 7,000 words. Research articles should be less than 10,000 words. Research papers are usually longer than review papers. Review papers are reports of significant research (typically less than 7,000 words, including tables, figures, and references)

A research paper must include:

- a) A title which should be relevant to the theme of the paper.
- b) A summary, known as an abstract (less than 150 words), containing the major results and conclusions.
- c) Up to 10 keywords that precisely identify the paper's subject, purpose, and focus.
- d) An introduction, giving fundamental background objectives.
- e) Resources and techniques with sufficient complete experimental details (wherever possible by reference) to permit repetition, sources of information must be given, and numerical methods must be specified by reference.
- f) Results which should be presented concisely by well-designed tables and figures.
- g) Suitable statistical data should also be given.
- h) All data must have been gathered with attention to numerical detail in the planning stage.

Design has been recognized to be essential to experiments for a considerable time, and the editor has decided that any paper that appears not to have adequate numerical treatments of the data will be returned unrefereed.

- i) Discussion should cover implications and consequences and not just recapitulate the results; conclusions should also be summarized.
- j) There should be brief acknowledgments.
- k) There ought to be references in the conventional format. Global Journals recommends APA format.

Authors should carefully consider the preparation of papers to ensure that they communicate effectively. Papers are much more likely to be accepted if they are carefully designed and laid out, contain few or no errors, are summarizing, and follow instructions. They will also be published with much fewer delays than those that require much technical and editorial correction.

The Editorial Board reserves the right to make literary corrections and suggestions to improve brevity.



FORMAT STRUCTURE

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

All manuscripts submitted to Global Journals should include:

Title

The title page must carry an informative 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) where the work was carried out.

Author details

The full postal address of any related author(s) must be specified.

Abstract

The abstract is the foundation of the research paper. It should be clear and concise and must contain the objective of the paper and inferences drawn. It is advised to not include big mathematical equations or complicated jargon.

Many researchers searching for information online will use search engines such as Google, Yahoo or others. By optimizing your paper for search engines, you will amplify the chance of someone finding it. In turn, this will make it more likely to be viewed and cited in further works. Global Journals has compiled these guidelines to facilitate you to maximize the web-friendliness of the most public part of your paper.

Keywords

A major lynchpin of research work for the writing of research papers is the keyword search, which one will employ to find both library and internet resources. Up to eleven keywords or very brief phrases have to be given to help data retrieval, mining, and indexing.

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

Choice of the main keywords is the first tool of writing a research paper. Research paper writing is an art. Keyword search should be as strategic as possible.

One should start brainstorming lists of potential keywords before even beginning 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 a research paper?" Then consider synonyms for the important words.

It may take the discovery of only one important paper to steer in the right keyword direction because, in most databases, the keywords under which a research paper is abstracted are listed with the paper.

Numerical Methods

Numerical methods used should be transparent and, where appropriate, supported by references.

Abbreviations

Authors must list all the abbreviations used in the paper at the end of the paper or in a separate table before using them.

Formulas and equations

Authors are advised to submit any mathematical equation using either MathJax, KaTeX, or LaTeX, or in a very high-quality image.

Tables, Figures, and Figure Legends

Tables: Tables should be 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. Authors must submit tables in an editable format and not as images. References to these tables (if any) must be mentioned accurately.



Figures

Figures are supposed to be submitted as separate files. Always include a citation in the text for each figure using Arabic numbers, e.g., Fig. 4. Artwork must be submitted online in vector electronic form or by emailing it.

PREPARATION OF ELETRONIC FIGURES FOR PUBLICATION

Although low-quality images are sufficient for review purposes, print publication requires high-quality images to prevent the final product being blurred or fuzzy. Submit (possibly by e-mail) EPS (line art) or TIFF (halftone/ photographs) files only. MS PowerPoint and Word Graphics are unsuitable for printed pictures. Avoid using pixel-oriented software. Scans (TIFF only) should have a resolution of at least 350 dpi (halftone) or 700 to 1100 dpi (line drawings). 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: Authors are advised 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. Also, you can email your editor to remove the color fee after acceptance of the paper.

TIPS FOR WRITING A GOOD QUALITY SCIENCE FRONTIER RESEARCH PAPER

Techniques for writing a good quality Science Frontier Research paper:

1. Choosing the topic: In most cases, the topic is selected by the interests of the author, but it can also be suggested by the guides. You can have several topics, and then judge which you are most comfortable with. This may be done by asking several questions of yourself, like "Will I be able to carry out a search in this area? Will I find all necessary resources to accomplish the search? Will I be able to find all information in this field area?" If the answer to this type of question is "yes," then you ought to choose that topic. In most cases, you may have to conduct surveys and visit several places. Also, you might have to do a lot of work to find all the rises and falls of the various data on that subject. Sometimes, detailed information plays a vital role, instead of short information. Evaluators are human: The first thing to remember is that evaluators are also human beings. They are not only meant for rejecting a paper. They are here to evaluate your paper. So present your best aspect.

2. Think like evaluators: If you are in confusion or getting demotivated because your paper may not be accepted by the evaluators, then think, and try to evaluate your paper like an evaluator. Try to understand what an evaluator wants in your research paper, and you will automatically have your answer. 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.

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

4. Use of computer is recommended: As you are doing research in the field of science frontier then this point is quite obvious. Use right software: Always use good quality software packages. If you are not capable of judging good software, then you can lose the quality of your paper unknowingly. There are various programs available to help you which you can get through the internet.

5. Use the internet for help: An excellent start for your paper is using Google. It is a wondrous search engine, where you can have your doubts resolved. You may also read some answers for the frequent question of how to write your research paper or find a model research paper. You can download books from the internet. If you have all the required books, place importance on reading, selecting, and analyzing the specified information. Then sketch out your research paper. Use big pictures: You may use encyclopedias like Wikipedia to get pictures with the best resolution. At Global Journals, you should strictly follow here.



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

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

8. Make every effort: Make every effort to mention what you are going to write in your paper. That means always have a good start. Try to mention everything in the introduction—what is the need for a particular research paper. Polish your work with good writing skills and always give an evaluator what he wants. Make backups: When you are going to do any important thing like making a research paper, you should always have backup copies of it either on your computer or on paper. This protects you from losing any portion of your important data.

9. Produce good diagrams of your own: Always try to include good charts or diagrams in your paper to improve quality. Using several unnecessary diagrams will degrade the quality of your paper by creating a hodgepodge. So always try to include diagrams which were made by you to improve the readability of your paper. Use of direct quotes: When you do research relevant to literature, history, or current affairs, then use of quotes becomes essential, but if the study is relevant to science, use of quotes is not preferable.

10. Use proper verb tense: Use proper verb tenses in your paper. Use past tense to present those events that have happened. Use present tense to indicate events that are going on. Use future tense to indicate events that will happen in the future. Use of wrong tenses will confuse the evaluator. Avoid sentences that are incomplete.

11. Pick a good study spot: Always try to pick a spot for your research which is quiet. Not every spot is good for studying.

12. Know what you know: Always try to know what you know by making objectives, otherwise you will be confused and unable to achieve your target.

13. Use good grammar: Always use good grammar and words that will have a positive impact on the evaluator; use of good vocabulary does not mean using tough words which the evaluator has to find in a dictionary. Do not fragment sentences. Eliminate one-word sentences. Do not ever use a big word when a smaller one would suffice.

Verbs have to be in agreement with their subjects. In a research paper, do not start sentences with conjunctions or finish them with prepositions. When writing formally, it is advisable to never split an infinitive because someone will (wrongly) complain. Avoid clichés like a disease. Always shun irritating alliteration. Use language which is simple and straightforward. Put together a neat summary.

14. 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 for your topic. You may also maintain your arguments with records.

15. Never start at the last minute: Always allow enough time for research work. Leaving everything to the last minute will degrade your paper and spoil your work.

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

17. Never copy others' work: Never copy others' work and give it your name because if the evaluator has seen it anywhere, you will be in trouble. Take proper rest and food: No matter how many hours you spend on your research activity, if you are not taking care of your health, then all your efforts will have been in vain. For quality research, take proper rest and food.

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

19. Refresh your mind after intervals: Try to give your mind a rest by listening to soft music or sleeping in intervals. This will also improve your memory. Acquire colleagues: Always try to acquire colleagues. No matter how sharp you are, if you acquire colleagues, they can give you ideas which will be helpful to your research.



20. Think technically: Always think technically. If anything happens, search for its reasons, benefits, and demerits. Think and then print: When you go to print your paper, check that tables are not split, headings are not detached from their descriptions, and page sequence is maintained.

21. Adding unnecessary information: Do not add unnecessary information like "I have used MS Excel to draw graphs." Irrelevant and inappropriate material is superfluous. Foreign terminology and phrases are not apropos. One should never take a broad view. Analogy is like feathers on a snake. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Never oversimplify: When adding material to your research paper, never go for oversimplification; this will definitely irritate the evaluator. Be specific. Never use rhythmic redundancies. Contractions shouldn't be used in a research paper. Comparisons are as terrible as clichés. Give up ampersands, abbreviations, and so on. Remove commas that are not necessary. Parenthetical words should be between brackets or commas. Understatement is always the best way to put forward earth-shaking thoughts. Give a detailed literary review.

22. Report concluded results: Use concluded results. From raw data, filter the results, and then conclude your studies based on measurements and observations taken. An appropriate number of decimal places should be used. Parenthetical remarks are prohibited here. Proofread carefully at the final stage. At the end, give an outline to your arguments. Spot perspectives of further study of the subject. Justify your conclusion at the bottom sufficiently, which will probably include examples.

23. Upon 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 through which your research is going to be in print for 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 of 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 criteria peer reviewers will use for grading the final paper.

Final points:

One purpose of organizing a research paper is to let people interpret your efforts selectively. The journal requires the following sections, submitted in the order listed, with each section starting on a new page:

The introduction: This will be compiled from reference matter and reflect the design processes or outline of basis that directed you to make a study. As you carry out the process of study, the method and process section will be constructed like that. The results segment will show related statistics in nearly sequential order and direct reviewers to similar intellectual paths throughout the data that you gathered to carry out your study.

The discussion section:

This will provide understanding of the data and projections as to the implications of the results. The use of good quality references throughout the paper will give the effort trustworthiness by representing an alertness to 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 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 avoid:

- Insertion of a title at the foot of a page with subsequent text on the next page.
- Separating a table, chart, or figure—confine each to a single page.
- Submitting a manuscript with pages out of sequence.
- In every section of your document, use standard writing style, including articles ("a" and "the").
- Keep paying attention to the topic of the paper.
- Use paragraphs to split each significant point (excluding the abstract).
- Align the primary line of each section.
- Present your points in sound order.
- Use present tense to report well-accepted matters.
- Use past tense to describe specific results.
- Do not use familiar wording; don't address the reviewer directly. Don't use slang or superlatives.
- Avoid use of extra pictures—include only those figures essential to presenting results.

Title page:

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

Abstract: This summary should be two hundred words or less. It should clearly and briefly explain the key findings reported in the manuscript and must have precise statistics. It should not have acronyms or abbreviations. It should be logical in itself. Do not cite 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 approaches 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. Use comprehensive sentences, and do not sacrifice readability for brevity; you can maintain it succinctly by phrasing sentences so that they provide more than a 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 limit the initial two items to no more than one line each.

Reason for writing the article—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 for this; results of any numerical analysis should be reported. Significant conclusions or questions that emerge from the research.

Approach:

- Single section and succinct.
- An outline of the job done is always written in past tense.
- Concentrate on shortening results—limit background information to a verdict or two.
- Exact spelling, clarity 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 of comprehending and calculating the purpose of your study without having to refer to other works. The basis for the study should be offered. Give the most important references, but avoid making a comprehensive appraisal of the topic. Describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will give no attention to your results. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here.



The following approach can create a valuable beginning:

- Explain the value (significance) of the study.
- Defend the model—why did you employ this particular system or method? What is its compensation? Remark upon its appropriateness from an abstract point of view as well as pointing out sensible reasons for using it.
- Present a justification. State your particular theory(-ies) or aim(s), and describe the logic that led you to choose them.
- Briefly explain the study's tentative purpose and how it meets 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 for every section. If you make the four points listed above, you will need at least four paragraphs. Present surrounding information only when it is necessary to support a situation. The reviewer does not desire to read everything you know about a topic. Shape the theory 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 soundly written procedures segment allows a capable scientist to replicate 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 to give the least amount of information that would permit another capable scientist to replicate 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 section, mention the specific item describing the way, but draw the basic principle while stating the situation. The purpose is to show 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:

Materials may be reported in part of a section or else they may be recognized along with your measures.

Methods:

- Report the method and not the 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—detail how procedures were completed, not how they were performed on a particular day.
- If well-known procedures were used, account for the procedure by name, possibly with a reference, and that's all.

Approach:

It is embarrassing to use vigorous voice when documenting methods without using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result, when writing up the methods, most authors use third person passive voice.

Use standard style in this and 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 as 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. Use statistics and tables, if suitable, to present consequences most efficiently.

You must clearly differentiate material which would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matters should not be submitted at all except if requested by the instructor.

Content:

- Sum up your conclusions in text and demonstrate them, if suitable, with figures and tables.
- In the manuscript, explain each of your consequences, and point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation of an exacting study.
- Explain results of control experiments and give 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 manuscript.

What to stay away from:

- Do not discuss or infer your outcome, report surrounding information, or try to explain anything.
- Do not include raw data or intermediate calculations in a research manuscript.
- Do not present similar data more than once.
- A manuscript should complement any figures or tables, not duplicate information.
- Never confuse figures with tables—there is a difference.

Approach:

As always, use past tense when you submit 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 section.

Figures and tables:

If you put figures and tables at the end of some details, make certain that they are visibly distinguished from any attached appendix materials, such as raw facts. Whatever the position, each table must be titled, numbered one after the other, and include a heading. All figures and tables must be divided from the text.

Discussion:

The discussion is expected to be the trickiest segment to write. A lot of papers submitted to the journal are discarded based on problems with the discussion. There is no rule for how long an 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 implications of the study. The purpose here is to offer an understanding of your results and support all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of results should be fully 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 the prospect, and let it drop at that. Make a decision as to whether each premise is supported or 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 an experiment might be personalized to accomplish a new idea.
- Give details of all of your remarks as much as possible, focusing on mechanisms.
- Make a decision as to whether the tentative design sufficiently addressed the theory and whether or not it was correctly restricted. Try to present substitute explanations if they are sensible alternatives.
- One piece of 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 other available information. Present work done by specific persons (including you) in past tense.

Describe generally acknowledged facts and main beliefs in present tense.

THE ADMINISTRATION RULES

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CRITERION FOR GRADING A RESEARCH PAPER (COMPILATION)
BY GLOBAL JOURNALS

Please note that following table is only a Grading of "Paper Compilation" and not on "Performed/Stated Research" whose grading solely depends on Individual Assigned Peer Reviewer and Editorial Board Member. These can be available only on request and after decision of Paper. This report will be the property of Global Journals.

Topics	Grades		
	A-B	C-D	E-F
<i>Abstract</i>	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
<i>Introduction</i>	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
<i>Methods and Procedures</i>	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
<i>Result</i>	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
<i>Discussion</i>	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
<i>References</i>	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring



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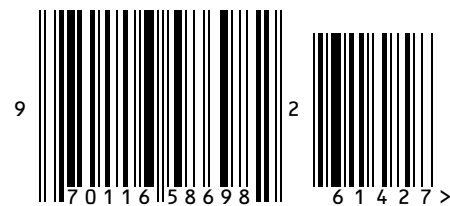
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ISSN 9755896



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