Evaluation of Irrigation Regime
Theoretical Expansion of Access

Highlights

Evaluation Antibacterial Efficacy
Uncertainties of Agricultural Production

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

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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 an 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.

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.
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; Nawai et al. 2010;Mohd Noor Mohd Shariff, 2010; Euclides Matusse, 2019).

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](image-url)
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 area 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:

\[ r = \frac{\sum (x - m_x)(y - m_y)}{\sqrt{\sum(x - m_x)^2 \sum(y - m_y)^2}} \tag{1} \]

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.

\[ DEF = NxTFator \tag{2} \]

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 be calculated in the Equation Eq.3.

\[ TAEA_{(agr)} = LOS + LR + RPP + LOG \tag{3} \]

Where: \( TAEA_{(agr)} \) - 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.

\[ AEmp_{(agr)} = \frac{\left( TAEA_{(agr)} \times DEF \right)}{N^2 - N} \tag{4} \]

Where: \( AEmp_{(agr)} \) - accessibility of agricultural lending by the farmer from formal and informal sources, \( TAEA_{(agr)} \) - 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.

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² Direcção Nacional de Terras (http://www.dnageca.gov.mz/dnt)
³ Direcção Provincial da Industria e Comércio (https://www.pmaputo.gov.mz/)
\[ TERM_{(cred)} = LR + RPP + LOG \]  
(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.

\[ TCRED_{(agric)} = \left( \frac{TERM_{(cred)} \times DEF}{N^2 - N} \right) \]  
(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; Ndige 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.

\[ RPC = LOS + LR + RPP \]  
(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.

\[ SDI = \frac{k}{\sum_{i-j}} \left( \frac{KM_{ij} \times N_i \times N_j}{N^2 - N} \right) \]  
(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.

\[ RPC_{(agric)} = \left( \frac{RPC \times SDI}{N^2 - N} \right) \]  
(9)

Where: \( RPC_{(agric)} \) - reimbursement capacity per farmer, \( RPM \) - 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>
<thead>
<tr>
<th>Age (in years)</th>
<th>Frequency</th>
<th>Percentage(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20-29</td>
<td>0</td>
<td>0.00</td>
</tr>
<tr>
<td>30-39</td>
<td>6</td>
<td>20.00</td>
</tr>
<tr>
<td>40-49</td>
<td>7</td>
<td>23.33</td>
</tr>
<tr>
<td>50-59</td>
<td>17</td>
<td>56.67</td>
</tr>
<tr>
<td>Total</td>
<td>30</td>
<td>100.00</td>
</tr>
</tbody>
</table>

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>
<thead>
<tr>
<th>Education Level (in years)</th>
<th>Frequency</th>
<th>Percentage(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 (no formal education)</td>
<td>10</td>
<td>40.00</td>
</tr>
<tr>
<td>1-6 (primary school)</td>
<td>11</td>
<td>35.00</td>
</tr>
<tr>
<td>7-12 (secondary school)</td>
<td>9</td>
<td>25.00</td>
</tr>
<tr>
<td>13-18 (university)</td>
<td>0</td>
<td>0.00</td>
</tr>
<tr>
<td>Total</td>
<td>30</td>
<td>100.00</td>
</tr>
</tbody>
</table>

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)

<table>
<thead>
<tr>
<th>Agricultural Experience (in years)</th>
<th>Frequency</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-5</td>
<td>4</td>
<td>13.33</td>
</tr>
<tr>
<td>6-10</td>
<td>6</td>
<td>20.00</td>
</tr>
<tr>
<td>11-15</td>
<td>3</td>
<td>10.00</td>
</tr>
<tr>
<td>16 – forward</td>
<td>17</td>
<td>56.67</td>
</tr>
<tr>
<td>Total</td>
<td>30</td>
<td>100.00</td>
</tr>
</tbody>
</table>

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)

<table>
<thead>
<tr>
<th>Land size (hectares)</th>
<th>Frequency</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.10-4.99</td>
<td>27</td>
<td>90.00</td>
</tr>
<tr>
<td>5.0-8.99</td>
<td>3</td>
<td>10.00</td>
</tr>
<tr>
<td>9.00-12.99</td>
<td>0</td>
<td>0.00</td>
</tr>
<tr>
<td>13.00 – forward</td>
<td>0</td>
<td>0.00</td>
</tr>
<tr>
<td>Total</td>
<td>30</td>
<td>100.00</td>
</tr>
</tbody>
</table>

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)

<table>
<thead>
<tr>
<th>Household (in years)</th>
<th>Frequency</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-3</td>
<td>3</td>
<td>10.00</td>
</tr>
<tr>
<td>4-6</td>
<td>7</td>
<td>23.33</td>
</tr>
<tr>
<td>7-9</td>
<td>17</td>
<td>56.67</td>
</tr>
<tr>
<td>10-12</td>
<td>3</td>
<td>10.00</td>
</tr>
<tr>
<td>Total</td>
<td>30</td>
<td>100.00</td>
</tr>
</tbody>
</table>

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)

<table>
<thead>
<tr>
<th>Marital status</th>
<th>Frequency</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Married</td>
<td>13</td>
<td>43.33</td>
</tr>
<tr>
<td>Single</td>
<td>17</td>
<td>56.67</td>
</tr>
<tr>
<td>Total</td>
<td>20</td>
<td>100.00</td>
</tr>
</tbody>
</table>

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 been 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)

<table>
<thead>
<tr>
<th>Distance (in kilometers)</th>
<th>Frequency</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-2</td>
<td>30</td>
<td>100.00</td>
</tr>
<tr>
<td>3-4</td>
<td>0</td>
<td>0.00</td>
</tr>
<tr>
<td>4-5</td>
<td>0</td>
<td>0.00</td>
</tr>
<tr>
<td>5-6</td>
<td>0</td>
<td>0.00</td>
</tr>
<tr>
<td>Total</td>
<td>30</td>
<td>100.00</td>
</tr>
</tbody>
</table>

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)

<table>
<thead>
<tr>
<th>Income (in MTN meticais)</th>
<th>Frequency</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5,000,00-20,000,00</td>
<td>9</td>
<td>30.00</td>
</tr>
<tr>
<td>21,000,00-45,000,00</td>
<td>2</td>
<td>6.67</td>
</tr>
<tr>
<td>46,000,00-60,000,00</td>
<td>5</td>
<td>16.66</td>
</tr>
<tr>
<td>66,000,00-80,000,00</td>
<td>14</td>
<td>46.67</td>
</tr>
<tr>
<td>Total</td>
<td>30</td>
<td>100.00</td>
</tr>
</tbody>
</table>

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)

<table>
<thead>
<tr>
<th>Amount (in MTN meticais)</th>
<th>Frequency</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10,000,00-30,000,00</td>
<td>4</td>
<td>13.33</td>
</tr>
<tr>
<td>31,000,00-60,000,00</td>
<td>2</td>
<td>6.67</td>
</tr>
<tr>
<td>61,000,00-90,000,00</td>
<td>17</td>
<td>56.67</td>
</tr>
<tr>
<td>91,000,00-100,000,00</td>
<td>7</td>
<td>23.33</td>
</tr>
<tr>
<td>Total</td>
<td>30</td>
<td>100.00</td>
</tr>
</tbody>
</table>
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)**

<table>
<thead>
<tr>
<th>Sex</th>
<th>Frequency</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>17</td>
<td>56.67</td>
</tr>
<tr>
<td>Female</td>
<td>13</td>
<td>43.33</td>
</tr>
<tr>
<td>Total</td>
<td>30</td>
<td>100.00</td>
</tr>
</tbody>
</table>

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: Analise De Regressão**

<table>
<thead>
<tr>
<th>Variables</th>
<th>AEmp</th>
<th>TCRED</th>
<th>CarSoc</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearson’s Correlation</td>
<td>.794</td>
<td>.463</td>
<td>.647</td>
</tr>
<tr>
<td>Sig. (1-tailed)</td>
<td>.000</td>
<td>.005</td>
<td>.000</td>
</tr>
</tbody>
</table>

**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**

<table>
<thead>
<tr>
<th>Pearson’s Correlation</th>
<th>AEmp</th>
<th>TCRED</th>
<th>CarSoc</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correlation</td>
<td>.794</td>
<td>.463</td>
<td>.647</td>
</tr>
<tr>
<td>Sig. (1-tailed)</td>
<td>.000</td>
<td>.005</td>
<td>.000</td>
</tr>
</tbody>
</table>

**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 $T_{CRE}_D^{(agric)}$ and the metric $R_{PC}^{(agric)}$.

Null Hypothesis ($H_0$): there is no significant correlation between the metric $A_{Emp}^{(agric)}$ and the metric $R_{PC}^{(agric)}$.

Alternative Hypothesis ($H_1$): there is a significant correlation between the metric $A_{Emp}^{(agric)}$ and the metric $R_{PC}^{(agric)}$.

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 $T_{CRE}_D^{(agric)}$:

- 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 $T_{CRE}_D^{(agric)}$ 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 ($\mu$) 13.622, and standard deviation ($\sigma$) 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 $T_{CRE}_D^{(agric)}$, considering the distribution of the observed normal values.

Analysis correlation $R$ model: as metric distribution $T_{CRE}_D^{(agric)}$ and $A_{Emp}^{(agric)}$ 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.

$$y = ax + b \quad (10)$$

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

The conclusions reveal that there is a hardly 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 $R_{PC}^{(agric)}$:

- 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 $R_{PC}^{(agric)}$ : 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 ($\mu$) 0.657, and standard deviation ($\sigma$) 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 ($p$...
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 ($\mu$) 18.632, and standard deviation ($\sigma$) 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 $RP_{(agric)}$ 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.

$$y = ax + b$$  \hspace{1cm} (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 ($r = 0.3079$) 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 requirement weighs heavily on the perspective of the needs of agribusiness cooperatives.

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

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References Références Referencias


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Endogeneous Uncertainties of Agricultural Production Yield | Case Study

By Md. Nazmul Hasan Suman

Abstract- Bangladesh is an agricultural country. Most of the people are involved in agriculture but the country still finds difficulties to feed its large people. Although for the last few decade researchers are inventing new variety of seed and pesticides, but it is not good enough. A good managerial system is still lack in agricultural field. Endogenous uncertainties are a big issue which is affecting the agricultural system of Bangladesh over centuries. This happens because of lots of criteria and sub criterial. Analytical Hierarchy Process helps to find out the main criteria which needs to be solved at first.

Keywords: endogenous uncertainties, analytical hierarchy process (AHP).

GJSFR-D Classification: FOR Code: 070199

Strictly as per the compliance and regulations of:
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I. INTRODUCTION

Being an agricultural country, the leading contributor to Bangladesh economy is agriculture sector. About 75% of the rural population and 40.62 percent of the total population is involved in agriculture. Agriculture sector contributes 14.23 percent to the country’s GDP (Finance Division, Bangladesh and 2018, 2018).

Rice one of the main crops in Bangladesh. Rice is cultivated in the country since time unknown and is cultivated all though the country. The environmental conditions of Bangladesh are suitable for rice to grow all-year round. Aus (pre-monsooned seasoned), Aman (monsoon-seasoned) and Boro (dry-seasoned) are the three main rice growing season in Bangladesh. Despite a year round production of rice, the national average rice yield is only 339.03 metric ton which is much lower than the other rice growing countries (Division, 2018). The low production yield is due to many adverse conditions that agriculture is facing including uncertainties (both exogenous and endogenous).

Being the staple food of about 160 million people of the country, the total production of rice needs to be increased significantly for this ever-increasing population. With the total cultivable land decreasing at a rate of more than 1% per year, it seems to be a tough ask. Adequate steps should be taken to increase the production yield per unit area to meet the increasing demand.

The main objective of this study is to discuss the effects of endogenous uncertainties in rice production and recommend feasible solutions to address the issue that may help the personnel concerned to take effective steps that may help to increase the production yield of rice in Bangladesh.

II. LITERATURE REVIEW

Yield uncertainty occurs when the quantity supplied and ordered has a significant differences by a random amount (Konstantaras, Skouri and Lagodimos, 2018). High endogenous uncertainty exists when situational information is sparse, overwhelming, contradictory or novel (Heuvel, Alison and Power, 2013). Risk is present in all agricultural management decisions because of different sources of uncertainty, and as long as farmers have different preferences with respect to risk, the choices he/she makes will be conditioned to a lower or higher degree by a risk minimizing process (Toledo, Engler and Ahumada, 2011). Socio-economic factors, such as the predominance of small and marginal farmers and tenancy cultivation in agrarian structure, did not impede the adoption of modern rice varieties in Bangladesh (Toledo, Engler and Ahumada, 2011). The major constraints to the adoption of rice modern varieties were in fact logistic factors such as a lack of irrigation facilities in the dry season and the topography, which affects flood depth and salinity of the soil in coastal areas (Toledo, Engler and Ahumada, 2011). About 60% of arable lands of Bangladesh are deficient in N, P, and K. Organic matter content of soils is much below the critical level of 1.5%. On the average, 25-30% of irrigation water is used by crops and the rest is lost due to faulty flood irrigation system. Farmer’s low quality seeds still meet about 95% seed requirement that is considered to be one of the major constraints to crop productivity (‘Ondal 1’, 2010).

Analytical Hierarchy Process (AHP) helps an organization to make its strategy more appropriately. Sometimes organization find difficulties to make appropriate decision before starting (Profile and Profile, 2018). AHP is a very effective tool to deal with complex decisions. We are fundamentally decision makers as our conscious or unconscious works are the result of some decision (Moktadir et al., 2019). If the decision making is too much complex to take, then AHP can help to take the best decision (Paul, Chakraborty and Ayuby, 2011). It is one of the oldest and most popular methodologies for making correct decision. Before starting decision, we just need a goal, criteria, sub-criteria and alternatives
and find out the best alternative to take the correct decision (Saaty, 2002).

In this paper we will try to identify the main endogenous uncertainties by prioritizing the weights of criteria. All over the world AHP is certified as an easy and effective tool that helps to make any type of complex decision. We took experts’ opinion and analyzed the criteria before writing this paper.

III. Data Collection and Analysis

In this investigation a primary data is used for analyzing the present scenario of the production system of rice production yield. These data were collected from experts and farmers. The primary data obtained from field survey was collected through visiting Bangladesh Rice Research Institute (BRRI), Rajshahi Regional Station. Chief scientist Mr. Aminul Islam, Ph. D (soil science) and senior scientific officer Mr. Dr. A B M Anwar Uddin helped us to identify the factors and relative information to make this paper. We had also taken data from at least 50 farmers of Rajshahi district. Onsite observations and use of questionnaires and interviews were also used in data collection process to identify the criteria and sub-criteria of the rice production. Moreover, it is known through survey that seed, knowledge gap, irrigation, technology and social problems mainly are the endogenous uncertainties which have negative impact on crops production. We had also taken data from at least 50 farmers of Rajshahi district. Onsite observations and use of questionnaires and interviews were also used in data collection process to identify the criteria and sub-criteria of the rice production. Moreover, it is known through survey that seed, knowledge gap, irrigation, technology and social problems mainly are the endogenous uncertainties which have negative impact on crops production. After completing data collection this data is analyzed to utilize in this study by computing the comparison matrix of the criteria and sub criteria.

Factors responsible for variation in production yield (according to experts and farmers):

1. Quality of Seed: Seed is a key input for improving crop production and productivity. Increasing the quality of seeds can increase the yield potential of the crop and thus, is one of the most economical and efficient inputs to agricultural development (FAO, 2006) (14). Good quality of seed can increase crop production by 15-20% alone. But of the total seed requirement, only one-tenth is supplied to the farmers. As a result, farmer’s low quality seeds still meet about 90% seed requirement that is considered to be one of the major constraints to crop productivity. The seeds need to be germinated enough before sowing at the right temperature. Also, the seeds need to be pure and variety free for the desired production of rice.

2. Knowledge: It is a common picture of the farmers of developing countries. Necessary information sometimes not understood by the farmers and thus the of cultivation process are not scientific and modern. Since they are mostly uneducated, they lack the technical and technological knowledge related to production. Sometimes, they don’t receive the precautionary message from the authority at the right time.

3. Timing: It is important to sow the seeds, fertilize them and provide irrigation at the right time. Every crops proper timing. The whole production maintains a fix timing schedule. Otherwise, the expected yield cannot be achieved.

4. Fertilization: Farmers normally use urea in recommended doses. Sometimes it is overdosed as well. Because of high prices, they apply Phosphorus and Potassium fertilizers at the rates that are far below than the recommended amount. Chemical fertilizers are not normally integrated with organic manures and farmers do not use balanced fertilizers that are necessary for high productivity.

5. Use of Pesticides: The use of fertilizers, quality seeds, and irrigation together cannot ensure sustainable production unless timely and appropriate measures for the management of pests and diseases are simultaneously pursued. It is important to note that the incidence of diseases and pests has lately become very severe due to the adverse effects of climate change and temperature increase. Sometimes, the farmers use excess pesticides and insecticides which reduce the immunity of the paddy and results in dis-satisfactory production.

6. Irrigation: Irrigation is one the main problems of Bangladesh. Farmers often cannot provide sufficient water. Climate change also affecting the agricultural system because of scarcity of water. Conservation of rain water during monsoon is also virtually non-existent that could be utilized for irrigating crops during dry season. Irrigation must be provided at the right time and at the required rate. But due to scarcity of water in the dry season, the farmers don’t get enough irrigation in due time.

7. Socio-economic: Since most of the farmers do not own a land of their own, the land is generally leased out to them. The farmer, as tenants, does not know for how long he will be able to retain the land in his possession. He may hesitate to make any long-term improvements in land as he may not be sure about earning the additional return from such improvements.

8. Use of Technology: Some of the incurred problems (such as sowing, harvesting, fertilizing) may be overcome with the help of modern equipment. But the farmers lack adequate financial support to purchase the equipment and are carrying with the ancient processes.
IV. Methodological Approach

a) Analytical Hierarchy Process (AHP) Analysis

The basic procedure of AHP consists of following these steps (Mahmud et al., 2016). These are given below:

Step 1: Developing the weights for the criteria by
1. Evaluating a single a pair-wise matrix for the criteria;
2. Normalizing each column of the matrix and calculating appropriate priority or weights;
3. Computing and checking the Consistency Ratio (CR) by using the following equation; computing and checking the Consistency Ratio (CR) by using the following equation

\[
CR = \frac{CI}{CR}
\]

Here, \( CI = \text{Consistency index} = \frac{\text{Eigen Value} - n}{n - 1} \)

Where, the small \( n \) denotes the number of criteria. Random Consistency Index (RI) and which is taken from the table below:

<table>
<thead>
<tr>
<th>Criteria</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>RI</td>
<td>.58</td>
<td>.90</td>
<td>1.12</td>
<td>1.24</td>
<td>1.32</td>
<td>1.41</td>
<td>1.45</td>
<td>1.49</td>
</tr>
</tbody>
</table>

If the value of CR is less than 0.1 (10%), then the pair-wise comparison is considered as acceptable. If the consistency is greater than 0.1 then this comparison matrix will not accurate. The relative importance values in the comparison matrix are determined with Saaty’s 1-9 scale (Table 2), where a score of 1 represents equal importance between the two elements and a score of 9 shows the extreme importance of one element (row component in the comparison matrix) compared to the other one (column component in the comparison matrix). Saaty’s table (1-9) is given below:

**Table 2: The fundamental scale of absolute numbers (Saaty, 2002)**

<table>
<thead>
<tr>
<th>Intensity of importance</th>
<th>Definition</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Equal importance</td>
<td>Two activities contribute equally to the objective.</td>
</tr>
<tr>
<td>2</td>
<td>Weak or slight</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Moderate importance</td>
<td>Experience and judgment slightly favor one over another.</td>
</tr>
<tr>
<td>4</td>
<td>Moderate plus</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Strong importance</td>
<td>Experience and judgment strongly favor one over another.</td>
</tr>
<tr>
<td>6</td>
<td>Strong plus</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Very strong importance</td>
<td>Activity is strongly favored and its dominance is demonstrated in practice.</td>
</tr>
<tr>
<td>8</td>
<td>Very, very strong</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Absolute importance</td>
<td>Importance of one over another affirmed on the highest possible order.</td>
</tr>
</tbody>
</table>

Step 2: Developing the ratings for each decision alternative for each criterion by,
1. Constructing a pair-wise comparison matrix for each criterion and each matrix containing the pair-wise comparisons of the performance of decision alternatives on each criterion;
2. Multiplying the values in each row together and calculating the nth root of above said product; Normalizing the nth root of product values that is mentioned above to obtain the corresponding ratings and calculating and checking the Consistency Ratio (CR)

b) Problem Structure and Solution Methodology for AHP

Our goal is to find out key main endogenous uncertainties in crops production yield which affect the system most. To solve this problem, we have selected some criteria and divided these criteria into subsequent sub-criteria. Considering that these criteria are independent and so a Hierarchical structure for this problem is constructed. The hierarchical structure is given Fig.1 represents that criteria and sub-criteria of this problem do not have any relationship or interdependency among them. Furthermore, AHP method is used to resolve this case.
The hierarchical structure shows that this problem has five criteria, three sub-criteria. At the first stage we need to determine priority vector for the criteria. The priority vector provides the priority indices for the criteria. The pair-wise comparisons of the criteria in terms of their relative importance values along with column totals are shown in the Table 3 below considering these short terms for the criteria and sub-criteria. The criteria are seed, knowledge gap, irrigation, technology and social problem. And the sub-criteria of knowledge gap are timing, imbalance fertilization and pesticides and insecticides.

Table 3: Pair-wise Matrix of the criteria of endogenous uncertainties of production system of Rice

<table>
<thead>
<tr>
<th></th>
<th>Quality of Seed</th>
<th>Knowledge</th>
<th>Irrigation</th>
<th>Use of Technology</th>
<th>Socio-economic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quality of Seed</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Knowledge</td>
<td>1/3</td>
<td>1</td>
<td>1/2</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Irrigation</td>
<td>1/2</td>
<td>2</td>
<td>1</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Use of Technology</td>
<td>1/5</td>
<td>1/3</td>
<td>1/4</td>
<td>1</td>
<td>1/2</td>
</tr>
<tr>
<td>Socio-economic</td>
<td>1/4</td>
<td>1/2</td>
<td>1/3</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 4: Priorities of the criteria

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Priority</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quality of Seed</td>
<td>0.419</td>
<td>1</td>
</tr>
<tr>
<td>Knowledge</td>
<td>0.160</td>
<td>3</td>
</tr>
<tr>
<td>Irrigation</td>
<td>0.263</td>
<td>2</td>
</tr>
<tr>
<td>Use of Technology</td>
<td>0.062</td>
<td>5</td>
</tr>
<tr>
<td>Socio-economic</td>
<td>0.097</td>
<td>4</td>
</tr>
</tbody>
</table>

Check for Consistency:

Eigen value = 5.068
CI = (5.068-5)/(5-1) = 0.017
RI = 0.12
CR = CI/RI = 0.01517 = 1.51% < 10
Table 5: Pair-wise Matrix of the sub criteria of Knowledge

<table>
<thead>
<tr>
<th>Sub-criteria</th>
<th>Timing</th>
<th>Fertilization</th>
<th>Use of Pesticides</th>
</tr>
</thead>
<tbody>
<tr>
<td>Timing</td>
<td>1</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Fertilization</td>
<td>1/3</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Use of Pesticides</td>
<td>1/4</td>
<td>1/2</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 6: Priorities of the sub criteria of Knowledge

<table>
<thead>
<tr>
<th>Category</th>
<th>Priority</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Timing</td>
<td>0.625</td>
<td>1</td>
</tr>
<tr>
<td>Fertilization</td>
<td>0.238</td>
<td>2</td>
</tr>
<tr>
<td>Use of Pesticides</td>
<td>0.137</td>
<td>3</td>
</tr>
</tbody>
</table>

Check for Consistency:

- Eigen value = 3.018
- CI = (3.018-3)/(3-1) = 0.0009
- RI = 0.58
- CR = CI/ RI = 0.01551 = 1.55% < 10

Computing all the comparison, priority of these priorities the overall criteria weight is determined criterion and sub criterion have found and by using (table 5).

Table 7: Computation of Overall criteria weight (OCW) of each criterion

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Sub- Criteria</th>
<th>Sub Criteria Weight</th>
<th>Overall Criteria Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quality Seed</td>
<td>Timing</td>
<td>0.625</td>
<td>0.419</td>
</tr>
<tr>
<td>Knowledge</td>
<td>Fertilization</td>
<td>0.238</td>
<td>0.160</td>
</tr>
<tr>
<td>Irrigation</td>
<td>Use of Pesticides</td>
<td>0.137</td>
<td>0.097</td>
</tr>
<tr>
<td>Use of Technology</td>
<td></td>
<td>0.062</td>
<td></td>
</tr>
</tbody>
</table>

V. Result Analysis

So, from the calculation we found out that uncertainty over ‘Quality of Seed’ is the criteria with highest weight (0.419). Uncertainty over ‘Irrigation’, ‘Knowledge’, ‘Socio-economic’, ‘Use of Technology’ are the next criteria in order with priority of 0.263, 0.160, 0.097and 0.062 respectively. So uncertainty over ‘Quality of Seed’ is the most influential uncertainty.

Recommendations

So on the basis of what we have analyzed and the result we found, we have figured out a solution framework that can help us solving the problem addressed resulting in an increase of the production yield. Our recommendations are-

1. Ensuring the best quality seed: To make sure the seed is at least 90% germinated, there is no variety in seeds and the pure seeds are collected for the next year to produce good crops.

2. Dynamic framework for irrigation: Steps should be taken for the conservation of rain water so that it can be used in dry season and a dynamic framework should be established to ensure availability of water for irrigation throughout the year.

3. Training the farmers: The farmers should be trained on regular basis and Department of Agriculture Extension should take steps to let them know the key scientific factors of rice cultivation as much as possible. They must have adequate knowledge about timing, use of fertilization and use of pesticides.

4. Financial security of the farmers: The govt. should ensure financial support to the farmers and credit should be given to them at a nominal rate. Also, the farmers should be given subsidies and it should be ensured that they get the subsidies properly. Also, the outrage of the intermediate media should be brought under control.

5. Priorizing the use of technology: Use of technology should be given priority and technologies should be designed considering the facts of the farmers and farmers should be trained about the use of technology in rice cultivation.

VI. Conclusion

So from the study, we saw that seed is the most important endogenous factor in rice cultivation. Factors like irrigation, knowledge, socio-economic condition of the farmers and the use of technology also influence the
rice cultivation to some extent. We figured out the endogenous uncertainties related to these factors and gave a few recommendations. We believe if the recommendations are applied, the rice production yield will increase by large margin, which can help to meet the ever-increasing demand of this crop in Bangladesh. In future more research can be done on other crops as well. Finding out the more root cause can help the agricultural system more disciplined and productive.

References

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

By Hussein H. A. M, Dagash Y. M. I & Maarouf I. Mohammed

*University of Sudan for Science and Technology*

**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 Rhodes 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

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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. *, Dagash Y. M. I. * & Maarouf I. Mohammed *

**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 Rhodes 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 (*Chloris gayana*) 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 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°3E, 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 experiment was used with fertilizer treatments assigned to the main plots and the varieties to the sub-plots. The experiment was used with fertilizer treatments assigned via a local agent in the Sudan. Three 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 treatments were replicated four times, however, due to termite damage, the data of one of the replicates was deemed unreliable.

b) Treatments and experimental design

Two Rhodes grass (Chloris gayana 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/had 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 decease. 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 with120kgN/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.
References Références Referencias


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)

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

*. **: 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

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

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

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

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

<table>
<thead>
<tr>
<th>Dose</th>
<th>Dry matter yield (DMY)</th>
<th>Green matter yield(GMY)</th>
<th>Increase over control (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DMY</td>
<td>GMY</td>
<td>DMY</td>
</tr>
<tr>
<td>120kgN/ha</td>
<td>5.90</td>
<td>24.0</td>
<td>118.5</td>
</tr>
<tr>
<td>60kgN/ha</td>
<td>3.14</td>
<td>12.2</td>
<td>16.3</td>
</tr>
<tr>
<td>Control</td>
<td>2.70</td>
<td>10.6</td>
<td>-</td>
</tr>
</tbody>
</table>

**Fig. 1:** Effect of dose x variety interaction on dry matter yield of Rhodes grass
Effect of Nitrogen and Variety on Agronomic Performance of Rhodes Grass (Chloris gayana Kunth) in the Sudan

**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

<table>
<thead>
<tr>
<th>Month</th>
<th>2016</th>
<th>2017</th>
<th>2017</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Max Temp. (°C)</td>
<td>Min Temp. (°C)</td>
<td>Rain Fall (mm)</td>
</tr>
<tr>
<td>Jan</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Feb</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Mar</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Apr</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>May</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Jun</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Jul</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Aug</td>
<td>25.2</td>
<td>36.1</td>
<td>69.5</td>
</tr>
<tr>
<td>Sep</td>
<td>25.4</td>
<td>39.2</td>
<td>23</td>
</tr>
<tr>
<td>Oct</td>
<td>24.6</td>
<td>40.2</td>
<td>-</td>
</tr>
<tr>
<td>Nov</td>
<td>21.4</td>
<td>37</td>
<td>-</td>
</tr>
<tr>
<td>Dec</td>
<td>17.5</td>
<td>33.4</td>
<td>-</td>
</tr>
</tbody>
</table>

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

Appendix II: Chemical and physical soil properties of the experimental site
**Appendix III:** Soil analysis for Nitrogen (N), Phosphorus (P) and potassium (K)

<table>
<thead>
<tr>
<th>Depth (cm)</th>
<th>N%</th>
<th>P (meg/kg)</th>
<th>K (meq/l)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-20</td>
<td>0.084</td>
<td>0.53</td>
<td>0.195</td>
</tr>
<tr>
<td>0-20</td>
<td>0.140</td>
<td>0.79</td>
<td>0.096</td>
</tr>
<tr>
<td>0-20</td>
<td>0.140</td>
<td>0.46</td>
<td>0.070</td>
</tr>
<tr>
<td>Mean</td>
<td>0.121</td>
<td>0.59</td>
<td>0.120</td>
</tr>
<tr>
<td>20-40</td>
<td>0.112</td>
<td>0.54</td>
<td>0.079</td>
</tr>
<tr>
<td>20-40</td>
<td>0.098</td>
<td>0.54</td>
<td>0.066</td>
</tr>
<tr>
<td>20-40</td>
<td>0.098</td>
<td>0.51</td>
<td>0.084</td>
</tr>
<tr>
<td>Mean</td>
<td>0.103</td>
<td>0.53</td>
<td>0.076</td>
</tr>
</tbody>
</table>
Evaluation of Irrigation Regime on Tomato (Lycopersicon Esculentum), at Hadero Tunto Zuria Woreda, Ethiopia

By Tamirneh Kifle
Areka Agricultural Research Center

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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**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,
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, latitude ranges between 07°10’N to 07°12’N and longitude ranges between 037°38’ to 037°43’19”. Hadaro 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.

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 (ETb) and the effect of crop characteristics (Kc) are important (Doorenbos and Pruitt, 1977). The long term and daily climate data such as maximum and minimum air temperature, relative humidity, wind speed, sunshine hours, and rainfall data

![Figure 1: Map of study area](image-url)
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.

\[ \text{ETc} = \text{ETo} \times Kc \]  

(1)

Where, ETc = crop evapotranspiration, Kc = crop coefficient, ETo = reference evapotranspiration.

e) Irrigation Water Management

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

\[ \text{TAW} = \frac{(F_c-P_{wt}) \times BD \times D_z}{100} \]  

(2)

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

\[ \text{I}_{\text{net}}(\text{mm}) = \text{ETc}(\text{mm}) - \text{P}_{\text{eff}}(\text{mm}) \]  

(3)

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

\[ \text{IRg} = \frac{1}{E_{a}} \times 100 \]  

(4)

Ea=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:

\[ t = \frac{I_g \times l \times w}{6 \times Q} \]  

(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:

\[ \text{NI} = \text{GI} - \text{TC} \]  

(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

<table>
<thead>
<tr>
<th>Soil properties</th>
<th>Bulk density (gm/cm³)</th>
<th>Infiltration rate (mm/hr)</th>
<th>Soil texture</th>
<th>EC (ds/m)</th>
<th>pH</th>
<th>FC (%)</th>
<th>PWP (%)</th>
<th>TAW (mm/M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average value</td>
<td>1.21</td>
<td>42</td>
<td>Clay</td>
<td>1.01</td>
<td>6.15</td>
<td>27.83</td>
<td>17.05</td>
<td>13.04</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>TRT</th>
<th>MY(t/ha)</th>
<th>UMY(t/ha)</th>
<th>TY(t/ha)</th>
<th>WUE(kg/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>125% MAD</td>
<td>22.2a</td>
<td>4.6a</td>
<td>26.82b</td>
<td>4.3b</td>
</tr>
<tr>
<td>100% MAD</td>
<td>29a</td>
<td>4.87a</td>
<td>33.94a</td>
<td>5.64a</td>
</tr>
<tr>
<td>75% MAD</td>
<td>23.9b</td>
<td>5.35a</td>
<td>29.32b</td>
<td>4.81a</td>
</tr>
<tr>
<td>Farmer practice</td>
<td>22.95b</td>
<td>5.42b</td>
<td>27.2b</td>
<td>5.46a</td>
</tr>
<tr>
<td>Cv</td>
<td>23.2</td>
<td>24.7</td>
<td>18.0</td>
<td>27.7</td>
</tr>
<tr>
<td>Lsd</td>
<td>4.7</td>
<td>0.97</td>
<td>4.4</td>
<td>1.2</td>
</tr>
</tbody>
</table>

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 Woreda. 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 (Appling 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

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

MAD = maximum allowable depletion, Ay = Adjusted yield, GI=Gross income, FC= Fixed cost, 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 (26.82 t/ha) was obtained from 125% MAD. The highest water use efficiency (5.64 kg/m³) was obtained from 100% MAD. The highest net income (288116 birr/ha) was obtained at T2 (applying at 100% MAD) that received 495.5 mm 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.

References

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

By Hussein H. A. M, Dagash Y. M. I & Maarouf I. Mohammed

*University of Sudan for Science and Technology*

**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 Rhodes 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

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

Hussein H. A. M *, Dagash Y. M. I * & Maarouf I. Mohammed p

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 Rhodes 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; NSWDPI, 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 et al., 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; Elnazer, 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°39N, Longitude 32°31'E, 280 meter above sea level. The location is in...
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 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 Mbwile 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 Mbwile 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.

References Références Referencias


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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)

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

*: **: 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

<table>
<thead>
<tr>
<th></th>
<th>ADF (%)</th>
<th>NDF (%)</th>
<th>CP (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>60kgN/ha</td>
<td>42.7</td>
<td>66.8</td>
<td>8.1</td>
</tr>
<tr>
<td>120kgN/ha</td>
<td>46.6</td>
<td>63.3</td>
<td>8.5</td>
</tr>
<tr>
<td>Control</td>
<td>44.3</td>
<td>68.4</td>
<td>8.1</td>
</tr>
<tr>
<td>Mean</td>
<td>44.5</td>
<td>66.7</td>
<td>8.2</td>
</tr>
<tr>
<td>SE ±</td>
<td>0.85</td>
<td>1.09</td>
<td>0.38</td>
</tr>
<tr>
<td>LSD (5%)</td>
<td>2.06</td>
<td>2.65</td>
<td>0.91</td>
</tr>
<tr>
<td>CV%</td>
<td>15.3</td>
<td>13.1</td>
<td>36.8</td>
</tr>
</tbody>
</table>
### Table 3: Effect of variety on nutritive value of Rhodes grass

<table>
<thead>
<tr>
<th></th>
<th>ADF (%)</th>
<th>NDF (%)</th>
<th>CP (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reclaimer</td>
<td>44.9</td>
<td>65.7</td>
<td>7.9</td>
</tr>
<tr>
<td>Fine cut</td>
<td>44.2</td>
<td>67.6</td>
<td>8.5</td>
</tr>
<tr>
<td>Mean</td>
<td>44.5</td>
<td>66.7</td>
<td>8.2</td>
</tr>
<tr>
<td>SE±</td>
<td>0.6</td>
<td>0.78</td>
<td>0.27</td>
</tr>
<tr>
<td>CV%</td>
<td>15.3</td>
<td>13.1</td>
<td>36.8</td>
</tr>
</tbody>
</table>

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

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

*: Number of days from zero cut

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

<table>
<thead>
<tr>
<th>Cutting age*</th>
<th>ADF (%)</th>
<th>NDF (%)</th>
<th>CP (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>75 day</td>
<td>50</td>
<td>37</td>
<td>40.7</td>
</tr>
<tr>
<td>182 day</td>
<td>45.1</td>
<td>49.3</td>
<td>66.8</td>
</tr>
<tr>
<td>268 day</td>
<td>49.6</td>
<td>40.6</td>
<td>72.5</td>
</tr>
<tr>
<td>Mean</td>
<td>44.5</td>
<td>66.7</td>
<td>8.2</td>
</tr>
<tr>
<td>SE±</td>
<td>1.49</td>
<td>1.91</td>
<td>0.66</td>
</tr>
<tr>
<td>LSD (5%)</td>
<td>3.55</td>
<td>4.55</td>
<td>1.57</td>
</tr>
<tr>
<td>CV%</td>
<td>15.3</td>
<td>13.1</td>
<td>36.8</td>
</tr>
</tbody>
</table>

*: Number of days from zero cut

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

<table>
<thead>
<tr>
<th>Variety Dose</th>
<th>ADF (%)</th>
<th>NDF (%)</th>
<th>CP (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reclaimer</td>
<td>Fine cut</td>
<td>Reclaimer</td>
<td>Fine cut</td>
</tr>
<tr>
<td>60kgN/ha</td>
<td>43.9</td>
<td>41.5</td>
<td>67.7</td>
</tr>
<tr>
<td>120kgN/ha</td>
<td>48.6</td>
<td>44.6</td>
<td>61.4</td>
</tr>
<tr>
<td>N0(Control)</td>
<td>43.4</td>
<td>45.3</td>
<td>67</td>
</tr>
<tr>
<td>Mean</td>
<td>44.5</td>
<td>66.7</td>
<td>8.2</td>
</tr>
<tr>
<td>SE±</td>
<td>1.22</td>
<td>1.57</td>
<td>0.54</td>
</tr>
<tr>
<td>LSD (5%)</td>
<td>2.92</td>
<td>3.78</td>
<td>1.31</td>
</tr>
<tr>
<td>CV%</td>
<td>15.3</td>
<td>13.1</td>
<td>36.8</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Cutting age*</th>
<th>ADF (%)</th>
<th>NDF (%)</th>
<th>CP (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reclaimer</td>
<td>Fine cut</td>
<td>Reclaimer</td>
<td>Fine cut</td>
</tr>
<tr>
<td>75 days</td>
<td>48.4</td>
<td>48.6</td>
<td>68.6</td>
</tr>
<tr>
<td>182 days</td>
<td>42.3</td>
<td>41.2</td>
<td>67.9</td>
</tr>
<tr>
<td>268 days</td>
<td>43.6</td>
<td>42.3</td>
<td>60.4</td>
</tr>
<tr>
<td>Mean</td>
<td>44.5</td>
<td>66.7</td>
<td>8.2</td>
</tr>
<tr>
<td>SE±</td>
<td>1.08</td>
<td>1.38</td>
<td>0.48</td>
</tr>
<tr>
<td>LSD (5%)</td>
<td>2.92</td>
<td>3.74</td>
<td>1.29</td>
</tr>
<tr>
<td>CV%</td>
<td>15.3</td>
<td>13.1</td>
<td>36.8</td>
</tr>
</tbody>
</table>

*: 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

<table>
<thead>
<tr>
<th>Variety</th>
<th>Cutting age</th>
<th>Reclaimer</th>
<th>75 day</th>
<th>182 day</th>
<th>268 day</th>
<th>Fine cut</th>
<th>75 day</th>
<th>182 day</th>
<th>268 day</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>60 kg N/ha</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>7.4</td>
<td>7.8</td>
<td>7.8</td>
<td>11.4</td>
<td>6.0</td>
<td>8.4</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>10.9</td>
<td>6.2</td>
<td>6.9</td>
<td>11.3</td>
<td>7.2</td>
<td>8.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>9.7</td>
<td>5.8</td>
<td>8.3</td>
<td>9.2</td>
<td>6.9</td>
<td>8.4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Reclaimer</td>
<td>Grand Mean</td>
<td>8.2</td>
<td></td>
<td></td>
<td>9.6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>SE±</td>
<td>0.96</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>LSD(5%)</td>
<td>2.25</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>CV%</td>
<td>36.8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Variety</th>
<th>Cutting age</th>
<th>Reclaimer</th>
<th>75 day</th>
<th>182 day</th>
<th>268 day</th>
<th>Fine cut</th>
<th>75 day</th>
<th>182 day</th>
<th>268 day</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>60 kg N/ha</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>68.4</td>
<td>66.9</td>
<td>67.6</td>
<td>70.6</td>
<td>65.5</td>
<td>62</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>64.5</td>
<td>71.7</td>
<td>48.7</td>
<td>69.3</td>
<td>67.2</td>
<td>59.3</td>
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<td></td>
<td></td>
<td>Control</td>
<td>71</td>
<td>66.5</td>
<td>63</td>
<td>74</td>
<td>72.7</td>
<td>61.8</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Grand Mean</td>
<td>66.7</td>
<td></td>
<td></td>
<td>2.77</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>SE±</td>
<td>2.77</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>LSD(5%)</td>
<td>6.57</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>CV%</td>
<td>13.1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Month</th>
<th>2016</th>
<th>2017</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Max Temp. (°C)</td>
<td>Min Temp. (°C)</td>
</tr>
<tr>
<td>Jan</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Feb</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Mar</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Apr</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>May</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Jun</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Jul</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Aug</td>
<td>25.2</td>
<td>36.1</td>
</tr>
<tr>
<td>Sep</td>
<td>25.4</td>
<td>39.2</td>
</tr>
<tr>
<td>Oct</td>
<td>24.6</td>
<td>40.2</td>
</tr>
<tr>
<td>Nov</td>
<td>21.4</td>
<td>37</td>
</tr>
<tr>
<td>Dec</td>
<td>17.5</td>
<td>33.4</td>
</tr>
</tbody>
</table>

Source: Ministry of Environment, Natural Resources and Physical Development Metrological Authority.
**Appendix II:** Chemical and physical soil properties of the experimental site

<table>
<thead>
<tr>
<th>Depth (cm)</th>
<th>pH</th>
<th>E(\text{C}_e) (dm/m)</th>
<th>Ca+Mg (mmol+L)</th>
<th>Na (mmol+L)</th>
<th>SAR</th>
<th>CaCO3</th>
<th>Clay (%)</th>
<th>Silt (%)</th>
<th>Sand (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-15</td>
<td>7.79</td>
<td>1.4</td>
<td>9.0</td>
<td>5.1</td>
<td>2.4</td>
<td>5.10</td>
<td>42.1</td>
<td>15.9</td>
<td>42.0</td>
</tr>
<tr>
<td>15-35</td>
<td>7.88</td>
<td>1.0</td>
<td>6.0</td>
<td>4.3</td>
<td>2.5</td>
<td>4.88</td>
<td>39.6</td>
<td>15.8</td>
<td>44.6</td>
</tr>
<tr>
<td>35-51</td>
<td>7.87</td>
<td>1.2</td>
<td>5.0</td>
<td>7.1</td>
<td>4.5</td>
<td>4.99</td>
<td>44.1</td>
<td>16.4</td>
<td>39.5</td>
</tr>
<tr>
<td>51-75</td>
<td>7.91</td>
<td>2.0</td>
<td>8.0</td>
<td>12.5</td>
<td>6.3</td>
<td>4.88</td>
<td>51.4</td>
<td>16.6</td>
<td>32.0</td>
</tr>
<tr>
<td>75-90</td>
<td>7.71</td>
<td>2.2</td>
<td>6.0</td>
<td>16.0</td>
<td>9.2</td>
<td>5.20</td>
<td>50.0</td>
<td>16.6</td>
<td>33.4</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Depth (cm)</th>
<th>N%</th>
<th>P (meg/kg)</th>
<th>K (meg/l)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-20</td>
<td>0.084</td>
<td>0.53</td>
<td>0.195</td>
</tr>
<tr>
<td>0-20</td>
<td>0.140</td>
<td>0.79</td>
<td>0.096</td>
</tr>
<tr>
<td>0-20</td>
<td>0.140</td>
<td>0.46</td>
<td>0.070</td>
</tr>
<tr>
<td>Mean</td>
<td>0.121</td>
<td>0.59</td>
<td>0.120</td>
</tr>
<tr>
<td>20-40</td>
<td>0.112</td>
<td>0.54</td>
<td>0.079</td>
</tr>
<tr>
<td>20-40</td>
<td>0.098</td>
<td>0.54</td>
<td>0.066</td>
</tr>
<tr>
<td>20-40</td>
<td>0.098</td>
<td>0.51</td>
<td>0.084</td>
</tr>
<tr>
<td>Mean</td>
<td>0.103</td>
<td>0.53</td>
<td>0.076</td>
</tr>
</tbody>
</table>
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Authors are solely responsible for all the plagiarism that is found. The author must not fabricate, falsify or plagiarize existing research data. The following, if copied, will be considered plagiarism:

- Words (language)
- Ideas
- Findings
- Writings
- Diagrams
- Graphs
- Illustrations
- Lectures
Authorship Policies

Global Journals follows the definition of authorship set up by the Open Association of Research Society, USA. According to its guidelines, authorship criteria must be based on:

1. Substantial contributions to the conception and acquisition of data, analysis, and interpretation of findings.
2. Drafting the paper and revising it critically regarding important academic content.
3. Final approval of the version of the paper to be published.

Changes in Authorship

The corresponding author should mention the name and complete details of all co-authors during submission and in manuscript. We support addition, rearrangement, manipulation, and deletions in authors list till the early view publication of the journal. We expect that corresponding author will notify all co-authors of submission. We follow COPE guidelines for changes in authorship.

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Appealing Decisions

Unless specified in the notification, the Editorial Board’s decision on publication of the paper is final and cannot be appealed before making the major change in the manuscript.

Acknowledgments

Contributors to the research other than authors credited should be mentioned in Acknowledgments. The source of funding for the research can be included. Suppliers of resources may be mentioned along with their addresses.

Declaration of funding sources

Global Journals is in partnership with various universities, laboratories, and other institutions worldwide in the research domain. Authors are requested to disclose their source of funding during every stage of their research, such as making analysis, performing laboratory operations, computing data, and using institutional resources, from writing an article to its submission. This will also help authors to get reimbursements by requesting an open access publication letter from Global Journals and submitting to the respective funding source.

Preparing your Manuscript

Authors can submit papers and articles in an acceptable file format: MS Word (doc, docx), LaTeX (.tex, .zip or .rar including all of your files), Adobe PDF (.pdf), rich text format (.rtf), simple text document (.txt), Open Document Text (.odt), and Apple Pages (.pages). Our professional layout editors will format the entire paper according to our official guidelines. This is one of the highlights of publishing with Global Journals—authors should not be concerned about the formatting of their paper. Global Journals accepts articles and manuscripts in every major language, be it Spanish, Chinese, Japanese, Portuguese, Russian, French, German, Dutch, Italian, Greek, or any other national language, but the title, subtitle, and abstract should be in English. This will facilitate indexing and the pre-peer review process.

The following is the official style and template developed for publication of a research paper. Authors are not required to follow this style during the submission of the paper. It is just for reference purposes.
Manuscript Style Instruction (Optional)

- Microsoft Word Document Setting Instructions.
- Font type of all text should be Swis721 Lt BT.
- Page size: 8.27” x 11”, left margin: 0.65, right margin: 0.65, bottom margin: 0.75.
- Paper title should be in one column of font size 24.
- Author name in font size of 11 in one column.
- Abstract: font size 9 with the word “Abstract” in bold italics.
- Main text: font size 10 with two justified columns.
- Two columns with equal column width of 3.38 and spacing of 0.2.
- First character must be three lines drop-capped.
- The paragraph before spacing of 1 pt and after of 0 pt.
- Line spacing of 1 pt.
- Large images must be in one column.
- The names of first main headings (Heading 1) must be in Roman font, capital letters, and font size of 10.
- The names of second main headings (Heading 2) must not include numbers and must be in italics with a font size of 10.

Structure and Format of Manuscript

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 un refereed.

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.
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 Electronic 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 your self, 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 though 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.

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**The Administration Rules**

Administration Rules to Be Strictly Followed before Submitting Your Research Paper to Global Journals Inc.

*Please read the following rules and regulations carefully before submitting your research paper to Global Journals Inc. to avoid rejection.*

**Segment draft and final research paper:** You have to strictly follow the template of a research paper, failing which your paper may get rejected. You are expected to write each part of the paper wholly on your own. The peer reviewers need to identify your own perspective of the concepts in your own terms. Please do not extract straight from any other source, and do not rephrase someone else's analysis. Do not allow anyone else to proofread your manuscript.

**Written material:** You may discuss this with your guides and key sources. Do not copy anyone else's paper, even if this is only imitation, otherwise it will be rejected on the grounds of plagiarism, which is illegal. Various methods to avoid plagiarism are strictly applied by us to every paper, and, if found guilty, you may be blacklisted, which could affect your career adversely. To guard yourself and others from possible illegal use, please do not permit anyone to use or even read your paper and file.
### 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.

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<tr>
<td>Abstract</td>
<td>Clear and concise with appropriate content, Correct format. 200 words or below</td>
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<tr>
<td>Introduction</td>
<td>Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited</td>
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<tr>
<td>Methods and Procedures</td>
<td>Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads</td>
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<tr>
<td>Result</td>
<td>Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake</td>
</tr>
<tr>
<td>Discussion</td>
<td>Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph, reference cited</td>
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