DETERMINING THE PERFORMANCE OF LOCAL BEAN VARIETIES IN LOWLAND AREAS. THE CASE STUDY OF NAROK SOUTH.

BY

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A project to be submitted in partial fulfillment of the requirement for the award of degree of Bachelor of Science in Applied Statistics with Computing of Maasai Mara University.

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MAY, 2017

DECLARATION

This is to certify that this is my own project and that no part of it has been presented in Maasai Mara University or elsewhere.

Signature …………………….   Date…………………………..

Cherotich Dorothy

Supervisor declaration

I certify that the candidate did this research under my supervision and has submitted it with my approval as the Supervisor.

Dr. John Matuya

Department of mathematics and physical sciences

Maasai Mara University

Signature…………………………. Date …………………………

DEDICATION

I dedicate this project to my siblings, my lecturers, my friends and relatives for their determination to make me excel in my studies even when times were hard. I pray that the Lord may reward them abundantly for their guidance and provision.

ACKNOWLEDGEMENT

My gratitude goes to Maasai Mara University for having contributed to the success of my bachelor’s degree.I would like to recognize the contribution of my undergraduate lecturers: Dr Matuya, Dr Ouno, Mr. Cheruiyot, Mrs. Gathogo, Dr. Karanja, Mr. Mutua and Mr. Nooseli Mr.Njunguna. In particular, I appreciate the extra tireless effort made by my supervisor Dr.Matuya for his guidance and support right throughout my project. I also acknowledge Hugo’s Farm for allowing me access their data which I have used in my study.. Finally appreciation also goes to my family for their all-round support.Above all, I thank the Almighty God for giving me good health throughout my study period.

ABSTRACT

The local bean varieties most common among farmers of Narok south is depended upon by other residents of Narok county and other regions within the country as their main source of food which has got high protein content and as well as source of income .This research was mainly aimed at determining the best performing local bean varieties in lowland areas of Narok south. It also aimed at determining if there exists a significant difference between blocks which are the yearly mean yield .These were achieved through a design of experiment that is Randomized completely block design of experiment (RCBD) that comprises of blocks (years) and treatments (local bean varieties).Data that was obtained that is secondary data was entered into excel and exported to R software package for analysis. This study found out that mwitemania, rosecoco, and Mwezi moja were superior varieties. This research is expected to be useful to Ministry of Agriculture and farmers of Narok south in making choices of best yielding local bean variety which will enable them increase beans production and earn a higher income from beans production.

ABBREVIATIONS

1. **KARI-Kenya** Agricultural Research Institute
2. **MoA-** Minstry of Agriculture
3. **RCBD-**Randomized Completely Block Design
4. **df-**degrees of freedom
5. **FAO-**Food and Agriculture Organization
6. MoALF- Ministry of Agriculture livestock and fisheries
7. CRD-Completely Randomized Design

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CHAPTER ONE

1.1. INTRODUCTION

Local bean (*phaseolus vulgaris*) is an important herbaceous grain legume in the world chiefly grown as a cheap source of protein among majority of sub-Saharan people.

Farmers frequently use as a vital component in crop rotation for its ability to fix nitrogen .According to FAO statistics estimate for the year (2006) world beans production was 1235kgha^{-1}while that of Africa was 799Kgha^{-1}

In Kenya local beans is an important food and cash crop which is mostly grown by small scale and large scale farmers. However, local bean (*phaseolus vulgaris*) production in Kenya is low and does not meet the increasing demand.

Food security in Kenya is dependent on the productive capacity of beans. The demand for beans has been higher than production hence causing a deficit. MoALF stated in their report that the yield of beans in the year(2010) was 8.3bags/ha, year (2011) was 7 bags/ha and year(2012) was 6.5bags/ha Thus this deficit or decline in beans production can be fixed through planting performing varieties for lowlands, midlands and the highland regions.

The high yielding varieties are both local and the developed varieties. However, despite the effort made by KARI and MOA that has led to the development and release of several high yielding beans varieties, farmers adoption to these varieties has been slow and most of the farmers still use low local seed varieties .Most farmers prefer this local varieties because of their availability .This study investigated through yearly yields the performing local bean variety for lowland areas especially for Narok South this is expected to help in increasing beans production.

1.2 STATEMENT OF THE PROBLEM

Since there has been a decline of beans production hence reduced income to beans farmers and scarcity of food since it is one of the staple foods which is a source of protein to most people in Narok and Kenya as a whole. This decline is majorly due to farmers planting local and low yielding varieties. Most of the studies that has been done have dwelt on improved varieties .KARI based their research on improved varieties in highlands. Therefore there was a need to determine the yielding local bean variety in Narok South and this will improve the bean production over the years. Also the difference between years of production will enable the farmers to know if there is consistent production if all factors are constant.

1.3 SIGNIFICANCE

Increasing bean production in the country can be best settled if the farmers are advised on planting the high yielding local and hybrid varieties. All agricultural institutes and research centers in Kenya have put a lot of effort on improving food production focusing mainly on beans production since it is the staple food and source of protein to most residents. This is mainly being achieved by determining the high yielding improved varieties. In Kenya this is majorly driven by KARI and other stakeholders in the research field.

This study will provide useful information to extension officers from Ministry of Agriculture and both large and small scale farmers. This will also provide information on the high yielding local bean variety in the lowland region that will help in increasing yearly bean production and thus increase their income.

1.4 OBJECTIVES

1.4.1 General objective

The broad objective was to determine the best performing local bean variety that has been under production over years in the lowland areas and will improve production in the targeted area.

1.4.2 Specific objectives:

1. To determine if there is a difference in mean yield of local bean varieties.
2. To determine if there is difference in mean yield in years.

1.5 JUSTIFICATION OF STUDY

This study was important because over the years the country as a whole and especially Narok county which falls under Arid and Semi-arid land have been experiencing low bean production yet beans is considered as a staple food after maize in Narok and Kenya as a whole.

It is therefore important to large and small scale farmers to know the best local variety to grow which can improve their yearly bean production. An increased production would ensure an increased income from the sale of beans to the farmers who depend on the crop in Narok County.

1.6 LIMITATION

The limitation of this study was poor record keeping on yearly yields by small scale farmers which made data collection difficult. This was addressed by taking data from large scale farmers from the area since they were likely to keep the records of the yearly yields.

CHAPTER TWO

2.1. Introduction

In this chapter we tried to look at studies that have been done that are related to our study.

2.2 LITERATURE REVIEW

In order to obtain valid and reliable conclusions from trials of field experiments it is important to choose a correct experimental design .Fisher(1926) in his paper in the field experimental designs emphasized the importance of randomization in estimation of experimental error and described randomized complete blocking designs and Latin square design as adequate in studies related to Agriculture.

A field experiment was conducted on field of Jinka Agricultural Research Center in south Omo Zone of southern Ethiopia by Tekle Yoseph. et.al(2014) using thirteen improved bean varieties: Omo95,Awash1,Melka,Dima,Nasir,Darkred,Granscope,Roba,Argene,chore,Ebaya,Dinkinsh,Snnpr-1-20 and one local check were used under rain fed condition in 2009. The objective of this study was to select the best performing improved bean varieties that will increase productivity in the targeted areas. The experiment was carried out using completely block design (CRD) with 14 treatments. In this study, there were significant variations observed among the improved bean varieties for all the yield and yield component traits.

An on-farm bean research was carried out in kigoma region Tanzania by Tulole lugendo and Tuaeli Mbaga (2013) to evaluate improved beans varieties for yield under farmers management conditions and to asses performance of the improved beans varieties .Nine farmers from three village with three farmers per village participated in beans trials .A RCBD with 5 plots per replication was used to evaluate bean varieties:Lyamugo90,Jesca,Uyole 94,Kablanket and kigoma yellow(control).they found that Lyamungo 90 and Jesca out yielding other varieties with $P<0.001$.

Another study was conducted in Ethiopia during dry season to assess the drought response of small red-seeded improved bean varieties by Asfa et.al(2013) using lattice design replicated twice under contrasting moisture regimes terminal drought stress and non- stress from November 2014 to March 2015 .11 genotypes significantly ($p<-0.05$) outperformed the drought check cultivar under both stress and non- stress conditions in seed yielding potential.

A research on the improved climbing beans varieties done by Lara Ramaekers et.al in KARI Embu (2013). The aim of this research was to asses awareness, trial and adoption rates of improved climbing beans in central highlands .A survey was done and the results were that 90% of the farmers were aware, 40% had grown on their farms at least for one season and only about 11% had maintained its production.

A study to determine the factors influencing improved bean varieties and efficiency among smallholder farmers in eastern Uganda by Welusi (2012) .The study was conducted in Busia ,mbale ,Bundaki and Tororo districts based on a sample of 280 households selected using a multi-stage sampling technique. In the analysis, descriptive statistics, a stochastic frontier model and a two limit

Tobit regression was employed. It was established that improved bean productivity is influenced by plot size and planting fertilizer. Tobit model estimation revealed that technical efficiency was positively influenced by value of assets at 1% level and extension service and group membership at 5% level.

In this study we tried to find the best performing local bean variety that is planted and depended upon by farmers using RCBD since most of the studies that have been done do consider the improved bean varieties.

CHAPTER THREE

3.1. METHODOLOGY

3.1.1 Introduction

In this study we used randomized complete block design (RCBD) which analyses data using a two way ANOVA and thereafter uses the F-test to test the means of the blocks/years and treatments/local beans varieties. RCBD is superior to the T-test because it compares more than two variables .RCBD comprises of the following parameters; v-treatments, r-replicates ,b-blocks and k being the size of the block .Where $bk = vr = N$ represents the experimental units i.e $bk = N$.We first group the units into b blocks(years) of v units such that the units in each block are nearly homogenous then assign at random the v treatments to each block subject to the treatment appearing once and only once in the block.

3.2. BASIC CONCEPTS

3.2.1. RCBD MODEL

The model for RCBD design is given by;

$X_{ij} = \mu + \alpha_i + \beta_j + e_{ij}$ ……………………….1

Where $X_{ij}$is the unit of i^{th}treatment (local bean varieties) in the j^{th}block(years) i.e ($i = 1 \ldots..4$ and $j = 1,2 \ldots 4$)

- μ is the overall mean
- α_i is the effect of i^{th} treatment
- β_j is the effect of j^{th}block
- e_{ij} error due to unknown variation

For RCBD to be used the following assumption is made:

- Our assumption is that $e_{ij} \sim N(0, \sigma^2)$

In ANOVA we use blocks, treatments and the error term as the possible sources of variations

For analysis we have

- SST=Total sum of squares
- SSB=sum of squares due to blocks
- SSTr = sum of squares due to treatment
- SSE=sum of squares due to error

The procedure involves calculations of the form:-

(i)Total Sum of Squares

$TSS = \sum_{i=1}^{v} \sum_{j=1}^{b} X_{ij}^2 - \frac{G^2}{N}$ ……………………2

Where $\frac{G^2}{\mathrm{N}}$ is the correction factor.

$N = b \times k$ is all the experimental units.

G – is the total sum of all units

V – is the number of treatments

b – is the number of blocks

(ii)Sum of Treatment is given by

SSTr = $\frac{1}{b}\sum_{i=1}^{v} T_i^2 - \frac{G^2}{N}$ …………………3

Where $T_i = \sum_{j=1}^{b} X_{ij} = X_{i.}$

r is the block size

With degrees of freedom $k-1$

(iii)Sum of Block is given by

SSB=$\frac{1}{v}\sum_{j=1}^{b} B_j^2 - \frac{G^2}{N}$ ……………………………..4

Where $B_j = \sum_{i=1}^{v} X = X_{.j}$

With $b-1$ degrees of freedom

(iv) $TSS = SSTr + SSB + SSE$

$SSE = TSS - SSB - SSTr$…………………………………..5

The SSE has $N - v - b + 1$ degrees of freedom

This table below shows the expected layout of our ANOVA table

Table 3.1 ANOVA Table

Source of variation	Degree of freedom	Sum of Squares	Mean sum of squares	F-value
Treatments	$k-1$	SST	$MSTr = \frac{SSTr}{k-1}$	$\frac{MSTr}{MSE}$
Blocks	$r-1$	SSB	$MSB = \frac{SSB}{r-1}$	$\frac{MSB}{MSE}$
Error	$N-r-k-1$	SSE	$MSE = \frac{SSE}{N-k-r+1}$	
Total	$N-1$	TSS		

3.2.2. ANOVA F-TEST FOR RCBD

For RCBD to use ANOVA F-test it is assumed that the population is from a normal distribution with mean μ and variance σ^2 for all N units and the samples are independent .The required tests will thereafter be taken as discussed:

$$H_0: \alpha_1 = \alpha_2 = \cdots = \alpha_I$$
$$H_a: \alpha_1 \neq \alpha_2 \neq \cdots \neq \alpha_I$$

i. The test statistic for treatments is given by the following mathematical relationship ;-

$F_c = \frac{MST}{MSE}$ ……………………6

Where we compare $F_c$with $F_{\alpha(v-1,N-v-b+1)}$

If reject the null hypothesis if $F_c > F$otherwise we do not reject.

ii. The test statistic for blocks is provided by the following mathematical relationship ;-

$F_c = \frac{\text{MSB}}{\text{MSE}}$ ……………7

Where we compared $F_c$with $F_{\alpha(v-1,N-v-b+1)}$

Reject the null hypothesis if $F_c > F$ otherwise accept

3.2.3 TREATMENT COMPARISON TEST USING T-TEST

If the null hypothesis for treatment (local bean varieties) is rejected then further investigation to determine which of the treatment contributed to the difference.

This is performed by the use of paired comparison of treatment test that is t-test.

The mathematical relationship for the t-test is given by;

$$T_c = \frac{X_{i.} - X_{.j}}{\sqrt{\frac{2MSE}{\text{v}}}} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots.. \quad 8 \qquad \ldots.$$

$X_{i.}$ is the mean of ith treatment with higher value

$X_{.j}$is the mean of jth treatment with lower value

$\boldsymbol{v}$ Number of treatments

The hypotheses to be tested are

$$H_0: \alpha_i = \alpha_j$$
$$H_a: \alpha_i \neq \alpha_j$$

α_i is the mean of the i^{th} treatment

$\alpha_j$is the mean of the j^{th} treatment

CHAPTER FOUR

DATA ANALYSIS AND INTERPRETATION

The design was based on four local beans varieties with four replications which were equal to the number of blocks i.e ($v = 4\ and\ b = r = 4$).The data analyzed here was obtained from farm records at Hugo's farm which had the yearly yields for each variety in 90-kilogram bags. The varieties under study were Mwitemania, Wairimu, Rosecoco, Mwezi moja.

The data was entered into the spreadsheets (MS-EXCEL) and then analyzed by R software package.

4.1. Randomization

We used the process of randomization in this research work to minimize bias. The varieties of beans under research were hereby represented by alphabetical letters as follows:

A-Wairimu, B-Mwezi moja, C- mwitemania, D- Rosecoco.

By use of randomization process we considered treatment randomization within blocks by generating random numbers using excel

Block 1	C	A	B	D
	2	0	1	3

Which when arranged in ascending order becomes:

Block 1	A	B	C	D
	0	1	2	3

For block II

Block II	D	C	A	B
	2	1	3	0

When arranged in ascending order becomes

Block II	B	C	D	A
	0	1	2	3

When we did it for every block our results were as shown in the table below.

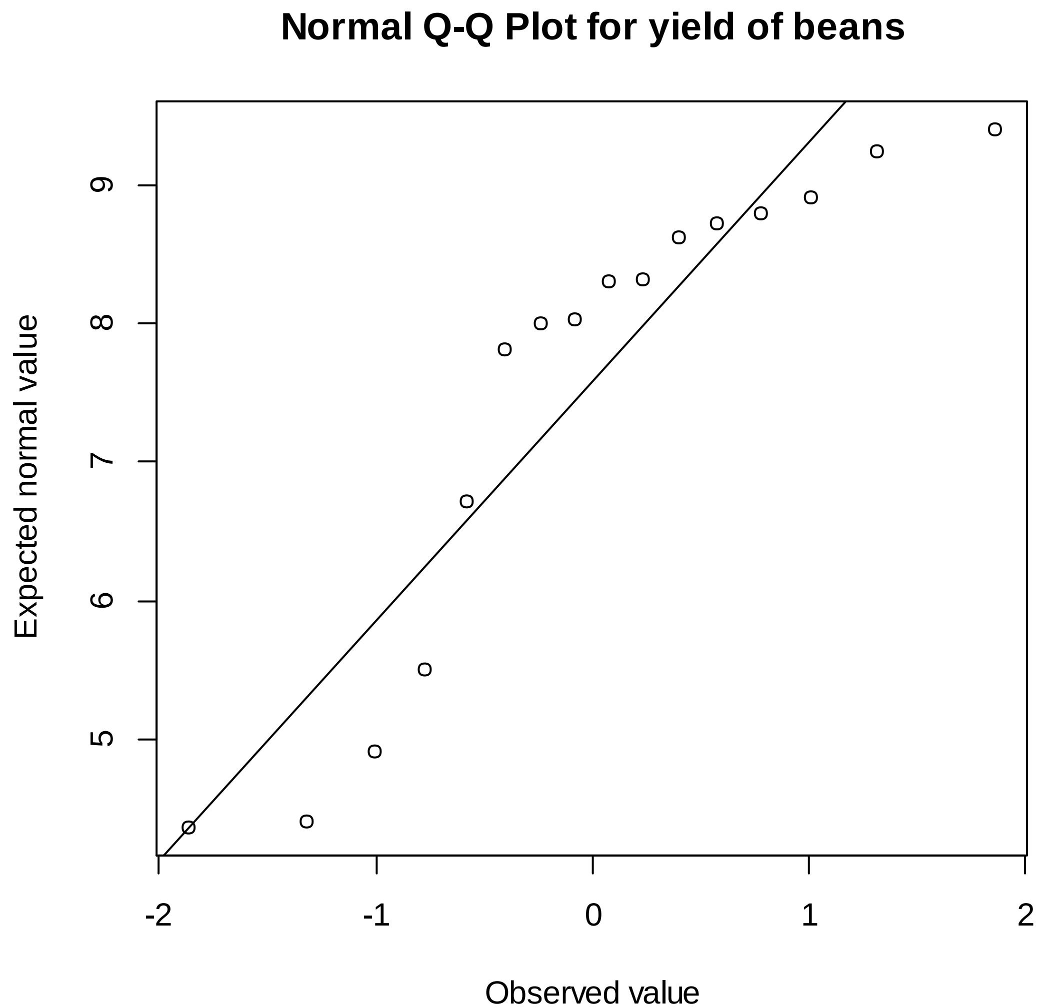
Table 4.1 Randomized treatments with yield in 90kg bags per acre

Block I	A(4.37)	B(6.72)	C(8.32)	D(8)
Block II	B(5.5)	C(8.8)	D(8.73)	A(8.3)
Block III	A(4.41)	C(7.82)	D(8.91)	B(8.62)
Block IV	B(4.92)	A(8.03)	C(9.4)	D(9.25)

This is a table of average yearly yields of the randomized varieties in each block.

DATA ANALYSIS

We used Q-Q plots to summarize our data main characteristics .This helped in determining the data’s distribution. It shows whether the data conforms from a normal distribution. This is normally a plot of quartile of quantitative response against quartiles of the normal distribution.



From the graph it can be realized that the data entries are close to the line of fit indicating that the data is normally distributed. This property allows us to apply ANOVA.

4.2. CALCULATIONS

In this section we provide calculations of the total sum of squares, sum of squares due to block, sum of treatments and sum of errors as follows.

$$\sum_{K=1}^{4} B_1 = 4.37 + 6.72 + 8.32 + 4.92 + 8 = 27.41$$

Similarly we did for block 2,3 and 4 and results obtained provided in table 4.2.Our computations for treatment has been calculated as follows:

$$\sum_{b=1}^{4} T_A = 4.37 + 5.5 + 4.41 + 4.92 = 19.2$$

We similarly did this for every treatment and the results provided in table 4.2.

Table 4.2

Treatment/ Blocks	$\sum_{i=1}^{4} T_i$	$\sum_{b=1}^{4} B_j$	$\sum T_i^2$	$\sum B_j^2$
1	19.2	27.41	368.64	751.3081
2	31.37	31.33	984.0769	981.5689
3	35.36	29.76	1250.3296	885.6576
4	34.17	31.6	1167.5889	998.56
Totals	120.1	120.1	3770.6354	3617.0946

We calculated the total sum of squares using equation (3) of the form $TSS = \sum_{i=1}^{v} \sum_{j=1}^{b} Y_{ij}^2 - \frac{G^2}{N}$

$\sum_{i=1}^{v} \sum_{j=1}^{b} Y_{ij}^2$=$8.75^2 + 6.75^2 + 7.733^2 + \cdots + 7.473^2$ =947.1734

Using the correction factor given by the following relationship we found

$$\frac{G^2}{N} = \frac{(\sum Y_{ij})^2}{N}$$

$$= 947.1734 - \frac{120.1^2}{16} = 45.6723$$

Similarly for sum of treatments we use equation (3)

$$= 942.65885 - \frac{120.1^2}{16} = 41.1563$$

From equation (4) we calculated the sum of blocks

$$= 904.27365 - \frac{120.1^2}{16} = 2.773$$

Similarly to find the sum of error we used equation (5)

$$= 45.6723 - 41.1563 - 2.773 = 1.743$$

4.2.1. Test the mean for the treatments

The main use of ANOVA here was to test for difference among means. This was done with the assumption that the population is normally distributed with experimental error normally distributed with mean $= 0$ and variance $= \sigma^2$.

We represented the means for each variety by $\alpha_A = \text{mean yield for Wairimu}$, similarly to $\alpha_B = \text{mwezi moja}$,$\alpha_C = \text{mwitemania}$ and $\alpha_D = \text{rosecoco}$

The hypotheses tested were;

$$H_0: \alpha_A = \alpha_B \dots. = \alpha_D$$

$$H_1: \alpha_A \neq \alpha_B \dots. \neq \alpha_D$$

Table 2.3 R-ANOVA TABLE

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
tm	3	41.16	13.719	70.900	1.39e-06 ***
blk	3	2.77	0.924	4.777	0.0294 *
Residuals	9	1.74	0.194		

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

The F-value at 0.05 at (3,9)=3.86

The F tabulated is less than F calculated 70.9 hence we reject the null hypothesis that the mean yields are equal hence conclude that there is a significance difference between the means of the treatment. Since the p-value is less than α(0.05) there is no doubt to reject that the mean yields are equal.

4.2.2. Comparison between treatments

Since there was significant difference between mean yields, we subjected the treatments to a paired comparison treatment, t- test.

It comprises testing two treatments as from equation (7) take the highest yielding variety which is mwitemania compare it with the other varieties.

From equation (8)

$\sqrt{\frac{2MSE}{V}} = \sqrt{\frac{2*13.179}{4}}$=2.567

Comparing mwitemania and Wairimu

The hypotheses tested are;

$$H_0: \alpha_C = \alpha_A$$

$$H_1: \alpha_C \neq \alpha_A$$

$$T_c = \frac{35.36 - 19.2}{2.567} = 6.295$$

t tabulated 3.192 is less than t calculated hence we reject the null hypothesis and conclude that mean treatment of mwitemania and Wairimu differ significantly.

Comparing mwitemania and Mwezi moja

The hypotheses tested are;

$$H_0: \alpha_C = \alpha_B$$

$$H_1: \alpha_C \neq \alpha_B$$

$$T_c = \frac{35.36 - 31.37}{2.567} = 1.55$$

t tabulated is greater than t calculated hence we do not reject the null hypothesis and conclude that the mean yield for treatment mwitemania and Mwezi moja do not differ significantly

Comparing mwitemania and Rosecoco

The hypotheses tested are;

$$H_0: \alpha_C = \alpha_D$$

$$H_1: \alpha_C \neq \alpha_D$$

$$T_c = \frac{35.36 - 34.17}{2.4351} = 0.463$$

t-tabulated is greater than t calculated we do not reject the null hypothesis and conclude that the mean yield of varieties mwitemania and Rosecoco do not differ significantly.

Table 4.4 R-table for treatment pairwise comparisons using t tests

	A	B	C
B	5.6e-05	-	-
C	4.6e-06	0.12	-
D	8.6e-06	0.27	0.51

Since the p-value between treatment C,D and B is greater than α(0.05) we do not reject the null hypothesis and conclude that they do not differ significantly .But the p –value of A with B,C and D is less than α(0.05) we reject the null hypothesis and conclude that A differ significantly from B,C and D.

FOR BLOCKS

The F calculated is greater than F tabulated so we reject the null hypothesis and conclude that there is enough evidence to reject the null hypothesis .Since the p-value is less than α (0.05) this showed that the blocks yield differed significantly.

CHAPTER FIVE

5.1. Conclusions

The mean bean yield for all the varieties showed significant difference at 5% level of significance .Among these varieties mwitemania has the highest yield followed by Rosecoco ,Mwezi moja and Wairimu in that order. Mwitemania showed a mean production of 35.36-90 kg bags per acre while Wairimu which is the lowest had a mean yield of 19.2-90kg bags per acre.

On carrying out a paired comparison treatment test at 5% level of significance, it was realized that between Mwitemania, rosecoco, and Mwezi moja the mean yield do not differ significantly i.e. mean yield equal .From these observed results mwitemania, rosecoco and Mwezi moja varieties are realized to be superior varieties.

5.2. Recommendations

We recommend that farmers in Narok South should major on planting mwitemania, rosecoco and Mwezi moja local bean varieties to boost general production in their farms since they are high yielding. We recommend to the ministry of agriculture and other institutions to advice farmers on planting these varieties. Finally we recommend agricultural institutions and any other interested parties to include farmers' preference, effects of pests and diseases, early maturing varieties and adaptability of the varieties to the environmental conditions which our research did not cover.

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APPENDICES

Appendix 1:

TIME PLAN

September 2016	Development of proposal.
November (2016) - January 2017	Understanding, preparing and submitting research proposal.
February 2017	Collecting data and putting them to right form for analysis.
April 2017	Data analysis and presentation.

BUDGET

S/NO	Item	Amount(ksh)
1	Transport	1100
2	Stationery	300
3	Lunch	700
4	Other expenses	3000
5	Printing and Binding	2200
	Total	6200

Appendix2: R-PROCEDURE FOR Q-QPLOT

```
> c<-read.table("C:/Users/Evans/Desktop/Documents/norm.txt",header=TRUE,sep="\t",
na.strings="NA",strip.white=TRUE)

> c

   block treatment yield
1      1         A  4.37
2      1         B  6.72
3      1         C  8.32
4      1         D  8.00
5      2         B  5.50
6      2         C  8.80
7      2         D  8.73
8      2         A  8.30
9      3         A  4.41
10     3         C  7.82
11     3         D  8.91
12     3         B  8.62
13     4         B  4.92
14     4         A  8.03
15     4         C  9.40
16     4         D  9.25

> attach(c)

> require(graphics)

> qqnorm(yield,main='Normal Q-Q Plot for yield of beans',xlab='Observed value',ylab='Expected
normal value')

> qqline(yield,main='Normal Q-Q Plot for beans')
```

Appendix 3: R-procedure for RCBD analysis.

```
data1<-read.table("C:/Users/Evans/Desktop/Documents/datacomp.CSV",header=TRUE,sep="\t",
na.strings="NA",strip.white=TRUE)

data1

r = c(t(as.matrix(data1))) # response data

r

f = c("A", "B", "C","D")

k = 4

n = 4

tm= gl(k, 1, n*k, factor(f))   # matching treatment

tm

blk = gl(n, k, k*n)             # blocking factor

blk

av = aov(r ~ tm + blk)

summary(av)

pairwise.t.test(r,tm,p.adj="bonf")    # generating pairwise comparison using t test
```