

**TITLE PAGE**

**COMPUTER APPLICATIONS OF EXPERIMENTAL  
DESIGN AND ANALYSIS**

**BY**

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**ABSTRACT**

The development of Computer, and its Software packages to aid in solving complex organisational problems can be seen as a blessing as it has meaningfully improved the activities in the world scientifically and technologically. However, this project has successfully developed a program using Basic Language that is capable of evaluating the effect of Nitrogenous fertilizers and the effect of pesticides on crops. Statistical analysis used is analysis of variance (ANOVA). The analysis as restricted to Randomised Complete Block Design and Latin Square Design helped in making meaningful decisions and recommendations.

**DEDICATION**

This project is dedicated to Mr. & Mrs V. O. Anyanwu and children, Eberechukwu, Uchechukwu, Chiaka, Chukwugoziem, Onyinyechukwu and Kechinyere.

**CERTIFICATION.**

This project worked was supervised and approved as meeting the requirement for the award of Postgraduate Diploma in Computer Science of the Department of Mathematics and Computer Science, Federal University of Technology, Minna.

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## CHAPTER ONE

### 1.0 GENERAL INTRODUCTION:

Based on the assumption that new knowledge is most often obtained by careful analysis, and interpretation of data. It is important that considerable thought and effort be given to learning their collection in order that maximum information be obtained for the least expenditure of resources.

In designing an experiment objectives must be stated clearly as questions to be answered, Hypothesis to be tested and effects to be estimated. It is extremely important to define clearly the population for which inferences are to be drawn and sample that population randomly. By definition, an experimental could be a planned enquiry to obtain new facts or to confirm or deny the result of previous experiments where such inquiry will aid in administrative decisions such as recommendation of a variety, Procedure or type of an application or treatment. An important objective of experimentation could be to discover some things about a particular process or to compare the effect of several conditions on some phenomena.

In this project, we shall employ the use of computer system with an aid of BASIC Programmable language that is interactive in nature to carry out analysis of variance on the data collected, which marks the bases of rejection or acceptance. The Hypothesis that will lead to valid decision-making. For an example in considering an experiment in which n varieties of crops are planted on several acre lots and their yields per acre recorded. The interest is in testing the null hypothesis that the n varieties of crop produce equal yields on the average. To test for the equality of several means simultaneously, we employ a technique called analysis of variance.

The analysis of variance is a method for splitting the total variation of our data into meaningful components that measure different sources of variation. In the experiment, we obtain two components; first measuring the variation due to experimental error and the second measuring variation due to experimental error plus any variation due to the different varieties of crop or treatments. In doing this, set of observation may be classified according to two criteria at once by means of a rectangular array in which the columns represent one criterion of classification and the rows represent a second criterion of classification. For example the first array may be the yield of the crops using different kinds of fertilizer. The yields are obtained. Each treatment combination defines a cell in our array for which we have obtained a singular observation.

The n varieties of crops layout only is called one-way classification and its analysis of variance is called one-way analysis of variance. While that of observations classified according to two criteria at once by means of rectangular array of rows and columns is called Two-way classification and its analysis is called Two-way analysis of variance. At times more than two criteria may be of interest such as row, column and treatment. One of the appropriate analysis to be used is Latin-Square Design.

## **1.2 AIM AND OBJECTIVES.**

The aim of this project is to use a computer programmable language of BASIC, with the aid of appropriate algorithm, then write an interactive program that will carry out an analysis of variance of both Two-way classification and that of Latin Square Design. The ANOVA tables will aid in evaluating the following.

1. The column (crop) effect is that is; the presence of significant variations in the average yields of different varieties of crops and row (fertilizer) effect on the crop yield for Two-way classification.

$\mu_i$  is the effect on the  $i^{\text{th}}$  row

$j$  is the effect on the  $j^{\text{th}}$  column.

$b_k$  is the effect of the  $k^{\text{th}}$  treatment.

$e_{ijk}$  is the error associated with the  $Y_{ijk}$  observation.

#### ANOVA TABLE FOR LATIN SQUARE

SV				
Rows	$P^{-1}\sum Y_i^2 - C = SS_R$	(p-1)	$SS_R/p-1$	MSR/MSE
Columns	$P^{-1}\sum Y^2_{.j} - C = SS_C$	(p-1)	$SS_C/p-1$	MSC/MSE
Letter	$P^{-1}\sum Y^2_{..K} - C = SS_L$	(p-1)	$SS_L/p-1$	MSL/MSE
Error	$SS_E = SS_T - SS_R - SS_C - SS_L$	(p-1)(p-2)	$SS_E/(p-1)(p-2)$	-
Total	$\sum \sum \sum Y^2_{ijk} - C = SS_T$	(P <sup>2</sup> -1)	-	-

$$\text{Where } C = \frac{Y^2_{...}}{p^2} \text{ OR } P^{-2}Y^2_{...}$$

#### ASSUMPTIONS OF LATIN-SQUARE DESIGN

1. Normality: Any random variable in the model is assumed to be normally distributed.
2. Independence: All the experimental effects are mutually independent.
3. Homoscedasticity: Constant variance, the variance of the random variable in the model do not depend on the subscript.

#### LIMITATIONS OF LATIN-SQUARE DESIGN.

1. It ignores interactions thus if interaction is present, the ordinate of the experimental effect are adversely affected.
2. In the basic design all factors are made to appear at the same M level, and this is a limitation on the basic design since in real life all experimental factors do not usually occur at the same experimental level.
3. The basic Latin Square is not used when the experiment involve three or more than three factors. In this case, a graeco-Latin Square becomes more appropriate.

## STATISTICAL HYPOTHESES AND TESTS OF SIGNIFICANCE.

The statistical procedure for comparing two or more treatment means employs the use of an assumption called the null hypothesis, which assumes that the treatments have no effect. We then proceed to test the probability that means are divergent as those of our samples would occur by chance alone if the samples were indeed random samples from normally distributed populations with equal means and variance. If our analysis leads to the conclusion that we could expect such mean differences quite frequently by chance, we do not reject the null hypothesis and conclude that we have no good evidence of a real treatment effect. If the analysis indicates that the observed differences would rarely occur in random samples drawn from populations with equal means and variance, we reject the null hypothesis and conclude that at least one treatment had a real effect. At least one of the means is said to be significantly different from the others.

If the probability is 5% or less that the observed variation among means could occur by chance, we say that the means are significantly different. If the probability is 1% or less that the observed variation among means could be expected to occur by chance, the differences are said to be highly significant.

By definition we could define hypothesis as a testable opinion or believe. There are two types of errors in hypothesis testing; Type I Error and Type II Error.

A Type I Error is made when a true null hypothesis is rejected when it is true.  $\alpha$

Is the probability that Type I Error is made.  $\beta$  Is also called the level of significance or size of Type I Error

A Type II Error is made when the false null hypothesis is accepted or when null hypothesis is accepted when it is false  $\beta$  Is the probability that Type II Error is made.

The complement of  $\beta$  .i.e [1-  $\beta$ ], which is probability of rejecting the null hypothesis when it is false, is called 'Power of a statistical test'

COMPUTER PROGRAMMING WITH BASIC LANGUAGE. In this review, it is important we look at what computer is before talking about computer programming and languages.

A computer is said to be a machine, which accepts data from input device, perform arithmetic and logical operations in accordance with a predefined program and finally transfer the processed data to an output device either for further processing or in final form. It has a further capability of storing data as may be required.

For a computer to be controlled, it requires writing a program and this process is referred to as programming. Therefore a program can be defined as a set of sequence of instructions, which informs a computer of the steps required for achieving a defined task. Each instruction defines a basic operation to be performed, identifies the address of the data to be processed, the peripheral device (input or output device) to be used. However, the act of giving instructions to the Computer is made possible through the Computer programming Languages. A programming language is simply the mode of communicating to Computer. It is in the form of an artificially defined set of characters, symbols and words plus the rules for combining these characters, symbols and words into meaningful communications. So designed to be conveniently used by human beings in developing programs.

BASIC is the acronym for Beginners. All-purpose symbolic instruction code. It is developed at Detmouth College in 1963. Basic is a high level language designed for people who have no prior programming experience and is one of the easiest of all programming language to learn. It is widely used in programming scientific, mathematical and many business problems. One good thing about BASIC is that it encourages running the program in an interactive mode. As soon as the user submits a program and some data to the computer, the computer executes the program, produces the result back to the user immediately. Another very vital characteristic of BASIC is its availability on all Disk Operating System (DOS).

There are BASIC Interpreters and BASIC Compilers depending on the version of DOS available. The versions are;

1. GWBASIC available on DOS 3.3
2. BASIC and BASICA available on DOS 4.01.
3. QBASIC available on DOS 5 and above.

It should be noted that GWBASIC, BASIC and BASICA are Interpreter while QBASIC is a Compiler.

## **CHAPTER THREE**

### **3.1 SYSTEM ANALYSIS AND DESIGN**

#### **INTRODUCTION**

Just as it is known that computer is composed of various forms of software, so the procedure for computerising a problem is made more complex by a large area of computing which is called Para computing, and of which system analysis and design form the major part. One of its main functions is to convert on existing manual system into a computerized system. In system analysis and design the concern is usually with man made system involving input, processes and outputs. A system can be regarded as “ a set of interacting elements responding to inputs to produce outputs.

#### **DEFINITION OF SYSTEM**

System analysis is defined as the methods of determining how best to use computer with other resources to perform task which meet information need of an organisation.

#### **GENERAL SYSTEM THEORY**

The emphasis of system theory is not only to examine and analyse the individual part of a system or organisation but also it is vital that the system is viewed as a totality where the whole is greater than the sum of the parts.

The general system theory was developed to provide and unifying bases for the scientific discipline such as Physics, Chemistry, Biology etc. that arose because of individual scientific discipline. However, the general system theory applies to other activities as well. These include Business, Government, and Agriculture etc. The theory tends to bring order and structure to chaos, Segmentation and complexity. At the same time, this theory takes into account the dynamics of change and the uncertainty that exist in the universe.

At this point, it becomes necessary to investigate the manual system currently used in determining the effect of fertilizer application (Chemicals) and the methods of arrangement (rows and columns) on crop yield. This is to see how best computer application could be used for more efficient production. The study of this chapter will result in the design and implementation of the proposed system to be applied.

### **PROBLEM IDENTIFICATION**

Problem identification is the reviews of current system thereby identify its nature and scope of problem that gives room for re-evaluation of the current of existing old system. Among other problems that could be identified are the magnitudes of the problem (major or minor). If the system model is incorrectly defined etc. This is to enable the analyst to provide the best way of solving the exiting problem.

A look at the manual system used by the statistics department of National Research Institute Badeggi in analysing curses of variation in farm products, the problem that could be identified are as follows:

- a. The manual system of evaluation is tedious, tiring and highly uninteresting.
- b. Misplacement, mishandling and loss of previous calculation and its methods.
- c. There may be delay in evaluation due to human weakness. More time being consumed using manual system.
- d. More often than not, human errors do result using manual system.
- e. The method may be found inefficient

### **FEASIBILITY STUDY**

This is to determine whether a solution to the problem is feasible. This is to prevent wasting many years or months of effort and money in trying to evaluate and execute a project that is too large, uncontrollable or impossible to carry out. The feasibility study is a miniature systems analysis and design efforts that entails an exploration of alternatives design options

and an analysis of the costs and benefits of each alternative. If the study seems to be realistic in their potential costs and benefits, then the project proceeds to the next phase but if not it can be terminated.

The major studies that are normally evaluated are as follows:

- a. **Operational feasibility:** This study is concerned with the workability of the proposed system when developed and implemented. The operational feasibility of the proposed system was carried out and was found to be operationally feasible.
- b. **Technical feasibility:** This test seeks to clarify if the proposed system can be achieved with the current equipment, that is existing software technology PC models, and personnel. However it was found that N.C.R.I has computers with the software that is capable of evaluating the analysis. But the analysts have to be trained on the use of the proposed system for efficiency.
- c. **Economical/financial feasibility:** The cost of implementation of new system be relatively reasonable and affordable by the organisation.

#### **OPERATION OF THE CURRENT SYSTEM**

The system under review or investigation needs to be well understood. This is to enable analysis, design and recommendations. The experimental design and analysis used in the current system are Latin square design and randomised complete block design of manual operation.

#### **TESTING FOR THE SIGNIFICANCE OF MODEL**

Parameter Estimates Using ANOVA The model for Latin Square Design is,  $Y_{ijk} = U + \alpha_i + T_j + \beta_k + e_{ijk}$

Analysis to evaluate the effect of the five different 100 Ib of Nitrogen i.e.  $(\text{NH}_4)_2\text{SO}_4$ ,  $\text{NH}_4\text{NO}_3$ ,  $\text{Co}(\text{NH}_2)_2$ ,  $\text{Ca}(\text{NO}_3)_2$ ,  $\text{NaNO}_3$  and a non-fertilised control on sugar root yield in tons.

## Hypothesis

## Case I

$$H_0: T_1 = T_2 = T_3 = T_4 = T_5 = T_6 = 0$$

$$H_1: T_j \neq 0 \text{ for at least one } i^{\text{th}} \text{ treatment}$$

$$\alpha = 0.05$$

Decision Rule: Reject  $H_0$  if F-ratio is greater than  $F^{1-\alpha} (6-1), (6-2) (6-1) = 2.71$

## Case II

Analysis to evaluate row arrangement effect on the five different 100 lb of Nitrogen and a non-fertilized control and sugar root yields in tons.

$$H_0: \alpha_1 = \alpha_2 = \alpha_3 = \alpha_4 = \alpha_5 = \alpha_6 = 0$$

$$H_1: \alpha_i \neq 0 \text{ for at least on } i^{\text{th}} \text{ row } \alpha = 0.05$$

Decision Rule Reject  $H_0$  if F-ratio Row is greater than  $F^{1-\alpha} (6-1), (6-2) (6-1) = 2.71$

## Case III

Analysis to evaluate column arrangement effect on the five different 100lb of Nitrogen and a non-fertilized control on sugar root yields in tons.

$$H_0: \beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = \beta_6 = 0$$

$$H_1: \beta_k \neq 0 \text{ for at least one } k^{\text{th}} \text{ column}$$

$$\alpha = 0.05$$

Decision Rule; Reject  $H_0$  if F-ratio-column is greater than  $F^{1-\alpha} (6-1)(6-2)(6-1) = 2.71$

The model for Complete Randomised

Block Design is j

$$Y_{ij} = \mu + T_i + \beta_j + e_{ij}$$

Analysis to evaluate treatment effect of  $F_0$  and  $F_2$  are 0 and 22/3 oz fungicide/100lb seed of lima bean seedling respectively and  $I_0$ ,  $I_1$  and  $I_2$  are 0, 1/6 and 1/3 oz insecticide/100 lb seed respectively of the same lima bean seedling.

2. To evaluate the presence of significant variations in row, column and treatment effect for Latin-Square Design.
3. Conclusively give adequate recommendation(s) that will aid the Agronomist on the use of varieties of crops, fertilizers as well as arrangement of crops and ways of assigning treatments to crops so as to maximise yields.

### **1.3 JUSTIFICATION OF STUDY.**

The aid, the world of Computer has brought into Technological development in almost all fields of life can not be over emphasized. The field of agriculture is not left behind. Therefore it is quite justifiable to evaluate the means of improving agricultural productively, efficiency and accuracy, which will lead to the realisation of the global objective (food for all by the Year 2000).

The introduction of ANOVA in Agriculture has not only helped in yield of crops but has also contributed in time saving, improve qualities and output of farm products. It now becomes necessary that factors that effects yield positively or negatively be evaluated if desired objectives must be realised.

### **MOTIVATION.**

Agricultural Sector of any national economy is to be a focus if the nation must be sustained food wise. Hence the use of Computer technology to improve the productivity of agricultural products should be the major concern of the nation if the people's standard of living is to be improved. On this the writer is motivated to carry out this piece of work.

### **1.4 SCOPE OF STUDY**

The scope of this project is on the use of Computer programmable BASIC language to write a program that will analyse experimentation on the use of ANOVA to determine the yield of maize plants due to species as well as fertilizer effect on yield too. The data is collected from National Cereals Research Institute Badeggi in Bida of Niger State.

## **CHAPTER TWO**

### **2.0 LITERATURE REVIEW.**

A statistical design is a plan for the collection and analysis of data. It is essential to have a carefully thought out plan for the collection and analysis of data. Where this is not properly done, inferences drawn are likely to be proved wrong.

Data are the fundamentals of statistics and designs are the forerunners of data. The technique of the collection of data and the methodology of their analysis have a great bearing with the reliability of the results arrived at. Therefore, in any statistical enquiry, the problem of collecting and analysing data must be very carefully considered. The selection of an efficient design requires careful planning in advance of data collection and analysis. Thoughtlessness in selection of a design is very likely to make the statistical enquiry entirely useless. A detailed analysis of the actual data involves huge cost and labour and therefore it is imperative that an efficient design must be selected. This can be done only by visualizing the analysis of data obtainable in different plans and keeping in mind their standard error and cost. The design that gives the smallest sampling error is supposed to be best design for a particular investigation.

### **EXPERIMENTAL DESIGNS.**

It was F.A. Fisher who did pioneering work in the area of experimental designs particularly in the field of agricultural research. In 1935 he laid foundation for the subject in his monumental work entitled.

“The Designs of Experiments.” Since then the theory of experimental design has been further developed and its range of application now extends to not only all laboratory sciences, both basic and applied but even to business and social sciences.

Experimental designs concern the arranging of treatments or variables in such a manner that the inferences and conclusions regarding the effects of those treatments can be easily done and their reliability measured. Experiments are made with a view to find the validity of a particular hypothesis and to have an idea about the extent of the reliability that can be placed on a particular conclusion arrived at. If a physician wants to know whether a particular drug which has been invented will be beneficial in the treatment of a particular disease or if a farmer wants to know whether a new type of fertiliser will give him better yields. He will frame his investigation in terms of some suitable hypothesis. After this he will design an experiment to find out whether the hypothesis that he has presumed is correct or whether it is wrong and consequently has to be rejected. The selection of the design will have a very great bearing with the accuracy of the ultimate results. If a wrong design is selected it is quite likely that the conclusion arrived at may be absolutely fallacious. In the course of investigation or experimentation many complications and doubts are bound to arise and unless they are removed the experimental design will not be adequate.

In this project, Randomised Complete Block Design and Latin-Square Design of Standard order shall be used. An appropriate Basic Programmable language that is interactive shall be used.

#### **Definition of Terms.**

1. Experiment: An experiment is an operation designed to discover something unknown or to establish it when discovered.

2. **Design:** Design is concerned with the arrangement of configuration of the independent variables (or factors) in an experimental region so as to achieve the desired objective.
3. **Experimental Design:** It is the study of methods and procedures in experimentation so as to minimize the experimental errors through:
  - i. Suitable device of treatments.
  - ii. Adequate arrangement of experimental materials.
  - iii. Suitable allocation system.
  - iv. Appropriate analytical technique.
  - v. Relevant, valid inferences.
4. **Factor:** Factor is a quality of property according to which the data are classified. Factor could be one or two or more e.g variety of plants and types of fertilizers.
5. **Level of Factor:** Is a category of a factor i.e. various possible values of those factors are levels of the factors.
6. **Treatment:** A particular level or a combination of levels is called treatment.
7. **Experimental Plot (Unit):** This is the smallest unit or portion of the experimental domain that may be combination with a treatment to generate an observation.
8. **Randomisation:** Is the assignment of treatment to experimental Units in a random order such that each treatment has an equal chance of being tested under the most favourable conditions and possible sources of variation may not cause systematic error.
9. **Replication:** Is the repetition of treatment two or more times.

#### **EXPERIMENTATION STEPS.**

The selection of a procedure for research depends, to a large extent, on the subject matter in which the research is being conducted and on the objectives of the research. The

research might be descriptive and involve a sampling survey, or it might involve a controlled experiment or series of experiments. When an experiment is involved there are a number of considerations that should be carefully thought through if it is to be a success. The following are some of the more important steps to be taken.

1. **Definition of the Problem:** The first step in problem solving is to state the problem clearly and concisely. If the problem can not be defined, there is little chance of it ever being solve. With the definition of the problem, questions can be formulated which will lead to solution.
2. **Statement of Objectives:** This .may be in the form of questions to be answered. The hypothesis to be tested, or the effects to be estimated. Objectives should be written out in precise terms, order of importance and should not be vague or too ambiguous.
3. **Selection of treatments.**
4. **Selection of Experimental Material.**
5. **Selection of experimental design.**
6. **Selection of the Units for observation and the number of replications.** i.e deciding on the size and shape of field plots.
7. **Control of the effects of the adjacent units on each other.** This is usually accomplished through the use of border rows and by randomization of treatments.
8. **Consideration of data to be collected.**
9. **Outlining Statistical analysis and Summarization of results.** This involve writing out the sources of variation and associated degrees of freedom in the analysis of variance.
10. **Conducting the experiment.**
11. **Analysing data and interpreting results.**

12. Preparation of a complete, readable and correct report of research.

### **PESTICIDES.**

The term is used very broadly to include

- All Chemical products intended for use in the prevention or control of pests, diseases and weeds in crops.
- All chemical products used to protect harvested products against pests and diseases
- All chemical products used to eradicate material mosquitoes or to rid cattle of ticks

There are hundreds of pesticides. These can be classified in different ways.

method of classification is by type of pest or disease against which it is effective.

Pesticide Group	Effective Against.
Insecticides	Insects
Fungicides	Fungal Diseases (Fungi)
Herbicides	Weeds
Nematicides etc.	Nematodes (earthworm)

Some pesticides are effective only against a specific pest or disease. The effect of many pesticides is less selective, however, and these can kill a variety of animals or plant species. The classification of pesticides according to their degree of hazard to man is according to chemical composition.

### **NITROGEN**

Nitrogen is the first member of group V of periodic Table. The atomic number of nitrogen is 7 and its simplest electronic configuration can be represented as 2, 5. Nitrogen exhibits a covalency of three. It also exhibits a covalency of five. Nitrogen is a great

important in maintaining the fertility of soil. The fertility of soil depends in part on the presence in the soil of certain chemical elements. These elements are potassium, Nitrogen, and Phosphorus, together with traces of iron, sulphur, and others. It is obvious that unless nitrogen is continually supplied to the soil to balance the loss suffered by removal of crops, the fertility of the soil will decrease and its yield become meagre. Nitrogen fertilizers are also used to make good the loss of nitrogen. These fertilizers fall into the following classes.

1. Ammonium tetraoxosulphate (VI) derived from ammonia.
2. Fertilizers produced by manufacture, using the nitrogen of the air.
3. Farmyard manure.
4. Sodium nitrate from the deposits of this substance in Chile - 'Chile Saltpetre'

In this project, we shall investigate the effect of pesticide and various forms of Nitrogenous fertilizer on crop yields. Still in this project, lima bean seedling emerged from 100 seeds planted per plot  $F_0$  and  $F_2$  are 0 and  $22/3$  OZ fungicide/100 lb seed respectively.  $I_0$ ,  $I_1$  and  $I_2$  are 0,  $1/6$ , and  $1/3$  OZ insecticide /100 lb seed, respectively.

The effects of these treatments shall be investigated.

Further analysis shall also be done to investigate the effect of Nitrogen fertilizer on the sugar root yields. They are about five Nitrogenous fertilizers and one control on per acre. The five applied to give 100 lb of Nitrogen per acre and a non fertilized control. The fertilizers are:

- |    |               |   |                   |
|----|---------------|---|-------------------|
| A) | $(NH_4) SO_4$ | - | Ammonium Sulphate |
| B) | $NH_4 NO_3$   | - | Ammonium Nitrate  |
| C) | $Co (NH_2)_2$ | - | Cobalt Ammonia    |
| D) | $Ca (NO_3)_2$ | - | Calcium Nitrate   |
| E) | $Na NO_3$     | - | Sodium Nitrate    |

F) No Nitrogen - Nitrogen Nut Applied.

### **ANALYSIS OF VARIANCE (ANOVA)**

It was R.A. Fisher who introduced the term "Variance" in the analysis of statistical data. Fisher developed an elaborate technique of analysing the variances of two or more series for the purpose of studying their characteristics. Variance is the square of standard deviation of a series and gives an idea about the variability of the values of various items from the mean of the series.

The technique of variance analysis originated in agricultural research where the effect of various types of soils on the output or the effect on the technique of the analysis of variance was found to be extremely useful in all types of researches where the effects of one or two variables on a problem under study had to be determined on the basis of a number of experiments conducted simultaneously. This variance analysis can tell us whether different sample data classified on the basis of single variable are meaningful. It can also provide meaningful comparisons of sample data which have been simultaneously classified on the basis of two variables. The variance analysis studies the significance of the difference in means by analysing variance. The variance will differ only when the means are significantly different.

### **ASSUMPTIONS OF F-TEST**

1. That the Universe from which the samples are drawn follows the properties of standard normal curve or in other words the Universe is normally distributed.
2. That the samples drawn from the Universe are random and independent in each other.
3. That the variance of the population from which sample have been taken do not significantly differ from one another.

## VARIANCE ANALYSIS IN TWO-WAY CLASSIFICATION

(One observation per-cell)

In one-way classification we take into account the effect of only one variable. If there is a two-way classification the effect of two variable can be studied.

The procedure of analysis in a two-way classification is; Total both the columns and rows. The effect of one factor is studied through the column wise figures and totals and of the other through the row-wise figures and totals. The variance is calculated for both the columns and rows and they are compared with the residual variance or error.

TABLE OF ANOVA IN A TWO-WAY CLASSIFICATION

Source of Variation	Sum of square	Degree of freedom	Mean Square	Variation Ration (F-Ratio)
Between Block	$SS_B$	$(C-1)$	$MS_B = \frac{SS_B}{(C-1)}$	$\frac{MS_B}{MSE} = F_b$
Between Treatment	$SS_{tr}$	$(C-1)$	$MS_{tr} = \frac{SS_{tr}}{(r-1)}$	$\frac{MS_{tr}}{MSE} = F_{tr}$
Between Term	$SS_E$	$(C-1)(r-1)$	$MS_E = \frac{SS_E}{(C-1)(r-1)}$	-
TOTAL	$SS_T$	$(N-1)$	-	-

Note that ;  $C = \frac{T^2}{bt}$  is the correction factor

Where

$$SS_B = \frac{\sum T_{.j}^2}{t} - C$$

$$SS_{tr} = \frac{\sum T_{i.}^2}{b} - C$$

$$SS_E = SS_{Total} - SS_B - SS_{tr}$$

$$SS_{Total} = \sum Y_{ij}^2 - C$$

Where.

$SS_B$  = Sum of Squares due to block

$SS_{tr}$  = Sum of Squares due to treatment

$SS_E$  = Sum of Squares due to error

$SS_T$  = Sum of Squares due to total.

$MS_B$  = Mean Square due to block

$MS_{tr}$  = Mean Square due to treatment

$MS_E$  = Mean Square due to error.

The Model is given by:

$$Y_{ij} = U + T_i + \beta_j + e_{ij}.$$

Where:  $i = 1, 2, \dots, t$

$j = 1, 2, \dots, b$

Where;  $\beta_j$  represents the block effect

$T_i$  represents the treatment effect

$e_{ij}$  represents the Random error term

$Y_{ij}$  represents effect due to treatment  $i$  in block  $j$ .

The models Assumptions are:

i)  $e_{ij}$ 's are independently  $N(O, \delta_e^2)$

ii)  $T_i$ 's are independently  $N(O, \delta_t^2)$

iii)  $\beta_j$ 's are independently  $N(O, \delta_b^2)$

### HYPOTHESES

#### Case I:

$$H_0 : t_1 = t_2 = t_3 \text{ ----- } = t_i = 0$$

i.e (No treatment effect)

$$H_1 : t_i \neq 0 \text{ for at least one value of } i$$

(There is treatment effect at least for one)

At  $\alpha$  level of significance.

Decision Rule:

Reject  $H_0$  if  $F(\text{Treatment}) \geq F_{1-\alpha}(t-1, (t-1)(b-1))$

Otherwise do not reject  $H_0$ , and conclude accordingly.

#### Case II.

$$H_0 : b_1 = b_2 = b_3 \text{ ----- } = b_j = 0$$

i.e (No block effect)

$$H_1 : b_j \neq 0 \text{ for at least one value of } j$$

(There is block effect)

At  $\alpha$  level of significance.

Decision Rule:

Reject  $H_0$  if  $F(\text{Block}) > F_{1-\alpha} (b-1) (t-1) (b-1)$

Otherwise do not reject  $H_0$ ; and conclude accordingly.

### **LATIN SQUARE DESIGNS.**

A Latin Square of size  $P$  or a  $P \times P$  Latin Square is an arrangement of  $P$  letters each repeated  $P$  times in a Square array of size  $P$  in such a way that each letter appears exactly once in each row and in each column. Further definition of Latin Square design states that it is an  $M \times M$  Square arrangement of  $M$  treatments denoted by Latin letters A, B, C, ----- Z in  $M^2$  Plots such that each treatment occurs in each row once and in each column once.

Latin-Square design provides a means of investigating the effect of three factors at the same period, there are no interactions between the factors or the interaction is assumed to be negligible compared to the main effect, it is also called a three dimensional design. The rows and the columns constitute a factor each while the treatment constitutes the third factor. We have standard and non-standard Latin-Square design. A standard Latin Square is one in which the first row and the first column consist of letters written in an alphabetical order while non-standard are not written in an alphabetical order. In Latin Square, hypothesis on the significant effect on row, column and treatment (letter) are investigated.

### **THE LATIN-SQUARE MODEL.**

The model is given by:

$$Y_{ijk} = U + \alpha_i + T_j + B_k + e_{ijk}.$$

$$\text{Where } 1 \leq ijk \leq P$$

Where:

$Y_{ijk}$  is the obstruction in the  $j^{\text{th}}$  row,  $j^{\text{th}}$  column of the  $k^{\text{th}}$  treatment.

$U$  is a constant i.e overall mean.

## CHAPTER FIVE

### SYSTEM MAINTENANCE

#### 5.1 System Maintenance

The changing in operational conditions of the software is termed as system maintenance. Many reasons could be responsible for this. In the case of the Poverty Alleviation Programme, changes abound because the Programme itself is a new one which will undergo series of amendments that shall ultimately affects the Programme and the participants of the scheme until the Government is satisfied.

Finally, the chapter, advice on regular conduct of post-implementation review so that alteration to the software would be legitimately acceptable.

#### 5.2 Summary

The Poverty Alleviation Programme is a scheme conceived by the present Administration to alleviate the suffering of the masses by providing jobs for about 200, 000 Nigerians. Various programme activities ranging from potholes patching on highways, environmental sanitation, afforestation, vegetation control to maintenance of public buildings; including cleaning of hospitals and schools have been identified as the areas to mop up some of the unemployed in different parts of the country.

For government to measure the effect of this programme on tackling poverty that emanates from high unemployment in recent years, a viable database for the Programme was considered fit. Thus, proper documentation, processing, and storage or retrieval of data on the scheme can be conveniently done. With the database therefore, measurement indices like bio-data, employment profile, human resource utilisation, fall out rate, period on employment, etc can be determined.

This researcher therefore, as one of the officers in the Programme decide to put the activities of the scheme on computer, at least to demonstrate the typical database system that fit and which simultaneously, can make the implementation of the scheme smooth. Different reports were produced which in the minds of the researcher fits requirement of the scheme.

The involvement of co-officers and clerks from the beginning to the final implementation of the system arose their interest in the database system.

## Case I

Hypothesis:

$$H_0 : T_1 = T_2 = T_3 = T_4 = T_5 = T_6 = 0$$

$$H_1 : T_i \neq 0 \text{ for at least one } i^{\text{th}}$$

$$\alpha = 0.05$$

Decision Rule: Reject  $H_0$  if F-Ration treatment is greater than  $F^{1-\alpha} (6-1), (6-1) (6-1) = 4.56$

## Case II

Analysis to evaluate column (Block) arrangement effect of fungicide and insecticide/100 lb of lima bean seedling.

Hypothesis

$$H_0: \beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = 0$$

$$H_1: \beta_j \neq 0 \text{ for at least one } j^{\text{th}}$$

$$\alpha = 0.05$$

Decision Rule: Reject  $H_0$  if F- Ratio Block is greater than  $F^{1-\alpha} (5-1), (6-1)(5-1) = 5.80$

**SYSTEM DESIGN**

When a system has been analysed and the problem has been defined and approved by the management. The question that arises is where to commence the design of alternatives to the current system. The following techniques give a logical sequence in which to design the various elements of an alternative system.

The sequence of activities to be performed in designing a new system is as follows:

1. Look at the Objective of the new system.
2. Review all constraints for the proposed system.
3. Design the outputs that will be produced under the new system.
4. Design the processing steps that will be needed to produce the desired output e.g system flow chart.

5. Design the necessary input.
6. Incorporate necessary controls.
7. Design feedback procedures
8. Prepare a plan to install the new system if management approves the design.
9. Prepare cost analysis to show management in quantitative rather than qualitative terms, the benefits that can accrue from implementation of the proposed system

#### **NEW SYSTEM DESIGN CRITERIA.**

1. Volume: The proposed system is designed to handle large amount of data for evaluation.
2. Simplicity: The system though designed to handle complete operations of computation or evaluation should be simple to use.
3. Feasibility: This system can operate in a dynamic rather than static environment.
4. Security: The security of a system should be taken into consideration, such that the output reports are provided only to the authorised users.
5. Efficiency: The system should be designed to be of high efficiency ensuring the best output of the desired evaluation.
6. Users friendly: The system should be designed in such a way that it simply gives the operators a choice of different transaction for implementation

#### **INPUT DESIGN**

Input design is one of the items of elements of design. In designing a system, the type of input media, data collection methods, volume of input documents and design of input layouts. The designer must decide what files is needed to retain data for producing desired reports e.g. (cart files, disk files tape files etc.)

**Input Specification**

In designing a new system the input specification requires the following:

- a. Yields of sugar roots according to cell in tones due to fertilizers.
- b. Yields of lima bean seedling according to cell due to fungicide and insecticide applied.

**OUTPUT DESIGN**

This aspect of design work compels or requires the analyst to work very closely with the users or those that needed the output. Output design is established as a final check on the accuracy of the processed data.

In design outputs the time that the reported and the authorized users of the report and the objective of the analysis should be considered.

**OUTPUT SPECIFICATION:**

The output expected from the new system are:-

- a) F-ratio for Treatment effect for Latin Square Design
- b) F-ratio for Row effect for Latin Square Design
- c) F-ratio for Column effect for Latin Square Design
- d) F-ratio for treatment effect for Complete Randomised Block Design
- e) F-ratio for Column (Block) effect for Complete Randomised Block Design

Data control: Data control refers to as the exercise of cross checking measures to regulate a system so that it produce the design output or result. Data control ensures correct necessary data evaluation or processing.

**COST BENEFIT ANALYSIS**

A cost benefit analysis is necessary to determine economic feasibility. The primary objective of cost benefit analysis is to find out whether it is economically worthwhile to invest in the project.

Some of the elements of cost, which must be considered by a management cost accountant, include;

- a) Equipment cost (capital/leasing costs of computer and the peripheral devices)
- b) Installation cost (new building where there is non or if necessary i.e computer room)
- c) Development cost (software consultancy change over costs)
- d) Personnel costs (staff training, staff recruitment, relocation, staff salaries, allowance and pensions were needed. Redundancy payment, overheads.
- e) Operating cost
  - Consumable material (tape, cards, disk, stationeries)
  - Maintenance cost
  - Insurance/power/telephone cost
  - Standing by arrangements
  - Comprehensive cost of alternative method

The benefits for such projects are based on the problems that the analysis are to solve or aims to achieve in terms of monetary gain, profit maximization, cost minimization, time saved risk reduced complex problem simplified, task in manual methods of analysis overcome e.t.c

For the interest of this project, the following skeletal possible cost implications and benefits are stated.

- 1 CTX Branded computer system model V.L 400 ~~N~~65,000.00
- 2 Laser Jet Printer 1100, model C422A (Unit cost) ~~N~~50,000.00
- 3 Nulec (1600 AV) Stabilizer – ~~N~~6,000.00
- 4 Uninterrupted Power Supply (U.P.S) – ~~N~~18,000.00

Model, BK 650H APC

5. Air conditioner (Thermocool)- ~~N~~45, 000.00
6. Extension cables (with fuse)-N35,000.00
7. Installation cost per one PC-N3,500.00
8. Well carpeted computer room of 22ft by 15fts with furniture
9. Office accommodation of the staff with furniture and a protected room for back up.
10. Operation (running) cost including well connected telephone cable, power supply, stationeries etc.
11. Personnel cost: This is based on the management negotiation or governmental policy on salaries and allowances. The following staff may be required,
  - Management Service Director
  - Data Processing Manager.
  - Operation Manager
  - Programming Manager
  - System Analysis and Design Manager
  - Computer Operator
  - System Programmer
  - System Analyst
  - Data Input Clerk
  - Maintenance Technician

The management may decide to send some of the old staff for training on the use of computer, development of software package and analysis so as to minimize personnel cost

Benefits;

In an agricultural research institute, the sole objects of the organisation is to discover the best chemicals (fertilizers) or method of farming that can be applied to yield the

maximum output and control weeds and pest. Over the years millions of money are lost on trials and error method, just to verify the best fertilizer that fits a crop and by weeds and pest.

But with this analysis it is believed that maximum yield which will lead to mass production of form product for the nation will be achieved.

Good technical advise will be given to minor formers or others who are in farm industry on the use of chemicals.

Complex jobs in the organisation that have been taking weeks and months to solve can be solved in few hours as it is believed that time is money

## **CHAPTER FOUR**

### **SOFTWARE DEVELOPMENT AND IMPLEMENTATION.**

#### **4.1 ALGORITHM REPRESENTATION**

##### **INTRODUCTION:**

System development and implementation is majorly concerned with all activities to be done when converting an old system or current system to new system.

System Development involves designing of the new system based on based on the outcome of the analysis and the recommendation made during the analysis. It also has to do with writing of the program and testing the program to ensure their correctness or functionality. In this case an analysed data from an old system is used for the new system. Good system development and implementation is essential to provide reliable system so as to meet the organisational goal.

#### **4.2 ALGORITHM AND PROGRAMMING LANGUAGE.**

##### **4.2.1 ALGORITHM.**

The word algorithm was derived from the name AL-Khowarizmu who authored an algebra text in the nine century. However, more precisely the word was a refashioning of an earlier word algorithm which was used for several years to refer to arithmetic procedure like long division. With the advent of computer, the term algorithm have got a new leaf since every computer program is written or is an algorithm.

An algorithm is a procedure for solving a problem in a finite number of steps. It can also be defined as a finite set or sequence of instructions or operators for coming out of a specific task or solving a problem. On the other hand, a program is an algorithm specifically expresses in a high language capable of execution by a computer. Generally algorithm are expressed in PSEUDOCODE not suitable for execution by computer.

#### 4.2.2 CHARACTERISTICS OF VALID ALGORITHMS

- a) Precision:-Algorithm steps should be void of assumption or should not be vague.
- b) Effectiveness or Efficiency: This means that the execution of an impossible task should be avoided in the algorithm.
- c) Finiteness: There must be an exact number of instructions in an algorithm
- d) Termination: There should be a stopping criterion to terminate an algorithm especially in a case of an instruction with repeated execution.
- e) Output:-An algorithm should provide an output of implementation.

In general, algorithm can be represented by any of the following forms:

1. Pseudocode (Structured English)
2. Flow charts
3. Nassi-Shneidermum structures flow (NSSF) diagrams.
4. English language.
5. Formulae
6. Decision trees
7. Wernier-on diagrams.

But for the purpose of this project, the forms of the algorithm that are used are;

- 1 Formulae
- 2 English language (structured)
- 3 Flow charts

#### 4.2.3 PROGRAMMING LANGUAGE:

The language that is being used for this project is BASIC (Beginners All-purpose Symbolic Instruction Code). It is a high level language designed for people with out prior programming experience. It is widely used in programming experience. It is widely used in

programming scientific, mathematical and many business problems. One good advantages running the computer in an interactive mode. Another vital characteristics of BASIC is its availability on all Disk Operating System (DOS).

### ALGORITHMS

For Latin square Design Analysis

$$Y_{ijk} = U + \alpha_i + J_j + B_k + C_{ijk}$$

$$1 \leq i, j, k \leq P$$

$$i = 1 \text{ to } P$$

$$j = 1 \text{ to } P$$

$$k = 1 \text{ to } P$$

$$C = (\sum Y_{...}^2) / P^2$$

$$C_i = (\sum Y_{i..}^2) / P$$

$$C_j = (\sum Y_{.j.}^2) / P$$

$$C_k = (\sum Y_{.k.}^2) / P$$

$$C_{yk} = (\sum \sum Y_{ijk.}^2) / P$$

$$S_{stotal} = C_{ijk} - C$$

$$S_{streatment} = C_i - C$$

$$S_{Scolumn} = C_k - C$$

$$S_{S_{Error}} = S_{S_{Total}} - S_{S_{treatment}} - S_{S_{row}} - S_{S_{column}}$$

$$M_{S_{treatment}} = S_{S_{treatment}} / (P-1)$$

$$M_{S_{row}} = S_{S_{row}} / (P-1)$$

$$M_{S_{column}} = S_{S_{column}} / (P-1)$$

$$M_{S_{Error}} = S_{S_{Error}} / ((P-2) * (P-1))$$

$$F_t - \text{Ratio} = M_{S_{treatment}} / M_{S_{Error}}$$

$$F_R - \text{Ratio} = MS_{\text{row}}/MS_{\text{Error}}$$

$$F_c - \text{Ratio} = MS_{\text{column}}/MS_{\text{Error}}$$

### ALGORITHM FOR COMPLETE RANDOMISED BLOCK DESIGN ANALYSIS

$$Y_{ijk} = U + \alpha_i + J_j + B_k + C_{ijk}$$

$$i = 1 \text{ to } t$$

$$j = 1 \text{ to } b$$

$$SS_{\text{total}} = (\sum \sum Y_{ij}^2) - ((y_{..}^2)/(t*b))$$

$$SS_{\text{treatment}} = ((\sum Y_{i.}^2)/b) - ((Y_{..}^2)/(t*b))$$

$$SS_{\text{Block}} = ((\sum \sum Y_{ij}^2) - ((y_{..}^2)/(t*b)))$$

$$SS_{\text{error}} = SS_{\text{total}} - SS_{\text{treatment}} - SS_{\text{BLOCK}}$$

$$MS_{\text{treatment}} = SS_{\text{treatment}}/t-1$$

$$MS_{\text{block}} = SS_{\text{block}}/b-1$$

$$MS_{\text{error}} = SS_{\text{error}}/(t-1)*(b-1)$$

$$F_t - \text{Ratio} = MS_{\text{Treatment}}/MS_{\text{Error}}$$

$$F_b - \text{Ratio} = MS_{\text{Block}}/MS_{\text{Error}}$$

### PSEUDOCODE (STRUCTURE)

Main Programme

1. Declare sub for Latin square
2. Declare sub for randomized complete block
3. Declare function to sum columns
4. Enter the do of column and nut of rows of the array to be used.
5. Dimension the array
6. Design a menu
7. Select case menu option.

Case 1

Call Sub Latin square.

Case 2

Call sub randomised complete block

Case 3.

Exit the program

End select.

9 End Program.

Sub Latin Square

1. Dimension arrays of summing rows, columns and letters.
2. Implement an error trap to check if conditions for latin square analysis are satisfied
3. Enter the values to be used in the analysis.
4. Sum each group of letters
5. Sum each column
6. Sum each row
7. Carry out the analysis using values obtained (4) (5) and (6) above
8. End sub

Sub Randomized complete Block Design.

1. Dimension arrays for summing columns and rows
2. Enter the values to be used in the analysis
3. Call function sum rows
4. Call function sum columns
5. Carry out the analysis using values obtained from (3) and (4) above
6. End sub

#### Function Sum Column

1. Initialise a variable to store the sum
2. Dimension array for the sum
3. Add the values
4. Assign final value to sum column
5. End function.

#### Function Sum Row.

1. Initialise variable to store sum
2. Dimension array for the sum
3. Add the values
4. Assign values to sum row
5. End function.

### **4.4 CHANGE OVER**

This simply means conversion from the old system to new system. There are four ways of conversion or change over. They are direct, parallel running, pilot running and staged change over.

1. Direct: This simply means processing current data by both old and new at a go. It is carried out when every one concerned had confidence in the new system. This method is relatively least expensive but must risky. However, for security reasons, the old system may be held including people and equipment, for reason of failure of the new system.
2. Parallel Running: This means processing data by both the old and new system to cross check the results. Its main attraction is that the old system is kept alive and operational until the new system has been proved for at least one system cycle. It allows the result of the new system to be compared with the old system before acceptance by the user for confidence sake.

system is producing the result needed. Inability of the system to achieve any of those objectives may raise doubt on the workability of the system.

## CHAPTER FIVE

### OBSERVATION CONCLUSION AND RECOMMENDATION

#### 5.1 OBSERVATION

This project being developed to improve the manual system of statistical evaluation on "analysis of variance" on the yields of sugar roots and beans is said to have shown the importance of computerised system in system analysis. It has not only shown the saving of time too but accuracy and more efficiency in system analysis with computer.

In the analysis for sugar root yield to evaluate Nitrogen effect, it was discovered that F-Ratio for Nitrogen column effect column and row effect showed 15.72, 1.41 and 2.72 respectively. When compared with the  $F^{1-\alpha} V_2 V_1$  from statistical which showed 2.71, we discovered that  $H_0$  is rejected for treatment and row effect; meaning that the presence of Nitrogen has great positive effect on the yield of sugar root and the row arrangement has positive contribution too. However being that 1.41 for column effect is less than 2.71 from table, that means that  $H_0$  is accepted indicating no significant change base on column.

In the case on beans, the F-ratio for treatment and block showed 46.58 and 2.60 respectively. Comparing them with  $F^{1-\alpha} V_2 V_1$  from table which gave 4.56 and 5.80 for both treatment and block. We reject  $H_0$  for treatment, which means that the application of fungicide, insecticide on time seedling has significant effect on the yield of the seed. While for that of block we do not reject  $H_0$  and conclude that the block or column arrangement has no significant effect on the yields.

#### 5.2 CONCLUSION

The computerized system of evaluating the effect of Nitrogen, insecticide and fungicide to evaluate significant changes in crop yield has clearly shown the wide range of advantages of computerized system over manual system. Therefore the need for computerized method of

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**APPENDIX**STANDARD LATIN SQUARE EXPERIMENTAL LAYOUT FOR SUGAR ROOT  
YIELDS

COLUMN						
Row	I	II	III	IV	V	VI
I	A=32.1	B=33.1	C=32.4	D=29.1	E=31.1	F=28.2
II	B=29.5	C=29.4	D=33.0	E=31.0	F=24.8	A=30.6
III	C=30.8	D=30.6	E=28.8	F=21.7	A=31.9	B=30.1
IV	D=31.4	E=31.9	F=26.7	A=30.4	B=28.8	C=33.1
V	E=30.3	F=25.8	A=30.3	B=29.9	C=33.5	D=32.3
VI	F=21.4	A=30.8	B=30.7	C=29.7	D=27.4	E=29.1

Standard Latin Square Experimental Design for Sugar root yields in tons.

**Treatments**

A=  $(\text{NH}_4)_2 \text{SO}_4$

B=  $\text{NH}_4 \text{NO}_3$

C=  $\text{Co} (\text{NH}_2)_2$

D=  $\text{Ca} (\text{NO}_3)$

E=  $\text{Na} \text{NO}_3$

F= Na Nitrogen

3. Pilot Running: This is similar to parallel running in a way. Under this method, data from one or more previous periods is ran on the new system after results have been obtained from the old system and the new results are compared with the old.
4. Staged Change Over: This involves constrained direct change over method. Here the new system is introduced piece by piece. A part or section is run using the new system while the remaining parts or selections are processed by the old system. Only when the selected part is operating successfully then the remaining is transferred. This method reduces the risk involved in direct system. But it has the disadvantages of delay in the implementation period.

#### **4.5 INSTALLATION**

In system installation, some tools are necessary in assessing the quality of a new system.

1. Test for code and Specification: This is to examine what the program should do and how it should do it in line with the result obtained.
2. Verification Test: By executing the software in a simulated environment, that is using some assumptions, testing a data for error finding.
3. Validation Test: This means the process of using a software in a live environment for the purpose of sporting error.
4. Certification Test: Software endorsement for correctness.

#### **4.6 POST IMPLEMENTATION REVIEW.**

After the system is implemented and conversion is completed, a review of the system is usually conducted by users and the analyst. This is a formal process to determine how well the system is working, how it has been accepted and if any adjustment is needed.

The most fundamental thing in post implementation review is to determine whether the system has met its objectives, if the performance level of the users has improved and if the

\*\*\*\*\*PROGRAM LISTING\*\*\*\*\*

Program to perform Analysis of variance

\*\*\*\*\*Main Program.bas\*\*\*\*\*

```
DECLARE SUB LatinSquare (t, b)
DECLARE SUB RandCompBlk (t, b)
DECLARE FUNCTION SumRow (t, b)
DECLARE FUNCTION SumCol (t, b)
```

```
PRINT "Enter the no of treatments = ", t
PRINT "Enter the no of blocks = ", b
IF t (<= 1) OR (b (<= 1) THEN
```

```
GO TO 100
```

```
IF
```

```
ON BASE 1
```

```
SHARED anova(t, b)
```

```
SHARED sumr(1 TO t), sumc(1 TO b)
```

```
PRINT : PRINT
```

```
PRINT "Press Any Key To Continue"
```

```
KEY$ = INPUT$(1)
```

```
OR (3)
```

```
DATE 3, 5
```

```
PRINT "***** MAIN MENU *****"
```

```
DATE 5, 15
```

```
PRINT "[ 1.] LATIN SQUARE "
```

```
DATE 7, 15
```

```
PRINT "[ 2.] RANDOMIZED COMPLETE BLOCK "
```

```
DATE 9, 15
```

```
PRINT "[ 3.] EXIT "
```

```
PRINT : PRINT
```

```
PRINT "SELECT MENU ITEM :- ", opt
```

```
SELECT CASE opt
```

```
1
```

```
LatinSquare t, b
```

```
2
```

```
RandCompBlk t, b
```

```
3
```

```
LS
```

```
DATE 20, 5
```

```
PRINT "PRESS ANY KEY TO QUIT"
```

```
KEY$ = INPUT$(1)
```

```
LS
```

```
SELECT
```

```
:
```

\*\*\*\*\*LATIN SQUARE\*\*\*\*\*

```
B LatinSquare (p, b)
M sum1(p)
A RED anova, sumr, sumc
  (p <> b) OR (p <= 2) THEN
LS
LOCATE 12, 10: COLOR (5)
PRINT "      !!!! ERROR !!!!"
LOCATE 13, 10: PRINT "      treatment and block must"
LOCATE 14, 10: PRINT "      be equal for latin square"
LOCATE 15, 10: PRINT "analysis andvalue must be more than two ";
EXIT SUB
END IF
sum = 0
FOR i = 1 TO p
  FOR j = 1 TO b
    tot = i + j
    INPUT anova(i, j)
    IF (tot <= (p + 1)) AND (i = 1) THEN
      sum1(j) = sum1(j) + anova(i, j)
    ELSEIF (tot <= (p + 1)) AND (i <> 1) THEN
      sum1(tot - 1) = sum1(tot - 1) + anova(i, j)
    ELSE
      sum1(tot - (p + 1)) = sum1(tot - (p + 1)) + anova(i, j)
    END IF
    sumr(i) = sumr(i) + SumRow(i, j)
    sumc(j) = sumc(j) + SumCol(i, j)
    gsum = gsum + (anova(i, j) ^ 2)
  NEXT j
NEXT i
sumtrow = 0: sumtcol = 0: sumstotal = 0: sumtlet = 0
FOR i = 1 TO p
  sumtrow = sumtrow + (sumr(i) ^ 2)
  sumstotal = sumstotal + sumr(i)
  sumtcol = sumtcol + (sumc(i) ^ 2)
  sumtlet = sumtlet + (sum1(i) ^ 2)
NEXT i
diff = (sumstotal ^ 2) / (p ^ 2)
SSTotal = gsum - diff
SSTreat = (sumtlet / p) - diff
SSCol = (sumtcol / p) - diff
SSRow = (sumtrow / p) - diff
SSError = SSTotal - SSTreat - SSCol - SSRow
MVAITreat = SSTreat / (p - 1)
MVAICol = SSCol / (p - 1)
MVAIRow = SSRow / (p - 1)
MvalError = SSError / ((p - 2) * (p - 1))
FRTreat = MVAITreat / MvalError
FRCol = MVAICol / MvalError
FRRow = MVAIRow / MvalError
PRINT "Col total ="; sumtcol, "Letter total ="; sumtlet, "Row total ="; su
  "Grand total ="; sumstotal
PRINT "SSTREAT ="; SSTreat, "SSROW ="; SSRow, "SSCOL ="; SSCol, "SSTOTAL =
  total, "SSERROR ="; SSError
PRINT "MEANVALTREAT ="; MVAITreat, "MEANVALROW = "; MVAIRow, " MEANVALCOL
  VALCol, " MEANVALERR = "; MvalError
PRINT "F-RATIO TREAT ="; FRTreat, "F-RATIO COL ="; FRCol, "F-RATIO ROW =";
PRINT "Press any key to continue"
a$ = INPUT$(1)
END SUB
```

RANDOMISED COMPLETE BLOCK EXPERIMENTAL LAYOUT FOR LIMA BEAN  
SEEDLINGS

BLOCKS

Treatment	I	II	III	IV	V
F <sub>0</sub> I <sub>0</sub>	55	69	71	78	68
F <sub>0</sub> I <sub>1</sub>	65	47	55	64	59
F <sub>0</sub> I <sub>2</sub>	47	37	58	48	54
F <sub>2</sub> I <sub>0</sub>	91	76	92	92	95
F <sub>2</sub> I <sub>1</sub>	85	93	97	88	96
F <sub>2</sub> I <sub>2</sub>	84	94	94	96	92

Randomized Complete Block Experimental Design for Lima Bean Seedlings.

RandCompBlk (t, b)

RED anova, sumr, sumc

n = 0

DO i = 1 TO t

DO j = 1 TO b

PUT anova(i, j)

sum = gsum + (anova(i, j) ^ 2)

sumr(i) = sumr(i) + SumRow(i, j)

sumc(j) = sumc(j) + SumCol(i, j)

KT j

TI i

sumrow = 0

sumcol = 0

sumtotal = 0

DO i = 1 TO t

sumtrow = sumtrow + (sumr(i) ^ 2)

sumtotal = sumtotal + sumr(i)

TI i

DO i = 1 TO b

sumtcol = sumtcol + (sumc(i) ^ 2)

TI i

diff = ((sumtotal ^ 2) / (t \* b))

total = gsum - diff

sumtreat = (sumtrow / b) - diff

sumblock = (sumtcol / t) - diff

error = SStotal - SSTreat - SSBLOCK

MVAltreat = SSTreat / (t - 1)

MValblock = SSBLOCK / (b - 1)

MValerror = SSError / ((t - 1) \* (b - 1))

Ftreat = MValtreat / MValerror

Fblock = MValblock / MValerror

PRINT "Col total ="; sumtcol; "Row total ="; sumtrow; "Grand total ="; sumst

PRINT "SSTREAT ="; SSTreat; "SSVBLOCK ="; SSBLOCK; "SSTOTAL ="; SStotal; "SS

="; SSError

PRINT "MEANVALTREAT ="; MValtreat; "MEANVALBLOCK = "; MValblock; " MEANVALER

; MValerror

PRINT "F-RATIO TREAT ="; FRTreat; "F-RATIO BLOCK ="; FRBlock

END SUB

```
*****SUM COLUMN*****  
FUNCTION SumCol (i, j)  
  sumc = 0  
  FOR anova, sumc  
    sumc = tsumc + anova(i, j)  
  Col = tsumc  
FUNCTION
```

```
*****SUM ROW*****  
FUNCTION SumRow (i, j)  
  sumr = 0  
  FOR anova, sumr  
    sumr = tsumr + anova(i, j)  
  Row = tsumr  
FUNCTION
```

\*\*\*\*\*OUTPUT LISTING\*\*\*\*\*  
\*LATIN SQUARE

Enter the no of treatments = 6  
Enter the no of blocks = 6

Press Any Key To Continue

\*\*\*\*\* MAIN MENU \*\*\*\*\*

- [ 1.] LATIN SQUARE
- [ 2.] RANDOMIZED COMPLETE BLOCK
- [ 3.] EXIT

SELECT MENU ITEM :- 1

33.1  
32.4  
29.1  
31.1  
28.2  
29.5  
29.4  
33.0  
31.0  
24.3  
30.6  
30.8  
30.6  
28.8  
21.7  
31.9  
30.1  
31.4  
31.9  
26.7  
30.4  
28.8  
33.1  
30.3

? 30.4  
? 28.8  
? 33.1  
? 30.3  
? 25.8  
? 30.3  
? 29.9  
? 33.5  
? 32.3  
? 21.4  
? 30.8  
? 30.7  
? 29.7  
? 27.4  
? 29.1

Col total = 191523.5

Grand total = 1071.7

SS TREAT = 185.7669

SS TOTAL = 281.8809

MEANVAL TREAT = 37.15339

MEANVAL ERR = 2.302728

F-RATIO TREAT = 15.72478

Press any key to continue

Letter total = 192538.1

SS ROW = 32.19141

SS ERROR = 47.25456

MEANVAL ROW = 6.438281

F-RATIO COL = 1.410909

Row total = 19161

SS COL = 16.66797

MEANVAL COL = 3.

F-RATIO ROW = 2.7

' RANDOM COMPLETE BLOCK

Enter the no of treatments = 6

Enter the no of blocks = 5

Press Any Key To Continue

\*\*\*\*\* MAIN MENU \*\*\*\*\*

[ 1.] LATIN SQUARE

[ 2.] RANDOMIZED COMPLETE BLOCK

[ 3.] EXIT

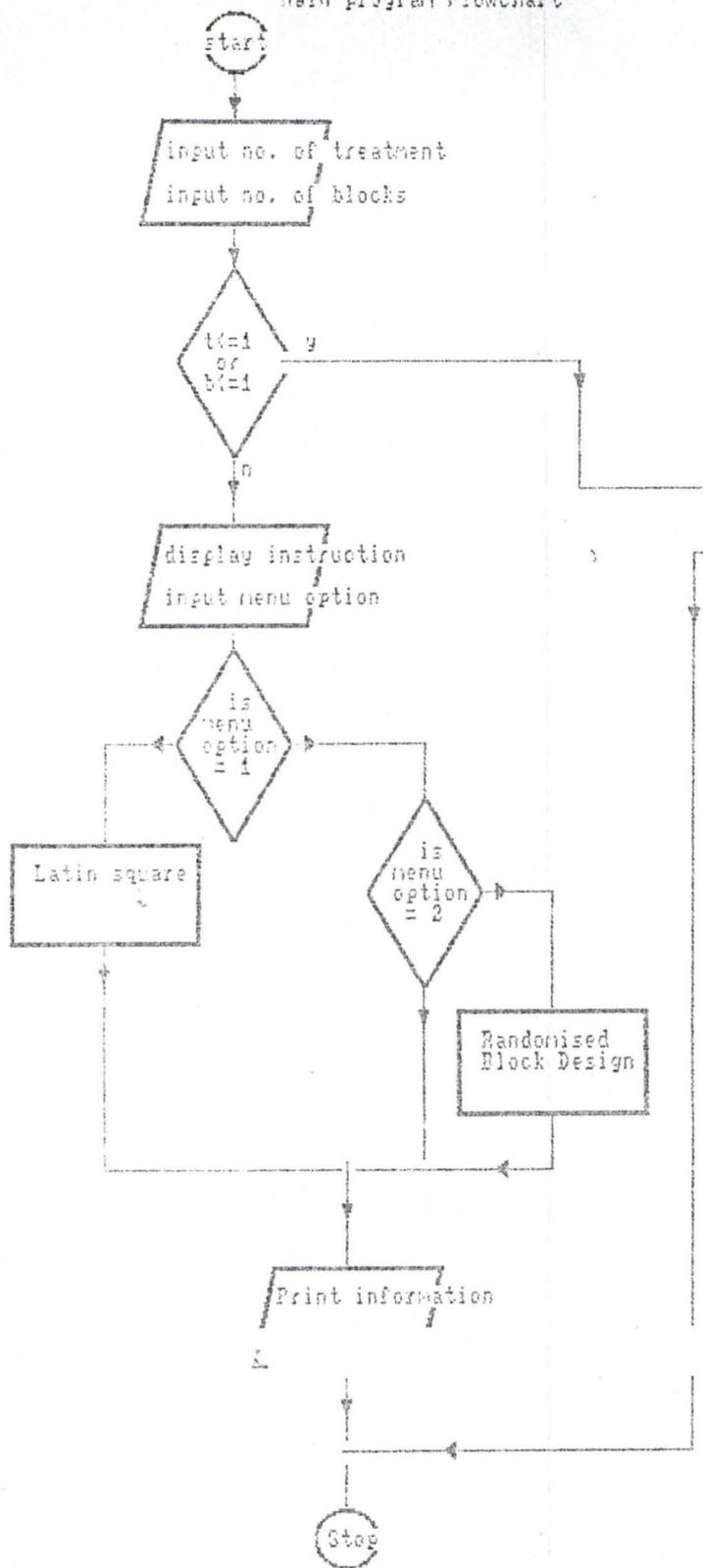
SELECT MENU ITEM :- 2

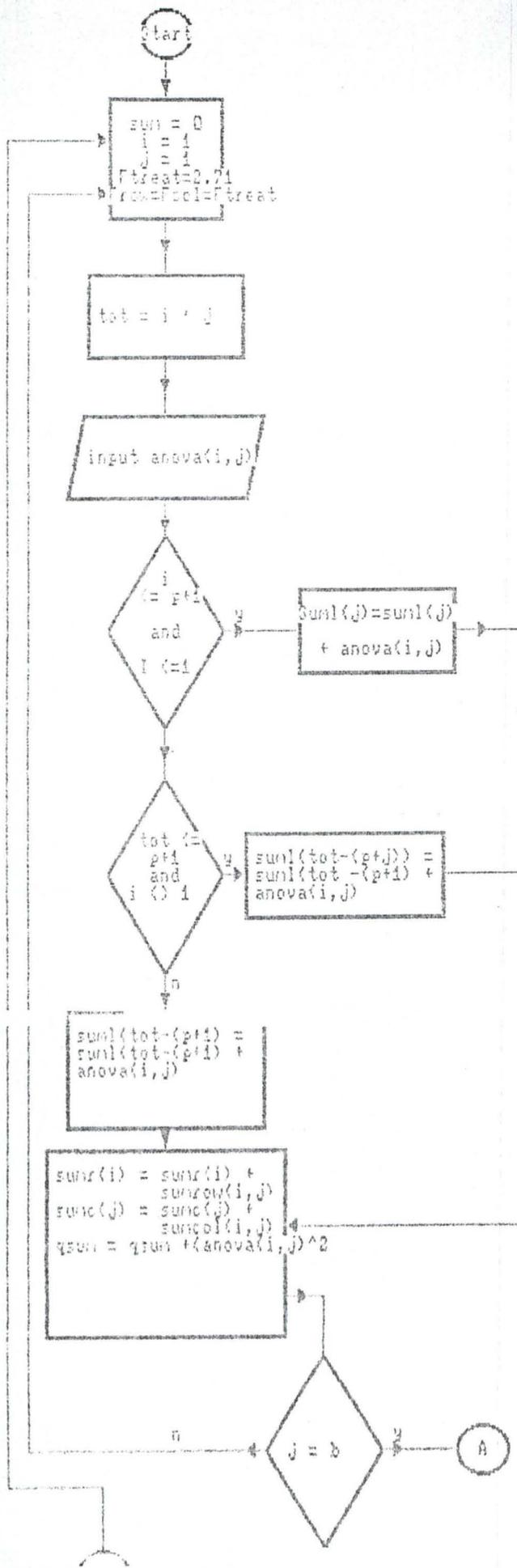
? 55  
? 69  
? 71  
? 78  
? 68  
? 65  
? 47  
? 55  
? 64  
? 59

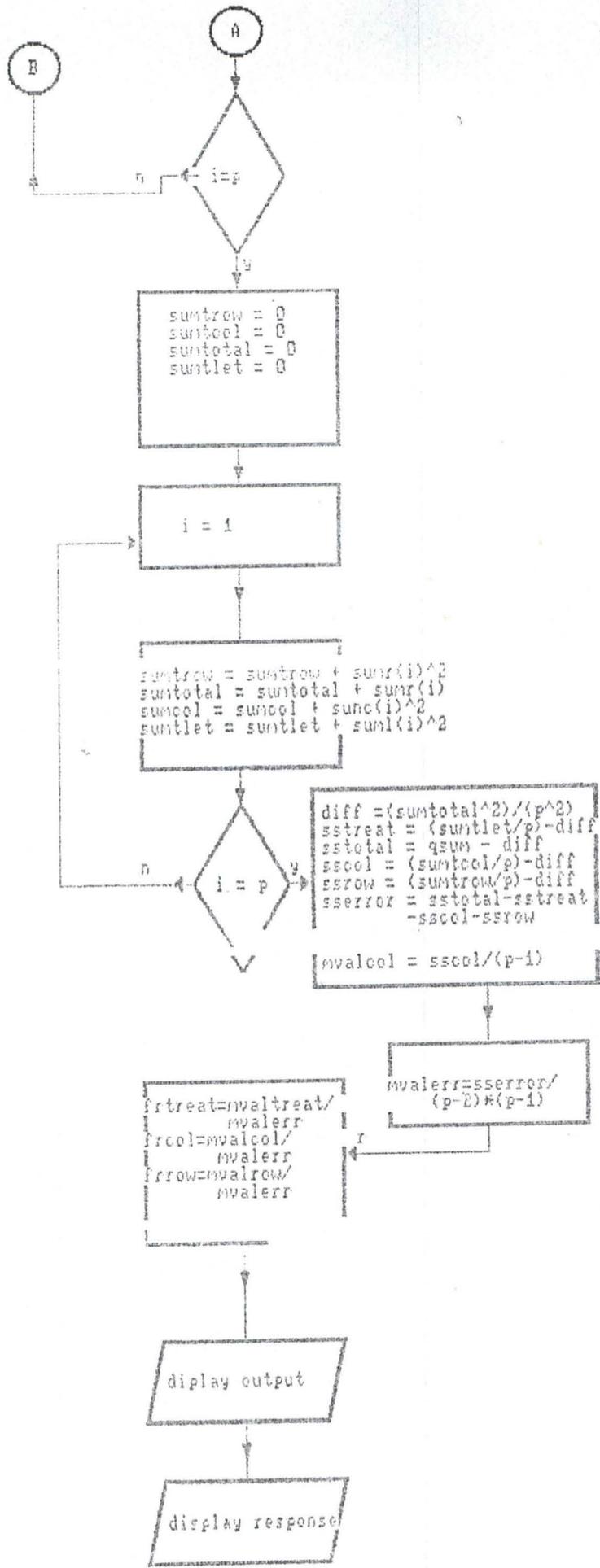
? 37  
? 58  
? 48  
? 54  
? 91  
? 76  
? 92  
? 92  
? 95  
? 85  
? 93  
? 97  
? 88  
? 96  
? 84  
? 94  
? 94  
? 96  
? 92

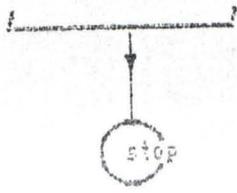
Col total = 1005926 Row total = 881114 Grand total = 2240  
SSTREAT = 8969.472 SSVBLOCK = 401.0052 SSTOTAL = 10140.67 SSERROR = 77  
MEANVALTREAT = 1793.894 MEANVALBLOCK = 100.2513 MEANVALERR = 38.509  
F-RATIO TREAT = 46.58206 F-RATIO BLOCK = 2.603271

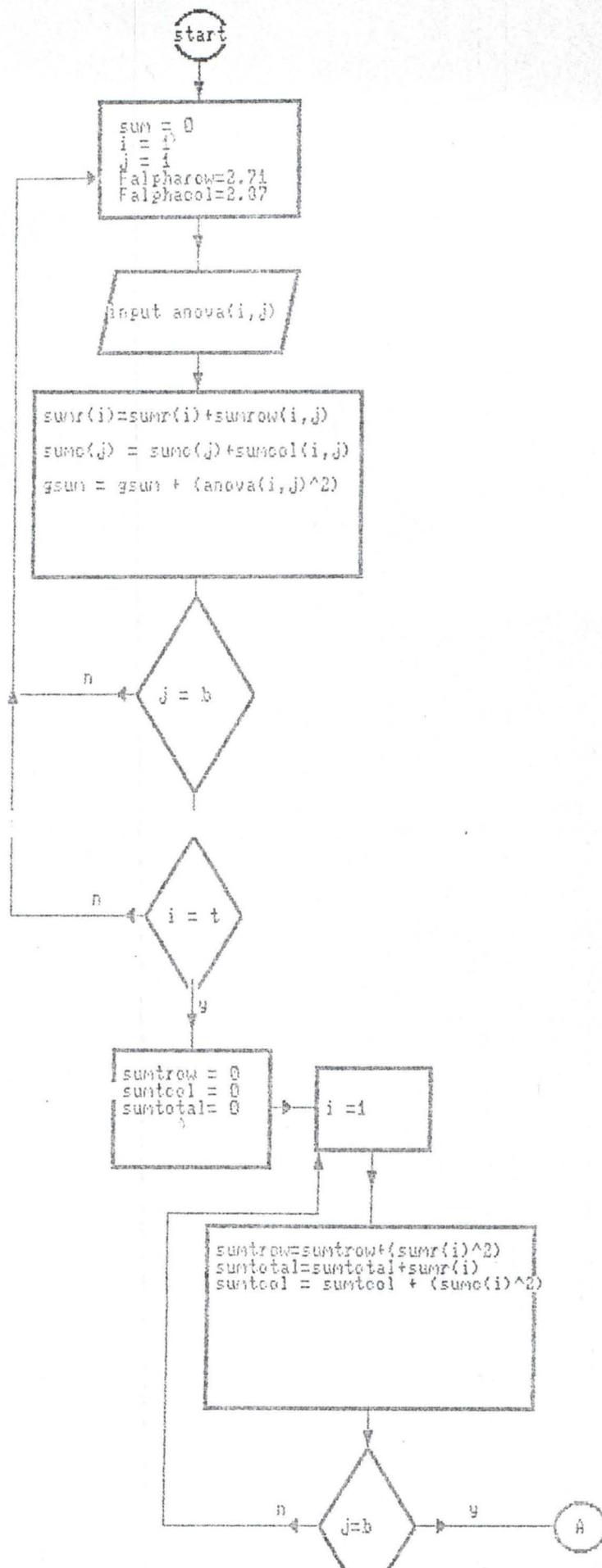
Main program Flowchart







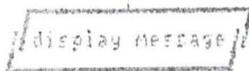
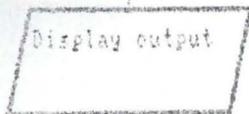






```
diff=(sumtotal^2)/(t*b)  
sstotal=gsun -diff  
sscol=(sumcol/b)-diff  
ssrow=(sumrow/t)-diff  
sserror=sstotal-sscol-ssrow  
nvalrow = sstreat/(t-1)  
nvalcol = sscol/(b-1)  
nvalerr = sserror/(t-1)(b-1)
```

```
Fcol=nvalcol/nvalerr  
Frow=nvalrow/nvalerr
```



	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	30
.95	3.01	2.62	2.42	2.29	2.20	2.13	2.08	2.04	2.00	1.98	1.93	1.89	1.84	1.78	1.74	1.66									
.975	4.41	3.95	3.16	2.93	2.77	2.68	2.58	2.51	2.46	2.41	2.34	2.27	2.19	2.11	2.04	1.92									
.990	5.98	4.56	3.95	3.61	3.38	3.22	3.10	3.01	2.93	2.87	2.77	2.67	2.56	2.44	2.35	2.19									
.995	8.29	6.01	5.09	4.58	4.25	4.01	3.84	3.71	3.60	3.51	3.37	3.23	3.08	2.92	2.78	2.57									
.999	10.2	7.21	6.03	5.37	4.96	4.66	4.44	4.28	4.14	4.03	3.86	3.68	3.50	3.30	3.14	2.87									
.999	15.4	10.4	8.49	7.46	6.81	6.35	6.02	5.76	5.56	5.39	5.13	4.87	4.59	4.30	4.06	3.67									
19 .9	2.99	2.61	2.40	2.27	2.18	2.11	2.06	2.02	1.98	1.96	1.91	1.86	1.81	1.76	1.71	1.63									
.95	4.38	3.52	3.13	2.90	2.74	2.63	2.54	2.48	2.42	2.38	2.31	2.23	2.16	2.07	2.00	1.88									
.975	5.92	4.51	3.90	3.56	3.33	3.17	3.05	2.96	2.88	2.82	2.72	2.62	2.51	2.39	2.30	2.13									
.990	8.18	5.93	5.01	4.50	4.17	3.94	3.77	3.63	3.52	3.43	3.30	3.15	3.00	2.84	2.71	2.49									
.995	10.1	7.09	5.92	5.27	4.85	4.56	4.34	4.18	4.04	3.93	3.76	3.59	3.40	3.21	3.04	2.78									
.999	15.1	10.2	8.28	7.27	6.62	6.18	5.85	5.59	5.39	5.22	4.97	4.70	4.43	4.14	3.90	3.51									
20 .9	2.97	2.59	2.38	2.25	2.16	2.09	2.04	2.00	1.96	1.94	1.89	1.84	1.79	1.74	1.69	1.61									
.95	4.35	3.49	3.10	2.87	2.71	2.60	2.51	2.45	2.39	2.35	2.28	2.20	2.12	2.04	1.97	1.84									
.975	5.87	4.46	3.86	3.51	3.29	3.13	3.01	2.91	2.84	2.77	2.68	2.57	2.46	2.35	2.25	2.09									
.990	8.10	5.85	4.94	4.43	4.10	3.87	3.70	3.56	3.46	3.37	3.23	3.09	2.94	2.78	2.64	2.42									
.995	9.94	6.99	5.82	5.17	4.76	4.47	4.26	4.09	3.96	3.85	3.68	3.50	3.32	3.12	2.96	2.69									
.999	14.8	9.95	8.10	7.10	6.46	6.02	5.69	5.44	5.24	5.08	4.82	4.56	4.29	4.00	3.77	3.38									
21 .9	2.96	2.57	2.36	2.23	2.14	2.08	2.02	1.98	1.95	1.92	1.87	1.83	1.78	1.72	1.67	1.59									
.95	4.32	3.47	3.07	2.84	2.68	2.57	2.49	2.42	2.37	2.32	2.25	2.18	2.10	2.01	1.94	1.81									
.975	5.83	4.42	3.82	3.48	3.25	3.09	2.97	2.87	2.80	2.73	2.64	2.53	2.42	2.31	2.21	2.04									
.990	8.02	5.78	4.87	4.37	4.04	3.81	3.64	3.51	3.40	3.31	3.17	3.03	2.88	2.72	2.58	2.36									
.995	9.83	6.89	5.73	5.09	4.68	4.39	4.18	4.01	3.88	3.77	3.60	3.43	3.24	3.05	2.88	2.61									
.999	14.6	9.77	7.94	6.95	6.32	5.88	5.56	5.31	5.11	4.95	4.70	4.44	4.17	3.88	3.64	3.26									
22 .9	2.95	2.56	2.35	2.22	2.13	2.06	2.01	1.97	1.93	1.90	1.86	1.81	1.76	1.70	1.65	1.57									
.95	4.30	3.44	3.05	2.82	2.66	2.55	2.46	2.40	2.34	2.30	2.23	2.15	2.07	1.98	1.91	1.78									
.975	5.79	4.38	3.78	3.44	3.22	3.05	2.93	2.84	2.76	2.70	2.60	2.50	2.39	2.27	2.17	2.00									
.990	7.95	5.72	4.82	4.31	3.99	3.76	3.59	3.45	3.35	3.26	3.12	2.98	2.83	2.67	2.53	2.31									
.995	9.73	6.81	5.65	5.02	4.61	4.32	4.11	3.94	3.81	3.70	3.54	3.36	3.18	2.98	2.82	2.55									
.999	14.4	9.61	7.80	6.81	6.19	5.76	5.44	5.19	4.99	4.83	4.58	4.33	4.06	3.78	3.54	3.15									
23 .9	2.94	2.55	2.34	2.21	2.11	2.05	1.99	1.95	1.92	1.89	1.84	1.80	1.74	1.69	1.64	1.55									
.95	4.28	3.42	3.03	2.80	2.64	2.53	2.44	2.37	2.32	2.27	2.20	2.13	2.05	1.96	1.88	1.76									
.975	5.75	4.35	3.75	3.41	3.18	3.02	2.90	2.81	2.73	2.67	2.57	2.47	2.36	2.24	2.14	1.97									
.990	7.88	5.66	4.76	4.26	3.94	3.71	3.54	3.41	3.30	3.21	3.07	2.93	2.78	2.62	2.48	2.26									
.995	9.63	6.73	5.58	4.95	4.54	4.26	4.05	3.88	3.75	3.64	3.47	3.30	3.12	2.92	2.76	2.48									
.999	14.2	9.47	7.67	6.70	6.08	5.65	5.33	5.09	4.89	4.73	4.48	4.23	3.96	3.68	3.44	3.05									
24 .9	2.93	2.54	2.33	2.19	2.10	2.04	1.98	1.94	1.91	1.88	1.83	1.78	1.73	1.67	1.62	1.53									
.95	4.26	3.40	3.01	2.78	2.62	2.51	2.42	2.36	2.30	2.25	2.18	2.11	2.03	1.94	1.86	1.73									
.975	5.72	4.32	3.72	3.38	3.15	2.99	2.87	2.78	2.70	2.64	2.54	2.44	2.33	2.21	2.11	1.94									
.990	7.82	5.61	4.72	4.22	3.90	3.67	3.50	3.36	3.26	3.17	3.03	2.89	2.74	2.58	2.44	2.21									
.995	9.55	6.66	5.52	4.89	4.49	4.20	3.99	3.83	3.69	3.59	3.42	3.25	3.06	2.87	2.70	2.43									
.999	14.0	9.34	7.55	6.59	5.98	5.55	5.23	4.99	4.80	4.64	4.39	4.14	3.87	3.59	3.36	2.97									
25 .9	2.92	2.53	2.32	2.18	2.09	2.02	1.97	1.93	1.89	1.87	1.82	1.77	1.72	1.66	1.61	1.5									
.95	4.24	3.39	2.99	2.76	2.60	2.49	2.40	2.34	2.28	2.24	2.16	2.09	2.01	1.92	1.84	1.71									
.975	5.69	4.29	3.69	3.35	3.13	2.97	2.85	2.75	2.68	2.61	2.51	2.41	2.30	2.18	2.08	1.91									
.990	7.77	5.57	4.68	4.18	3.85	3.63	3.46	3.32	3.22	3.13	2.99	2.85	2.70	2.54	2.40	2.17									
.995	9.48	6.60	5.46	4.84	4.43	4.15	3.94	3.78	3.64	3.54	3.37	3.20	3.01	2.82	2.65	2.38									
.999	13.9	9.22	7.45	6.49	5.89	5.46	5.15	4.91	4.71	4.56	4.31	4.06	3.79	3.52	3.28	2.89									
30 .9	2.88	2.49	2.28	2.14	2.05	1.98	1.93	1.88	1.85	1.82	1.77	1.72	1.67	1.61	1.55	1.46									
.95	4.17	3.32	2.92	2.69	2.53	2.42	2.33	2.27	2.21	2.16	2.09	2.01	1.93	1.84	1.76	1.62									
.975	5.57	4.18	3.59	3.25	3.03	2.87	2.75	2.65	2.57	2.51	2.41	2.31	2.20	2.07	1.97	1.79									
.990	7.56	5.39	4.51	4.02	3.70	3.47	3.30	3.17	3.07	2.98	2.84	2.70	2.55	2.39	2.25	2.01									
.995	9.18	6.35	5.24	4.62	4.23	3.95	3.74	3.58	3.45	3.34	3.18	3.01	2.82	2.63	2.46	2.18									
.999	13.3	8.77	7.05	6.12	5.53	5.12	4.82	4.58	4.39	4.24	4.00	3.75	3.49	3.22	2.98	2.59									

35 .9	2.87	2.48	2.27	2.13	2.04	1.97	1.92	1.87	1.82	1.77	1.72	1.67	1.62	1.56	1.50	1.43									
.95	4.12	3.27	2.87	2.64	2.48	2.37	2.28	2.21	2.14	2.07	1.99	1.91	1.82	1.73	1.65	1.51									
.975	5.48	4.09	3.49	3.15	2.92	2.76	2.64	2.54	2.45	2.36	2.26	2.15	2.04	1.92	1.81	1.62									
.990	7.42	5.24	4.35	3.85	3.52	3.29	3.12	3.01	2.91	2.81	2.70	2.59	2.47	2.34	2.22	1.99									
.995	8.98	6.11	5.01	4.50	4.17	3.94	3.77	3.63	3.52	3.43	3.30	3.15	3.00	2.84	2.71	2.49									
.999	12.9	8.41	6.91	6.03	5.44	5.02	4.70	4.48	4.28	4.14	3.89	3.63	3.36	3.08	2.83	2.44									
40 .9	2.84	2.44	2.23	2.09	2.00	1.93	1.88	1.83	1.78	1.73	1.68	1.63	1.58	1.52	1.46	1.39									
.95	4.08	3.23	2.83	2.60	2.44	2.33	2.24	2.17	2.10	2.03	1.95	1.86	1.77	1.68	1.59	1.44									
.975	5.42	4.05	3.45	3.11	2.88	2.72	2.60	2.50	2.41	2.32	2.22	2.11	2.00	1.88	1.76	1.55									