



# **Basic** Concepts and Applications of Experimental Designs and Analysis

**Felix Kutsanedzie**  
**Sylvester Achio**  
**Edmund Ameko**





# Basic Concepts and Applications of Experimental Designs and Analysis

*Felix Kutsanedzie*

*Sylvester Achio*

*Edmund Ameko*

Science Publishing Group

548 Fashion Avenue  
New York, NY 10018

[www.sciencepublishinggroup.com](http://www.sciencepublishinggroup.com)

Published by Science Publishing Group 2015

Copyright © Felix Kutsanedzie 2015

Copyright © Sylvester Achio 2015

Copyright © Edmund Ameko 2015

All rights reserved.

First Edition

**ISBN: 978-1-940366-50-0**

This work is licensed under the Creative Commons  
Attribution-NonCommercial 3.0 Unported License. To view a copy of  
this license, visit

<http://creativecommons.org/licenses/by-nc/3.0/>



or send a letter to:  
Creative Commons  
171 Second Street, Suite 300  
San Francisco, California 94105  
USA

To order additional copies of this book, please contact:

Science Publishing Group  
[book@sciencepublishinggroup.com](mailto:book@sciencepublishinggroup.com)  
[www.sciencepublishinggroup.com](http://www.sciencepublishinggroup.com)

Printed and bound in India

## **Dedication**

This book is dedicated to our families and friends for their constant support in course of writing this book. It is time to celebrate the successes we have chalked together.



## **Acknowledgement**

We wish to acknowledge our colleague lecturers, research fellows of Accra Polytechnic and all well wishers.





## Preface

Researchers, academics and students are engaged in one form of research or the other that requires designing. However be it as it may, most of these individuals are not conversant with selecting the appropriate experimental designs that should best suit their respective researches or studies. To some understanding the concepts and basis of these designs are quite a challenge. Still others have a huge challenge handling these designs because of the complex mathematics underpinning these designs.

In addition there is no one stop book that treats in details the various designs and the mathematical principles underlying them. One might advance the argument that computer applications aid analyzing of these designs but the same cannot be said of these designing and selecting the appropriate designs for individuals in the conduct researches.

This book covers thoroughly the explanations of the concepts and basic terms in almost all the known experimental designs; the mathematics underlying these; how to select the appropriate designs for a study and a logical sequence of analyzing these designs. For each of these designs, hypothetical examples of experiments have been provided with stepwise approaches towards analyzing them. It treats complex designs in a simplified way to enhance the understanding of its readership. The designs are arranged in a systematic order of increasing complexity.

Albeit the underlying principles of experimental designs and analysis are based on mathematic, the other aspect of designs, which is the actualization or practising is equally challenging. Oftentimes when it comes to mounting of an experiment using a particular design, people understand the mathematical basis, however identifying and allocating the different treatments or levels or factors of treatments to each plot or experimental units (as to whether they are

homogeneous or heterogeneous) become a dilemma to them. This book does not only deal with the mathematics behind each design but also how to identify the treatments; levels of treatments; whether a plot or a unit is homogenous or heterogeneous; and explains and demonstrate with practical examples on how to identify and allocate factor in the design as main factors or sub factors based when applicable.

Each chapter dwells extensively and exhaustively on a particular design with hypothetical data analysed and interpretations to aid the readers understanding of the design.

This is thus a must read book for all involved in designing of experiments in diverse fields.

# Contents

Preface .....	VII
<b>Chapter 1 Concepts and Basis of Experimental Design.....</b>	<b>1</b>
1.1 Introduction .....	4
1.2 Terms Used in Experimental Designs .....	4
1.3 Experimental Design .....	5
1.4 Experiment .....	5
1.5 Test Experiment.....	5
1.6 Control Experiment .....	6
1.7 Observatory Study .....	6
1.8 Treatments .....	6
1.9 Factor.....	7
1.10 Level.....	7
1.11 Replication.....	7
1.12 Experimental Unit .....	8
1.13 A Plot.....	8
1.14 A Block.....	8
1.15 Response Variable .....	9
1.16 Explanatory Variable.....	9
1.17 Experimental Error .....	9
1.18 Randomization.....	9
1.19 Single-Factor Experiment.....	10
1.20 Multi-Factorial Experiment .....	10
1.21 Full Factorial Treatment Design.....	10
1.22 Observational Unit.....	11
1.23 Conducting an Experiment .....	11

<b>Chapter 2 Complete Randomized Design (CRD)</b> .....	<b>15</b>
2.1 Introduction .....	18
2.2 Analysis of Data Obtained from the CRD .....	19
<b>Chapter 3 Complete Randomised Block Design</b> .....	<b>39</b>
3.1 Introduction .....	42
3.2 Merits of RCBD over CRD .....	43
3.3 Illustration of Randomized Complete Block Design .....	43
3.3.1 Finding the Treatments that are Significantly Different .....	49
3.3.2 The Fisher's LSD Test .....	49
3.4 Missing Data Handling .....	55
3.4.1 Handling a Single Missing Data .....	56
3.4.2 Handling More than One Missing Data Under RCBD .....	59
<b>Chapter 4 Latin Square Design</b> .....	<b>69</b>
4.1 Introduction .....	72
4.2 Handling More than One Missing Data Under LSD .....	87
<b>Chapter 5 Multifactorial Design</b> .....	<b>105</b>
5.1 Introduction .....	108
5.2 CRD .....	109
5.3 RCBD .....	114
5.4 LSD .....	122
<b>Chapter 6 Split Plot Experimental Design</b> .....	<b>131</b>
6.1 Introduction .....	134
6.2 Analysis of the Split Plot Design .....	139
6.3 Whole Plot Analysis .....	139
6.4 Sub Plot Analysis .....	143
6.5 Completing the ANOVA Table .....	145

**Chapter 7 Strip Plot Design..... 149**

7.1 Introduction ..... 152

7.2 For the Vertical Strip Analysis ..... 155

7.3 For the Horizontal Strip Analysis ..... 158

7.4 For the Interaction Strip Analysis..... 160

7.5 Completing the ANOVA Table..... 161

7.6 Taking the Decision and Making the Conclusion..... 163

