INTRODUCTION

This thesis is divided into three parts. The first part deals with the block structure properties of Balanced Incomplete Block (BIB) designs and Partially Balanced Incomplete Block (PBIB) designs. The second part deals with the problems of estimation of the parameters of some truncated distributions. The third part deals with the problem of using apriori knowledge in the estimation of a parameter from double samples. The thesis is based more or less on the following papers published by the author ([41], [42], [43], [44], [45], [46], [47], [48], [49], [50]).

(1) The asymptotic variances of method of moments estimates of the parameters of the truncated binomial and negative binomial distributions. (1961), Journal of the American Statistical Association, 56, 990-994.

(2) An upper bound for the number of blocks in balanced incomplete block designs. (1963),

Journal of the Indian Statistical Association, 1, 91-92.

(3) On the upper bound for the number of blocks in balanced incomplete block designs having a given number of treatments common with a given block. (1963), Journal of the Indian Statistical Association, 1, 219-220.

(4) Use of apriori knowledge in the estimation of a parameter from double samples. (1964), Journal of the Indian Statistical Association, 2, 42-51.

(5) An upper bound for the number of disjoint blocks in certain PBIB designs. (1964), the Annals of Mathematical Statistics, 35, 398-407.

(6) A note on balanced incomplete block designs. (1965), Vidya, Journal of Gujarat University, Ahmedabad, 8, 215-218.

(7) Bounds for the number of common treatments between any two blocks of certain PBIB designs. (1965), Annals of Mathematical Statistics, 36, 337-342.

(8) Estimation of parameters of doubly truncated

normal distribution from first four sample moments. (1966), Annals of the Institute of Statistical Mathematics, 18, 107-111. (Joint paper with Mr. M.C. Jaiswal).

(9) On the block structure of certain partially balanced incomplete block designs. (1966), Annals of Mathematical Statistics, 37, 1016-1020.

(10) On estimating the parameter of a doubly truncated binomial distribution. (1966), Journal of the American Statistical Association, 61, 259-263.

PART I

Part I contains Chapters 1, 2, 3, 4 and 5. It deals with properties of BIB designs and PBIB designs. The following definitions of a BIB design and a PBIB design will be useful in latter sections.

Definition 1. An arrangement of v treatments in b blocks of k plots $(k < v)$ is known as a balanced incomplete block design (BIB design), if every treatment occurs once and only once in r blocks and any two treatments occur together in λ blocks.

Definition 2. An incomplete block design is said to be partially balanced incomplete block (PBIB) design when

(i) there are v treatments arranged in b blocks, each block containing k plots with different treatments assigned to each;

(ii) each treatment occurs in r blocks;

(iii) with respect to any treatment, the remaining treatments can be divided into m groups containing $n_1, n_2, \ldots n_m$ treatments, such that the treatments of the i-th group occur with the given treatment λ_i times $(i = 1, 2, \ldots, m)$. The treatments of the i-th group are said to be i-associates of the given treatment. The numbers $n_1, n_2, \ldots, n_m$ and $\lambda_1, \lambda_2, \ldots, \lambda_m$ are independent of the given treatment. Some of the λ's may be equal;

(iv) if the treatment θ is i-associate of ϕ, then the treatment ϕ is i-associate of θ. If θ and ϕ are i-associates, then the number of treatments common between the j-associates of θ and k-associates of ϕ

is p^i_{jk} $(i, j, k = 1, 2, \ldots, m)$ and is independent of the pair of treatments with which we start.

Fisher's [19] inequality $b \geq v$ gives the lower bound for the number of blocks in a BIB design. In Chapter 1, an upper bound for the number of blocks in a BIB design is obtained. Majumdar [27] obtained the upper bound for the number of disjoint blocks (blocks having no treatments in common) in a BIB design. In Chapter 1, a generalization of this result is obtained, giving an upper bound for the number of blocks in a BIB design having a given number of treatments common with a given block, from which the results of Chakrabarti [10], Parker [30] and Seiden [40] follow. Chapter 1 is based on the papers published by the author ([42], [43], [44]).

Partially balanced incomplete block (PBIB) designs were introduced by Bose and Nair [7] in the year 1939. The PBIB designs with two associate classes were further classified by Bose and Shimamoto [8] as (i) Group Divisible (GD), (ii) Triangular, (iii) Latin Square with i constraints (L_i), (iv) Singly Linked Block (SLB) and (v) Cyclic. The GD designs were further classified as (a) Singular GD, (b) Semi-regular GD and (c) Regular GD. PBIB designs with three associate classes having a rectangular association scheme were introduced by Vartak [53]. In Chapter 2, an upper bound is obtained for the number of disjoint blocks in (i) semi-regular GD designs, (ii) certain triangular designs, (iii) certain two associates PBIB designs having L_2 association scheme and (iv) certain three associates PBIB designs having rectangular association scheme. Chapter 2 is based on the paper published by the author [45].

In Chapter 3, bounds are obtained for the number of common treatments between any two blocks of (i) semi-regular GD designs, (ii) certain triangular designs, (iii) certain two associates PBIB designs having L_2 association scheme and (iv) certain three associates PBIB designs having rectangular association scheme. The bounds were obtained by using certain results of (i) Bose and Connor [6], (ii) Raghavarao [34] and (iii) Vartak [54]. Simultaneously another kind of bounds for the number of common treatments between blocks of certain two associates PBIB designs were obtained by Agrawal [1], who used the method based on the characteristic roots of NN', N being the incidence matrix of the design. Chapter 3 is based on the paper published by the author [47].

In Chapter 4, the results of Chapter 1 are generalized and upper bounds are obtained for the number of blocks having a given number $l(\leq k)$ of treatments common with a given block in the four classes of PBIB designs mentioned in Chapter 3 and conditions under which two blocks of these designs are the same set, are derived. Chapter 4 is based on the paper published by the author [48].

In Chapter 5, an equi-replicate incomplete block design is considered and two results for this design are derived: (i) the necessary and sufficient condition in order that any two blocks will have the same number of treatments in common and (ii) Bounds for the number of disjoint blocks.

PART II

Part II contains Chapters 6, 7, 8 and 9. In recent years interest in truncated distributions has considerably increased. The truncated binomial distribution was considered by Fisher [18], Haldane ([20], [21]), Finney [17], Wilkinson [55]. Finney [17] has shown how to estimate the parameter of this distribution by an iterative process which requires special tables. He mentions several practical problems in which a truncated binomial distribution might be met. Rider [36] has obtained simplified estimators of the parameter of the truncated binomial distribution, using the method of moments, but no comparison was made by him with the maximum likelihood estimator. In Chapter 6, the asymptotic variance of the method of moments estimator of the parameter of the truncated binomial distribution is obtained and comparison of the asymptotic efficiency of the moment estimator of the parameter of the zero-truncated binomial distribution has been made with that of the maximum likelihood estimator. Comparison has been also made with the ratio estimator (Patil [30]) of the parameter of the zero-truncated binomial distribution. Further, in Chapter 6, the parameter of the doubly truncated binomial distribution has been estimated by the method of moments and comparison of its asymptotic efficiency has been made with that of the maximum likelihood estimator. Chapter 6 is based on the papers published by the author ([41], [49]).

The zero-truncated negative binomial distribution has been considered by Sampford [39], Brass [9], David and Johnson [15], Rider [36] and Khatri [24]. The maximum likelihood estimators of the parameters of the truncated negative binomial distribution are complicated to calculate. And so attempts (Rider [36], Brass [9], Khatri [24]) have been made to obtain simplified estimators. The three-moments estimators of the parameters of the zero-truncated negative binomial distribution were obtained by Rider [36], but no comparison was made with maximum likelihood estimators. In Chapter 7, the three-moments estimators of the parameters of the truncated negative binomial distribution in which k classes from the lower end of the distribution are truncated, are derived and their asymptotic variances and covariance are obtained. Further the asymptotic efficiency of the three-moments estimators has been studied in the case of the zero-truncated negative binomial distribution.

In Chapter 8, a new kind of the distribution i.e. the displaced negative binomial distribution has been studied. This distribution has been defined on the lines of the displaced Poisson distribution given by Staff [51]. The parameters of this distribution have been estimated by (i) maximum likelihood method, (ii) using zero-cell frequency and the first three sample moments and (iii) using the first four sample moments.

The estimators of the parameters of the singly truncated normal distribution have been obtained by Cohen [13] in terms of the first three sample moments, which are easy to compute as against the maximum likelihood estimators which are not easily computed. In Chapter 9, the estimators of the parameters of the doubly truncated normal distribution are obtained in terms of the first four sample moments. Chapter 9 is based on the paper published by the author and M.C. Jaiswal, Gujarat University, Ahmedabad, [50].

PART III

Part III contains Chapter 10. This chapter deals with the problem of finding a better estimator of the parameter of a population from double samples when some guessed estimate of the parameter is available. It generalizes the work of Katti [22]. Chapter 10 is based on the paper published by the author [46].

At the end, there is a complete bibliography of the papers consulted in preparing this thesis.

The results given in this thesis are, to the best of author's knowledge, new and are not submitted to any university for any degree or diploma. The author feels that the results of this thesis contributes substantially to the existing knowledge of the Designs and Inference.

The following are, in short, the new results established in this thesis and to which claim is made.

(1) An upper bound for the number of disjoint blocks in (i) semi-regular group divisible designs, (ii) certain two associates PBIB designs having triangular association scheme, (iii) certain two associates PBIB

designs having a L_2 association scheme and (iv) certain three associates PBIB designs having rectangular association scheme.

(2) Bounds for the number of common treatments between any two blocks of the four classes of designs considered in (1).

(3) Conditions under which no two blocks of the four classes of designs considered in (1) are the same set.

(4) The necessary and sufficient condition in order that any two blocks of an equi-replicate incomplete block design will have the same number of treatments in common.

(5) Bounds for the number of disjoint blocks in an equi-replicate incomplete block design.

(6) Asymptotic variances of the method of moments estimators of the parameters of the truncated binomial and negative binomial distributions.

(7) The moments estimator of the parameter of a doubly truncated binomial distribution.

(8) The displaced negative binomial distribution.

(9) Estimation of the parameters of the doubly

truncated normal distribution from first four sample moments.

(10) Preliminary test estimator of the parameter of the population when some guessed estimate of the value of the parameter is available.