

ABSTRACTS OF PAPERS*

SECTION : A

1. AN EFFICIENCY COMPARISON OF DUAL RATIO AND PRODUCT ESTIMATOR

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Many papers have appeared studying the ratio-type estimators under the superpopulation model of Durbin (1959). The present article investigates the efficiency of the dual ratio estimator suggested by Srivenkataramana (1980) with respect to the superpopulation model of Durbin. The bias and mean square error of the estimator are obtained for finite population. It is found that for the constant variance regression model, the dual ratio estimator is more efficient than the product estimator when the regressor variable (or auxiliary variable) has a gamma distribution with parameter greater than or equal to one. For convenience, the comparison has been made for an infinite population.

2. ON PROBABILITY PROPORTIONAL TO SIZE SAMPLING

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Many times the information on one or more auxiliary variables is available on all the units of the population. Probability proportional to size sampling is one of the several procedures that are used to obtain more

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efficient estimators of the population total, the size being the value of auxiliary character which is highly correlated with the character under study. If the regression of the study variable and auxiliary variable is linear then the efficiency of probability proportional to size sampling as compared to simple random sampling is high when the regression line passes through the origin. Efficiency of the PPSWR sampling decreases with the departure of regression line from origin inspite of the correlation being very high. Situations are not uncommon where the relationship between study variable and an auxiliary variable is non linear and in such situations PPSWR sampling is not expected to be very efficient.

Singh and Gupta (1972) proposed a scheme which consist in first selecting a preliminary sample of size m by PPSWR and determining a functional relationship between the study variable and auxiliary variable and thereafter selecting the sample of remaining units by PPSWR from the remaining units of the population using the value of the function of auxiliary variable as size measure. They considered the estimator which is a weighted function of two estimators, one based on the preliminary sample and other on PPSWR sample. The method described by them has got many limitations. In the present paper a procedure has been suggested which removes these limitations.

3. USE OF COLLAPSED STRATA IN ESTIMATION OF SAMPLING VARIANCE OF STRATIFIED SAMPLING

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When due to heterogeneity, the population is divided into a large number of strata and one unit is selected at random from each stratum, it is not possible to estimate the Sampling Variance. By using the technique of Collapsed Strata, some estimators of the Sampling Variance are proposed in this paper.

4. ROBUSTNESS OF SOME RATIO-TYPE ESTIMATORS UNDER SUPER POPULATION MODELS

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Large sample theory of ratio-type estimators for population mean (or

total) are available in literature. The exact theory (small sample properties) of such estimators has been examined under a given super-population model. When model under consideration fails to hold, the robustness of usual ratio estimator was studied by Royall and Herson (1973 I). In the present paper the Robustness of some ratio-type estimators has been examined when the model fails to hold. It is found that some of the ratio-type estimators are more robust as compared to usual ratio-estimator when model is incorrect.

5. ON A CHAIN PRODUCT ESTIMATOR IN TWO-STAGE SAMPLING

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Following the technique of constructing chain ratio estimator, suggested by Murthy (1967), a chain product estimator has been proposed in two-stage sampling when the variable under study and the auxiliary variable are negatively correlated. An exact expression for the bias of the estimator is obtained following the approach given in Sahoo and Swain (1983). The conditions for which the proposed chain product estimator is more efficient than the simple unbiased estimator and the usual product estimator in two-stage sampling, are also given.

6. MODIFIED ESTIMATORS OF MEAN WHEN POPULATION VARIANCE IS KNOWN

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A class of modified estimators have been suggested for the population mean μ as

$$\mu^{**} = \bar{x} + \frac{\sigma^2 \bar{x}}{n\bar{x}^2 + K\sigma^2} \quad \forall K \geq 2$$

when the population variance σ^2 is known. Their Bias and Mean Square Error are derived,

7. MODIFIED PRODUCT TYPE ESTIMATORS

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Many research papers have appeared on modified ratio and product type estimators. Among them, two relevant to the present papers are ;
Reddy's (1974) Estimator

$$\hat{y} = \frac{\bar{y} \bar{x}}{\bar{x} + (1 - \alpha)\bar{x}}$$

and Goyal's (1978) modified ratio type Estimator

$$\hat{y} = \frac{\bar{y}\bar{x}}{\bar{x}} + \frac{\alpha}{\bar{y}}, \alpha = \text{Constant}$$

Motivated by the above estimators the following estimators are proposed as

$$T_1 = \frac{\bar{y}\bar{x}}{\alpha\bar{x} + (1 - \alpha)\bar{x}} \text{ and } T_2 = \frac{\bar{y}\bar{x}}{\bar{x}} + \frac{K}{\bar{y}}$$

Where α and K are constants.

Their properties regarding the Bias, mean square error (MSE) and efficiency are investigated.

8. AN EMPIRICAL STUDY IN EVALUATING SAMPLING STRATEGIES FOR ESTIMATING THE DISTRIBUTION OF LAND HOLDING SIZES

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The commonly used sampling methods are generally oriented towards the estimation of point parameters like population total or population mean. In many practical situations the interest is more on estimating frequency distribution of a certain character rather than a point estimator. In order to see how conventional sampling methods can be used for estimating frequency distributions it is necessary to define certain error measures on the basis of which one can compare the different sampling strategies.

This study relates to the comparisons of certain sampling strategies empirically. For this purpose the data collected under the scheme 'Methodological investigations into high yielding varieties programme' have been taken. The two error measures namely, α_1 and α_2 , suggested by Murthy (1977) have been considered for the purpose of comparison,

On the basis of this study the following broad conclusions have been drawn.

- (i) The scheme 1.2 i.e. selecting ultimate units with simple random sampling without replacement is uniformly better in respect of both α_1 and α_2 than the scheme 1.1 i.e. (simple random sampling with replacement) and scheme 2.2 (sampling with pps with replacement).
- (ii) There does not appear to be any difference between stratified and unstratified sampling in terms of efficiency.
- (iii) Among the schemes 2.1 and 2.2, the scheme 2.1 with arrangement (c) namely arranging the units in ascending order of $\sum p_{ij}^2$ is generally better than other arrangements.

9. ESTIMATION OF THE MEAN USING SAMPLE OBSERVATION ON AN AUXILIARY CHARACTER

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When mean of auxiliary character is unknown, the ratio and product methods of estimation cannot be used to estimate the population mean of study character. In that case double sampling is used, in which the mean of the auxiliary character is first estimated from a large preliminary sample. However, double sampling is not feasible always. For such situations a generalised class of estimators is proposed and its properties under large sample approximations are studied. An optimum estimator is found out in this class. The characterising scalar of the proposed class of estimators is then estimated from the sample and the new estimator is examined. In case of double sampling alternative ratio and product type estimators are proposed and their properties under large sample approximations are studied.

10. SOME BAYESIAN RESULTS FOR NON RESPONSE

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A Bayesian approach is given to a two-phase sampling design when sampling is done from a multi-dimensional dichotomous population. The model is, in a sense, a sequential one and is developed for double dichotomous data with bayesian point of view. An attempt has been made to find an answer to a most prevalent question as how to determine optimal first phase sample size when losses in terms of given costs or variances

are defined. The second phase sample allocations are also discussed. Two cases viz. The Hansen Hurwitz method for the non-response problem; and two-phase random sampling, are discussed. The optimum allocation in each case is obtained by minimizing the expected posterior variance of the mean. Two different allocations/methods are employed and illustrated with some numerical examples.

11. A MODIFIED APPROACH TO BAYESIAN SAMPLING

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Problems of optimal sample size and of point estimation that arise naturally have been dealt with when one formalizes survey procedures and analyses them from a Bayesian viewpoint. The method uses logistic transformations for parameters and an exchangeable prior distributions. It is intended as a forerunner to a more generalised theory and will be applicable if the exchangeability assumption is reasonable. Two different approaches are employed; a Bayesian posterior analysis and a Bayesian pre-posterior analysis. Two different allocation methods are employed and illustrated with some numerical examples, for cases where some or all of the parameters are unknown.

12. ON MODIFYING CHAUDHURY'S SAMPLING SCHEME

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Chaudhury (1974) has given a sampling procedure in which the inclusion probability is proportional to size for any sample size ($n \geq 2$). But the procedure has some drawback. In this note a modification has been suggested that removes the drawback.

13. AN ESTIMATOR BASED ON MODIFIED VALUES OF STUDY AND AUXILIARY VARIABLES

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Ratio Method of estimation or pps estimator is preferred when their is near proportionality between study and auxiliary variables. In the absence of this property, modification of both the variables using auxiliary information is likely to improve the estimator. In this paper some estimators are

proposed along these lines and their performance is studied with other competing estimators.

14. ON TWO STAGE SUCCESSIVE SAMPLING WITH PARTIAL REPLACEMENT OF UNITS

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In sample surveys, of repetitive nature, one has got the opportunity of making use of the information contained in the first sample and utilise it for improving the precision of future estimates as also revise the earlier estimates in the light of the new experience. Estimates could be build up not only for the current period but also of the change over periods as also for the average over a given period. Under such inventions an important question that arises is : whether the same sample should be used every time or a completely new sample or a mixture of old and new. Replacement of part of the sample on each occasion is considered to be better of these three alternatives. In that case should the replacement of units be carried out at each stage of sampling and what should be the replacement fractions ?

In the present paper five different schemes of replacement of sampling units have been investigated. Further, for estimating the population parameters three alternative estimators have been developed and their efficiencies have been compared empirically with the help of data collected under the IASRI project on sampling investigations into high yielding varieties programme.

15. ON POST-STRATIFICATION IN TWO STAGE SAMPLING

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In certain situations, pre-stratification of the population with respect to the variable of interest is not possible, until the data have been collected, although the stratum sizes may be obtainable fairly accurately from official statistics or other sources. Personal characteristics like, age, sex, race, educational level, size of holding etc. are common examples. Under such circumstances we resort to what is known as post-stratification. This aspect in respect of single-stage sampling has been discussed in the available literature: Coctron, 1963; Des Raj, 1979; Harsen, Hurwitz O Madow, 1956; Murthy, 1967; Sukhatme O Sukhatme, 1970. However, not much work has been done in developing the theory of post-stratification in multi-stage

designs. In the present paper an attempt has been made to develop the theory of post-stratification in the case of two-stage design, the stratification being carried out on the basis of sample second stage units in the sample primary-stage units. An empirical illustration with the help of simulated data has also been carried out.

16. ON AUXILIARY INFORMATION OF RANDOMLY NON-RESPONDING UNITS FOR STUDY VARIABLE

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In most of the practical situations in sample surveys, the random non-response for some of the population units is present on the study variable only and not on both the study and auxiliary variables. It is because of the fact that the information on suitable auxiliary variable may be readily and easily obtained. A comparison between these two situations has been made by taking the usual difference estimator for population mean. The former has been found to be providing less efficient as well as less non-response robust estimator in comparison to the latter. Thus, the additional auxiliary information on randomly non-responding units for study variable should not be used in sample surveys. Apart from the extra cost and labour involved, its use leads to decrease in efficiency as well as non-response robustness of estimators.

17. AN ESTIMATOR OF POPULATION MEAN USING TWO AUXILIARY VARIABLES IN SAMPLE SURVEYS

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An estimator has been considered using two auxiliary variables and obtained the expressions for its bias and the mean square error and compared it with the estimators proposed by others. It is shown that there is considerable reduction in the mean square error and bias of the suggested estimator.

18. OPTIMIZATION OF UNRELATED QUESTION QUANTITATIVE RANDOMIZED RESPONSE MODEL

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Optimization of Greenberg's unrelated question quantitative randomiz-

ed response model has been proposed. An estimator for a sensitive characteristic population mean has been suggested under this model. The estimator of variance of this estimator and allocation of total sample size (n) into two samples of size n_1 and n_2 respectively have been derived. The variance under this model has been compared with the variance under Greenberg's quantitative model. Mean square error and smallest sample size required to make mean square error of optimized estimator less than mean square error of usual estimator in open interview have been obtained in case of false reporting. Criterion for selection of design parameters to reduce the mean square error as well as variance of estimator of sensitive variable population mean have been suggested.

19. A NEW ESTIMATOR WITH A PRELIMINARY TEST IN OPTIMIZED QUANTITATIVE RANDOMISED RESPONSE MODEL

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A new estimator involving a preliminary test of significance in two-sample single unrelated question optimised model for quantitative data has been proposed and its bias and mean square error in case of true and false reporting have been derived. Allocation of total sample size (n) into two samples of size n_1 and n_2 respectively has been discussed. Gain in efficiency due to this estimator under optimized model when variance of non-sensitive variable is known has been investigated theoretically and empirically.

20. ON MODIFIED RATIO ESTIMATOR FOR ESTIMATING THE MILK YIELD

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A modified ratio estimator is proposed for estimating the milk yield in a sample survey when relation between Y and X is of the form

$$\frac{X}{Y} = b_0 + b_1x + b_2x^2 + e_x$$

A new variable $Z_x = \hat{Y}_x$ has been generated based on above model and

is used as an auxiliary variable to propose the modified ratio estimator. The suitability of this estimator has been worked out for estimating the average milk yield. It is found to be superior than simple sample mean. The empirical comparison has shown that percentage efficiency of this estimator to simple sample mean varied from 121.02 to 1139.36.

21. ROBUSTNESS OF CONDITIONALLY SPECIFIED RATIO-ESTIMATORS WITH PRELIMINARY TESTING IN DOUBLE SAMPLING

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Modified ratio estimators as an alternative to the usual ratio estimator for a population mean in double sampling is proposed on the basis of preliminary test of a simple hypothesis about the auxiliary variate mean. Two phase sampling is assumed from bivariate normal and non-normal populations. Mathematical expressions for bias and Mean Square Error of these estimators are derived. The robustness of the estimators is studied in the light of results obtained for non-normal population. Gain in efficiency is investigated theoretically and empirically also.

22. ON SAMPLE SURVEYS OF PERENNIAL CROPS

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Area and yield estimation of crops are essential and for cereal crops crop-cutting experiments are used. For perennial crops this method is not applicable and some different techniques are to be used. Area is not found to be meaningful in case of scattered trees. In this paper the various problems faced in the survey of perennial scattered crop are being discussed with special reference to coconut in Assam.

23. ESTIMATION OF SPECIFIC WITHDRAWAL RATES IN BOVINES FROM SURVEY DATA

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In surveys for estimation of annual fertility and mortality rates of a bovine population, the changes taking place in the population due to sale/purchase, etc., are also recorded in addition to data on birth and

death. In a survey of the kind conducted in an ICDP area (Amritsar district) and a non-ICDP area (Ferozepur district) of Punjab, substantial transactions by way of disposal/acquisition were noticed. Defining 'withdrawal' as the event of certain bovines being lost from observation, before completing the year of demographic investigation, due to their disposal through sale or in any manner other than death, specific withdrawal rates in cattle and buffaloes with respect to sex, breed and age were estimated in this study. As the sample was drawn by stratified two stage sampling, the estimates were obtained as weighted ratios of withdrawals and the population exposed to the risk of withdrawal. The latter was determined using fractional exposures. Various comparisons of the estimates of specific withdrawal rates were made. The rates were generally lower in the ICDP area indicating that bovine population in the said area was less affected by withdrawals. The rates for female animals were higher among cattle as against buffaloes. The age-specific rates pertaining to cows in the most productive life-span were of the order of 20 per cent.

24. ON A PROCEDURE FOR ESTIMATING THE PRODUCTIVITY AT MICRO-LEVELS USING AUXILIARY INFORMATION

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The estimates of average yield of principal crops are obtained on the basis of crop cutting experiments conducted at the district level. A need has arisen that such estimates should be available at a smaller level say at tehsil/block level. A possible approach for obtaining such estimates is to use eye estimates of yields as auxiliary variable. As the proposed procedure is to be used on a large scale over time, it is essential that the same should not only be practical and operationally feasible, but also not entail, as far as possible, the need of providing additional man-power for the purpose. In this paper an approach for providing yield estimates for major cereal crops at the micro-level with a reasonable degree of precision has been suggested. The procedure involves the application of double sampling technique using the eye-estimates of yields at the village level as the auxiliary information.

25. ESTIMATION IN FINITE POPULATIONS UNDER A CALIBRATION MODEL

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Regression estimation of finite populations is studied when the auxiliary

variable is in the form of an estimate of the true response for a characteristic of interest. The structural problem is formulated as calibration, and both the classical and the inverse regression estimation approaches are investigated. It is shown that the inverse regression estimator of the population mean is more efficient than the two classical estimators considered. The asymptotic bias and variance of the inverse regression estimator are derived, and the estimation of the variance is discussed. Based on some simulation results the performances of four different variance estimators are evaluated.

26. ON USEFUL INFORMATION GENERATING FUNCTIONS

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A generating function has been defined for Belis and Guiasu's measure of useful information. A generalized useful information generating functions of which the first is a particular case has been defined and a new useful information measure of order α and type β characterized. Particular and limiting cases have been studied. The generating functions for uniform, geometric and exponential distributions have been discussed. Some important properties of the generalized useful information generating function have also been studied.

27. APPROXIMATE POWER OF ANALYSES OF VARIANCE TEST PROCEDURES BASED ON THREE PRELIMINARY TESTS IN A CONDITIONALLY SPECIFIED MIXED MODEL

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Approximate formulae for power of four analyses of variance test procedures based on three preliminary tests of significance in combination of crossed and nested classification in a mixed model have been derived.

28. ON THE EFFECT OF NON-NORMALITY IN ESTIMATION AND TESTING PROCEDURES : AN INTRODUCTION AND BIBLIOGRAPHY

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A review on the effects of departure from normality assumption on the

estimators and test procedures have been given. Certain fundamental problems have also been suggested. A bibliography on non-normality and related problems fills a void and will be a source of references for an investigator.

29. ROBUSTNESS TO NON-NORMALITY OF POOLED ESTIMATOR OF MEAN WITH KNOWN VARIANCES

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Considering non-normal population of Edgeworth type, mathematical expressions for the mean and mean square error of the estimator of population mean are derived under conditional expectation. The derived expressions would help to study how the pooled estimator for non-normal samples departs from that obtained for normal samples.

30. MOMENT APPROXIMATION TO THE SAMPLING DISTRIBUTION OF THE RATIO OF MEAN SQUARES IN MODEL-II WITH NON-NORMAL RANDOM EFFECTS

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Exact and approximate central moments of order four for the sampling distribution of the ratio of mean squares in a non-normal balanced Model-II are derived and compared. Attempt has also been made to obtain critical points of the classical F -distribution using Fisher-Cornish transformation.

31. ON SLIPPAGE TEST FOR ORDERED OBSERVATIONS

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Slippage test is given to any statistical procedure which is capable of testing the null hypothesis of equality of location parameters. If the populations are normally distributed with equal variances but possibly unequal means, the maximum likelihood test for detecting differences in location parameters is the usual F test. However in case of non-nor-

mal populations, the analysis procedures proposed by Conover (1968) are more powerful than the F test. This test is capable of testing whether one or more population distribution functions have slipped to the right of the other. This test places heavy reliance on the extreme values (largest) from each sample. If the populations having larger means also possess larger variances, then the extreme values of the samples are sensitive indicators of any difference in means and the tests are quite powerful. The test becomes relatively insensitive and unreliable when the variances of the populations remain equal or decrease with increase in means.

In this paper a test procedure is proposed utilising all the observations of the samples and used all order statistics for taking decisions. The method of analysis is easy to perform and is distribution-free in the sense that the null-distributions do not depend on the form of the population distribution from which the samples are drawn. A procedure for ranking the samples on the basis of various order statistics has been suggested and the probability distribution of the test-statistic has been worked out.

32. ANALYSIS OF LINEAR MODELS : AN INFORMATION THEORETIC APPROACH

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The concepts of "Information", "mean information per observation" for discriminating two hypotheses and the "divergence" which is a measure of difficulty of discriminating between two hypotheses were first discussed by Kullback and Leibler (1951). Kullback (1952, 1956) applied information theory in multivariate analysis by using divergence. Kullback and Rosenblatt (1957) have used the divergence, a measure of information for testing different hypotheses of interest regarding the sets of partial regression coefficients in the analysis of multiple regression (full rank model) in K categories.

In the present study the analysis of linear models is considered from the view point of information theory. Since the design matrix in linear models is not of full rank, the divergence between two hypotheses, $J(1, 2)$, has been investigated for the non-full rank case by usual reparameterization technique. It has also been investigated that $J(1,2)$ and its estimate remain unchanged for any reparameterization. Best linear unbiased estimates of the parameters are used in estimating the divergence $J(1, 2)$. The statistic $J(1, 2)$ is distributed as pF under usual null and alternative hypotheses respectively where F is the usual F distribution with $n = p$ and $n_1 = n - p$ d.f., p is the rank of design matrix and n is the total

No. of observations. The application of the approach is made for one-way and two-way classifications.

33. SOME PROBABILITY MODELS FOR ASCERTAINMENT OF FAMILIES IN SEGREGATION ANALYSIS

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Janardan *et al.* (1984) have given two classes of probability models for the distribution of number of boys in a family. Their models are based on polya urn schemes as well as some genetic considerations. In the present paper some probability models for the same situation have been suggested and investigated its suitability with the help of the data considered in Janardan *et al.* (1984). Also, the correlation coefficient between the number of boys and girls in a family for the same data has been determined in the case of each model.

34. POPULATION DYNAMICS OF BOVINES IN INDIA—A GROWTH MODEL ANALYSIS

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Cattle and buffalo population for 23 years from 1961 to 1983 have been taken for finding out the trend of growth of population. The four growth curves proposed by Dandekar (1980) have been fitted for this purpose. The study reveals that in respect of R^2 , $\log Y = (a + bt)^{-1}$ ($R^2 = 99.56\%$) for cattle and $\log Y = a + bt$ ($R^2 = 93.38\%$) for buffalo were found most fitted curves. The projections of populations of cattle and buffalo for the year 1990 and 2000 have also been worked out.

35. ANALYSIS OF THREE WAY CONTINGENCY TABLE AND MARKOV CHAINS

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Some useful tests for three way contingency tables and finite Markov chains are presented. The procedure depend on the use of a minimum discrimination information statistics (MDIS) and its asymptotic distribution properties. Tests of hypotheses of specified probabilities, independence, homogeneity of classifications, symmetry and no second order

interaction are developed for three way contingency tables. The test of hypothesis of no second order statistics is also carried out by defining it in the sense of an hypothesis of 'generalised' independence of classification assuming second marginal restraints as fixed. In this case the method of iteration is used to estimate the cell frequencies. For Markov chains, the test include the hypothesis of a specified matrix of transition probabilities, an unspecified matrix of transition probabilities, Markovity and homogeneity of several realizations of Markov chains. Sequence of discrete random variables capable of taking only a finite number of different values is discussed. Examples of the application of the statistical tests are given in the paper.

36. SOME CONTRIBUTION TO THE ANALYSIS OF FOUR-WAY CONTINGENCY TABLE DATA

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A contingency table is essentially a sample from a multivalued population with the various probabilities and partitions of the categories subject to restrictions in addition to those of the multinomial distribution. The analysis of contingency tables may, therefore, be closely related to that of multinomial samples. The procedure proposed here depends on the use of a minimum discrimination information statistics (m.d.i.s.) and its asymptotic properties. A consistent and simple approach based on the principle of minimum discrimination information is used to generate various hypotheses of no-interaction, of four way contingency table when certain marginals are considered as fixed. The hypothesis of no r th order interaction is defined in the sense of an hypothesis of generalized independence of classifications with fixed r th order marginal restraints. The no interaction cell frequencies are estimated by using convergent iterative procedure where estimated cell frequencies cannot be expressed as the functions of the specified marginals. It has been observed that the number of cycles required are different for different sets of marginals and also different for different effects for the same set of marginal restraints. The various hypotheses of independence, no, first, second and third order interaction in a four way contingency table are tested with valid interpretations using minimum discrimination information statistics as the test statistics. The results corresponding to different sets of marginals are presented in the form of analysis of information tables. The analysis is shown to be analogous to a forward stepwise type of multivariate regression analysis. The results are illustrated through a real life numerical example taken from literature,

37. IDENTIFYING ATTRIBUTES FOR ADVERTISING EFFECTIVENESS

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Various criterians have been formulated by researchers to measure the effectiveness of an advertisement. An attempt has been made to identify some important attributes and to rank them according to their significance in creating favourable selling climate by an advertisement. Firstly ten attributes were identified on the basis of information collected from respondents divided into three strata namely, university post-graduate students, university teachers and company executives dealing with the advertisements. These attributes are ranked according to percentage of respondents who were favourable to them as: Noticeability, Comprehension, need creation, interestvalue, memorability, believability, affective impact uniqueness, sociability and imagination stimulus. Wilcoxon test indicate significant differences between desired and existing level of attributes expressed by both executives and customers. This supports the belief that there exists a need for improvement in the future advertisements to make them more effective. Fridman test revealed that different categories of respondents have significant difference among themselves as regards the criterion to measure advertisement effectiveness. Also various advertisement effective attributes have significantly different appeal among the different respondents. These findings will be useful to the advertisers in designing advertisement campaigns and creating effective selling climate.

38. GROWTH ANALYSIS OF AREA, PRODUCTION, AND YIELD OF POTATO IN MAJOR POTATO GROWING STATES OF INDIA

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The growth rates of area, production and yield of potato for major potato growing states namely Assam, Bihar, Madhya Pradesh, Punjab, Uttar Pradesh, West Bengal and Himachal Pradesh have been studied utilizing the secondary data for a period of 30 years from 1950-51 to 1979-80 divided into 3 decades each. Exponential functions $Y_i = A \cdot B^t$, $i = 1, 2, 3$ differently for yield, area and total production have been fitted over time and growth rates studied.

The analysis revealed that area under potato increased in many states during 1950-51 to 1979-80. The growth rate of production was highest in

Bihar (19.99%) followed by Madhya Pradesh (19.12%) during 1950-51 to 1959-60. All the states witnessed positive growth in production of potato during 1970-71 to 1979-80. Decline in the yield rates was observed in Bihar and Madhya Pradesh during 1950-51 to 1969-70 where as positive increase in yield rates was witnessed in Assam, Punjab, Uttar Pradesh, West Bengal and Himachal Pradesh during 1970-71 to 1979-80.

39. A STUDY OF VARIETY REPLACEMENT IN PADDY CROP

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Since the introduction of high yielding varieties of major crops in the mid sixties, a number of varieties have been introduced from time to time. Many were found popular among farmers and continued to be adopted for many years before they were replaced by new varieties while some did not prove successful and were replaced by the cultivators. It is not known how long a high yielding variety continued to be adopted by the farmers and what is the extent of its adoption in different parts of the country. An attempt has been made to answer some of the above questions utilising data collected in an IASRI Research project conducted on paddy crop in Ernakulam district of Kerala State.

It was observed that nearly two-fifths of the cultivators had replaced the crop variety during the period 1979-80 to 1984-85 under study while the rest continued to grow the variety adopted by them earlier. During this period as many as 15 HYVs and 25 local varieties were reported to have been grown by the farmers. However, out of these only 6 HYVs and 8 local varieties were extensively cultivated by a majority of the farmers while the rest did not find acceptance and were by and large dropped. The accepted varieties of HYV were under cultivation for the past 7 to 15 years while the local varieties were cultivated for the past 7 to 50 years or so. The change was both from HYV to HYV/local and local to HYV/local. The main reasons for changing the variety were—for better yield, better grain quality, experimentation with a new variety, to fit in the cropping pattern, susceptibility to pest and disease attack, suitability to local conditions etc. Only about 15 per cent of the farmers grew more than one variety during a season for reasons more or less similar to the above.

40. AN ANALYSIS OF CONSTRAINTS IN ADOPTION OF HYV OF RICE

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The main thrust in agricultural development programmes is to ensure

timely availability of inputs in sufficient quantities and provision of adequate attention and resources to remove specific problems and difficulties so as to achieve higher production. An integral component of these programmes is the conduct of assessment and evaluation studies to bring to light the degree of achievement of the objectives of the programme as also the difficulties and bottlenecks faced in the implementation of the programme. In this paper such an evaluation study has been made with the help of data collected under an IASRI project in Ernakulam district of Kerala State during 1984-85. The study pertained to constraints in adoption of HYV rice.

It was seen that of the total rice growing farmers nearly 62 per cent did not adopt high yielding varieties at all or cultivated such seeds in only a part of their area under rice crop. The main constraints for partial or non-adoption of HYV of rice were reported as unsuitable local conditions (34 per cent farmers), lack of knowledge in HYVP/extension efforts and poor quality/taste of grains (16 per cent farmers each), lack of financial resources and growing HYV seeds results in less fodder (10 per cent farmers each) and non-availability of adequate quantity of good quality seed in time and susceptibility of HYV seeds to pests and diseases (7 per cent farmers each). A deeper examination of these constraints over the different holding size classes revealed that these constraints were statistically neutral to scale.

41. A STUDY ON USE OF HUMAN LABOUR FOR DIFFERENT AGRICULTURAL OPERATIONS IN THE CULTIVATION OF VEGETABLE CROPS IN DELHI

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For cultivation of agricultural commodities, human labour is essentially required for every agricultural operations carried out for the purpose. Since the farmers want to make the best of their scarce farm resources for getting maximum overall financial gain from their farm as a whole in an agricultural year, the optimum utilization of human labour on each and every agricultural operation attains a great significance. Role of human labour in different agricultural operations in case of vegetable crops is viz. Peas, cauliflower and Lauki is studied in this paper, using the data obtained from the survey on "Cost of cultivation of vegetable crops" in Delhi conducted by IASRI, during 1978-81.

42. STATISTICAL METHOD FOR ESTIMATION OF LOSS IN DRY POD YIELD DUE TO TIKKA AND RUST IN A GROUNDNUT VARIETY

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A linear equation model was used to obtain the prediction equation to find out the dry pod yield of groundnut due to intensity of tikka (X_1) and rust (X_2) as

$$Y = 37.08 - 0.0991 X_1 - 0.0856 X_2$$

Using this equation, the relation of percentage loss in dry pod yield (L) in terms of the percentage intensity of *tikka* (X_1) and the percentage intensity of rust (X_2) was obtained as

$$L = 0.2671 X_1 + 0.2305 X_2$$

This equation is useful to estimate the percentage loss in dry pod yield of groundnut (var *SB-XI*) due to *tikka* and rust.

43. A STUDY OF STORAGE LOSSES IN WHEAT DUE TO INSECT DAMAGE

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This study was conducted in villages Hambran and Dakha of Ludhiana District in Punjab. A grain sample of 250 gm was taken from 40 families, twice in the season—after a storage period of 3 and 9 months. The grains were tested for percentage weight loss, moisture content and germination. The main findings of the study revealed that Drum was the ideal storage structure, best suited to the environments in rural areas, as the grains stored in it had minimum weight loss and maximum germination. Fumigation was quite effective in reducing the storage losses. The percentage weight loss was less in the treated grains as compared to the untreated ones. There was a direct relationship between moisture content, weight loss and germination of the stored grains.

44. STUDIES FOR OBTAINING PRE-HARVEST SUGARCANE YIELD FORECASTS

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With a view to develop suitable model for forecasting pre-harvest esti-

mates of sugarcane yield, a pilot study was carried out in Kolhapur district (Maharashtra) during 1977-78 to 1979-80. Singh *et al.* (1976) and Jha *et al.* (1981) have developed suitable forecasting models based on biometrical characters for wheat and sugarcane crop respectively adopting multiple regression technique. This paper aims at examining the usefulness of forecasting equations using the technique suggested by Box and Wetz (1964). Multiple regression equations were fitted adopting four different models taking yield as the dependent variable in original scale and biometrical characters as the independent variables in original, logarithmic, square-root and reciprocal scales. It was found that no significant gain was achieved in R^2 values by transforming the independent variables. For selection of variables to enter finally in the prediction equation the technique of step-wise regression has been used. It was observed that number of canes, their height and girth would be adequate to forecast the yield at different stages of crop growth and these characters explained over 70% of variation in yield when the crop was seven months old. Therefore, a pre-harvest forecast of sugarcane yield is feasible at this stage.

45. EFFECT OF DRAINAGE SYSTEM ON AGRICULTURAL PRODUCTION IN FLOOD AFFECTED AREAS

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Out of 1500 million acre-feet of flood water in Indian rivers, only 120 million acre-feet of water is being harnessed. (An acre-feet means that quantity of water which would be necessary to cover one acre of land with water one foot deep). The area endangered by floods is nearly 20 million hectares in our country.

The disaster can be minimized by making flow of unwanted flood water to the sea in a systematic manner. This can be achieved, to some extent, by improving drainage system in such a way that the water takes its natural course immediately and without obstruction. This will also reduce loss of agricultural production in flood affected areas. The study, to this effect, is carried out under different drainage systems in-vogue in the selected villages of four tehsils of Faizabad districts, from where the data was collected on occurrence of flood, drainage system, inputs and yield in unaffected and flood affected areas under the, 'Pilot Sample survey to study the impact of flood on agricultural production in a region of U. P.' during the year 1981-83. The study revealed that the fields with better drainage system has higher productivity after being affected by flood even for paddy crop.

46. A STUDY ON ADDITIONAL YIELD OF HYV OF RICE OVER LOCAL VARIETIES

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IASRI, New Delhi

An attempt has been made to study the additional return per kg of additional *NPK* applied on high yielding variety of rice crop over the indigenous variety by utilizing the secondary data as available under one of the research projects, of IASRI, on sampling investigations into high yielding varieties programme. The data utilized pertained to one selected district from each of the four region of the country. It was seen that though the additional yield obtained for HYV over local for every additional dose of *NPK* was quite encouraging, but was highly variable both over space and time, being in the range of 5-10 kg in the southern region (Trichur-Kerala) : 8-27 kg in the Eastern region (Saran-Bihar); 12-22 kg in the Western region (Bilashpur-Madhya Pradesh) and 17-27 kg in Northern region (Ambala-Haryana). These high order of imbalances in the additional yield of HYV over local for every additional dose of *NPK* both over the years and different regions call for a deeper investigations of the Causal factors for such variations.

47. STATUS OF FORESTRY STATISTICS IN ENVIRONMENT MANAGEMENT

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IASRI, New Delhi

Forests are among the most natural and renewable resources and play an important role in maintaining the quality of environment. For proper management of forest resources of the country it is necessary that reliable data should be available on a continuous basis over many years on (i) statistics of forest resources namely, species-wise area and production of major and minor forest products, manpower engaged and pressure of grazing animals etc. and (ii) Statistics of management of forests lands such as type and extent of vegetation, topography, soil conservation and run off etc. The available statistics on these and other related parameters need to be refined as demand for such refinement arises with time. There is need to conduct research in the sample surveys on forestry, designing of silvicultural experiments and on problems of forest inventory.

48. FODDER CULTIVATION—A COST STUDY

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With increasing emphasis on livestock development in the country, studies on costs and returns of cultivated fodder crops have assumed great importance. An attempt has been made to estimate the cost of cultivation of major fodder crops grown both in rabi and kharif seasons based on data collected in the survey in Jallander district of Punjab State, 1983-84. The production in quintals per hectate of jowar, bajra, maize and berseem was estimated to be 274, 261, 238 and 718 respectively. The production cost per hectare of jowar, bajra, maize and berseem was Rs. 1161, Rs. 1257, Rs. 1322 and Rs. 5475 respectively. Berseem and jowar were found to be more remunerative.

49. A STUDY OF FERTILISER USE ON HIGH YIELDING VARIETIES OF RICE IN DIFFERENT HOLDING SIZE CLASSES

SATYA PAL, P. C. MEHROTRA and V. P. N. SINGH
IASRI, New Delhi

A study on the extent and intensity of fertiliser use on high yielding varieties of rice in different holding size classes was undertaken. For this purpose the secondary data as available under the IASRI project on sampling investigations into high yielding varieties programme in Bilaspur district of Madhya Pradesh during the period 1974-75 to 1979-80 were utilised. The study, through appropriate tests of significance, revealed that the proportion of high yielding varieties rice area receiving bulky manures, nitrogen and phosphorus as well as their average rates of application expressed as a proportion of the recommended levels were by and large neutral to scale in each of the six years.

50. A STUDY ON USE OF INSECTICIDES AND PESTICIDES IN VEGETABLE CULTIVATION

JAG MOHAN SINGH and A. K. GUPTA
IASRI, New Delhi

A study was carried out on the effect of use of insecticides and pesticides in cultivation of vegetable crops in Delhi. Apart from other inputs, the data was collected on the use of insecticides and pesticides in cultiv-

ation of different vegetables and yield from them under the "Pilot Sample Survey to evolve a sampling methodology for estimating the cost of cultivation of vegetable crops", conducted by I.A.S.R.I., during 1978-81. The study revealed that, in most of the cases, use of insecticides and pesticides could be reduced, thus reducing the cost of cultivation of vegetable crops.

SECTION : B

51. SOME NEW GROUP DIVISIBLE DESIGNS

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Vartak (1959) has constructed rectangular designs on replacing unity by the incidence matrix N_2 of a B.I.B.D. $(v_2, b_2, r_2, k_2, \lambda_2)$ and zero by $v_2 \times b_2$ null matrix with the incidence matrix N_1 of a B.I.B.D. $(v_1, b_1, r_1, k_1, \lambda_1)$. This design degenerates into a $L_2(S)$, when $N_1 = N_2$ and can not degenerate into a G. D. design. Rizvi (1982) constructed rectangular designs on replacing Zero by the incidence matrix of a S.B.I.B.D., $(4t + 3, 2t + 1, t)$ and unity by I_{4t+3} in the incidence matrix of a S.B.I.B.D. $(n, n - 1, n - 2)$ and concluded that these designs degenerate into a G.D. design where $t = (n - 2) \neq 1$. This conclusion is, however, not correct. On the contrary the above designs degenerate into G.D. designs when $t = 1$ and $n \neq 3$ or when $t \neq 1$ and $n = 3$. The designs which are obtained for $t = 1$ and $n = 5, 6, 7, 8$ respectively are not mentioned in Clatworthy (1973) and seem to be new designs. Two more G.D. designs which are not mentioned by Clatworthy (1973) can be obtained on replacing unity by the incidence matrix of a S.B.I.B.D. $(7, 3, 1)$ and Zero by $E_{7,7}$ in the incidence matrix of S.B.I.B.D. $(3, 2, 1)$ and S.B.I.B.D. $(4, 3, 2)$ respectively. As the efficiency of all these designs are quite high, these designs are of considerable practical utility.

52. PARTIALLY VARIANCE BALANCED DESIGNS WITH UNEQUAL BLOCK SIZES

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If the number of treatments in a varietal trial becomes large, the

experimenter may be interested in conducting the experiment with a small number of replications, say two or three for reasons of economy and non availability of large amount of experimental material. Such situations usually occur in genetical experiments. Here a rectangular design with two replications, each of the mn treatments (one replication of m blocks of size n and another of n blocks of size m) is constructed. Estimates of the treatment effects, variances of the elementary contrasts and efficiency of the design have been obtained by a simple method. This design, however, degenerates into a simple lattice design when $m = n$.

53. ANALYSIS OF A PB1B(2) DESIGN WITH ONE BLOCK MISSING

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The Analysis of a PB1B(2) design with a missing block (all the treatments in the missing block are the same associate of each other) is described through the estimation of missing observations following a non-iterative least squares estimation. The present method is simpler than that of Zelan (1954) and saves a lot of computational and analytical efforts.

54. CONSTRUCTION OF GROUP DIVISIBLE SECOND ORDER ROTATABLE DESIGNS THROUGH A GROUP DIVISIBLE DESIGN AND BALANCED INCOMPLETE BLOCK DESIGNS

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After Das and Dey introduced group divisible second order rotatable designs (GDSORD), several authors gave methods for the construction of these designs. In these methods, only one incomplete block design such as a BIBD, GDD or a BBD and some additional sets of points were used. In the methods suggested by Ramachandra Rao, Narasimham and Sastry at least three similar incomplete block designs were used for the construction of GDSORD. In this paper, another method is suggested for the construction of 2-GDSORD through a GDD and two BIB designs. The method is generalised for m -GDSORD where one GDD and m -BIBD are used.

60. ESTIMATION OF MISSING OBSERVATIONS IN EXPERIMENTAL DESIGNS

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Estimation of missing observations has been a long standing problem in experimental designs associated with the analysis of non-orthogonal data. Literature shows that some attempts have been made to solve this problem. In this paper a simple and systematic alternative procedure has been developed based on Analysis of Variance (ANOVA) approach. An attempt has been made for estimating the missing observations for Randomized Block Design (RBD) and Latin Square Design (LSD). Some numerical examples are illustrated.

61. ON THE ANALYSIS OF TWO WAY CLASSIFICATION WITH UNEQUAL SUB CLASS FREQUENCIES

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Expression for the upper bound for interaction sum of squares in two-way unbalanced classification is modified on the lines suggested by Singh (1985) and compared numerically with the upper bound derived by Federer and Zelen (1966) and the least squares procedure. This expression for the upper bound gives the value of the interaction sum of squares more close to the exact value than that of Federer and Zelen (1966). By using the upper bound obtained here for the interaction sum of square, an indirect approach for analysis of two way classification with unequal sub class frequencies is suggested without going for matrix inversion.

62. ASYMMETRICAL FACTORIAL CHANGE-OVER DESIGNS

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This paper deals with asymmetrical factorial split type change over designs with v levels of the main factor and 2 or 3 levels of the sub-factor. Appropriate designs as also their analysis is presented in presence or absence of first order residual effects. All the variances of elementary contrasts of direct and residual effects are obtained.

63. ROBUSTNESS OF DESIGNS—REVIEW AND COMMENTS

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A large number of experimental designs, optimal in one or more sense, are available in the literature. However, most of the optimal designs have been derived under "ideal conditions". When the ideal conditions are not met, even an optimal design may turn out to be poor. Some of the conditions which tend to 'disturb' the ideal conditions are as under :

- (i) Presence of one or more out lying observation(s);
- (ii) Non-availability of data (missing observations);
- (iii) Presence of systematic trends over units within a block;
- (iv) Deviation of the assumed model from the true model.

In the presence of the above 'disturbances' it is worthwhile to characterize designs which remain insensitive to such disturbances or, are robust. The present paper aims at critically reviewing the existing literature on the robustness of designs and pointing out possible areas which require further research.

64. SELECTION OF K-BEST TREATMENTS USING PAIRED COMPARISONS

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There are situations where we may wish to choose the two best treatments or three best treatments without ordering them. Here we consider the problem of selecting a fixed number K of best treatments out of a group of t treatments using paired comparison design under indifference Zone formulation. All details regarding implementation of the selection procedures have been provided.

65. TRIALLEL EXPERIMENTS WITH RECIPROCAL EFFECTS

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The theoretical aspect of triallel analysis has been dealt with by Rawl-

ing and Cockerham (1962), Ninkelman (1965) and Ponnuswamy *et al.* (1974). It was shown by Zelen (1954) that a partially balanced design with $(m + 1)$ associate classes can be derived from a partially balanced design with m associate classes by replacing each treatment by n treatments. In the present study, a four class association scheme has been derived from a partially balanced design with 3-associate classes. The total $(v - 1)$, i.e. $[p(p - 1)(p - 2) - 1]$ d.f. has been partitioned into 4 sets of $(p - 1)$, $p(p - 3)/2$, $p(p - 1)(p - 5)/6$ and $5p(p - 1)(p - 2)/6$ d.f. said to belong to general combining ability (g.c.a.) effects, first order specific combining ability (s.c.a.) effects, second order s.c.a. effects and reciprocal effects respectively. There is complete balance over these sets of degrees of freedom, in the sense of Shah (1958).

66. APPLICATION OF THE TECHNIQUE OF BALANCED FACTORIAL EXPERIMENTS IN AGRICULTURAL EXPERIMENTATION

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In agricultural field experiments factorial experiments are generally conducted in randomised block designs if the number of treatment combinations are less than 12. However, when the number of treatment combinations are equal to or exceed 12, we resort to incomplete blocks, particularly in agronomic field trials. There exist different procedures for constructing factorial experiments in incomplete blocks depending upon the number of factors bearing the same or different number of levels (i.e. symmetric or asymmetric) and as such separate methods of analysis are known which may be cumbersome to apply. The analysis of balanced factorial experiment known as BFE simplify the analysis of factorial experiments which are conducted in incomplete blocks and the procedure is applicable when the factorial experiments are conducted in complete blocks also. In this communication to illustrate the technique of analysis of balanced factorial experiment the data of an actual field experiment has been utilised.

67. OPTIMUM PLOT SIZE FOR INSECTICIDAL TRIALS

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Recent reports suggest that the variability due to pest attack is much

larger than that created by soil variability and a much larger plot size should be used for pesticide trials. Since this variability created by pest attack depends on the nature of attack of the pest, it becomes necessary to have studies of different pests, to confirm the above view points. The present study was done on tomato fruit borer (*Heloithis armigera*). This pest being a major pest attacking many different crops thus study has got a general importance also. For the study 216 plants of tomato var. Pusa Ruby was planted during monsoon season of 1985 and the crop was grown without plant protection measures. The observations under analysis were the number of infested fruits, percentage infestation based on number and weight. Unlike the earlier reports the variation due to pest attack was only slightly larger than those created by soil heterogeneity and could be brought within allowable limits by increasing the plot size.

68. OPTIMUM PLOT SIZE FOR PLANT PATHOLOGICAL TRIALS

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Uniformity trials to fix optimum plot size for yield trials have been conducted on many crops. Recent reports on uniformity trials on pesticide trials suggest that much larger plot size than usual should be taken up due to the inherent increase in variability. An attempt was made to examine the situation in plant pathological trials. For the present trials powdery mildew on okra which is a very fast spreading disease in optimum environments was taken. Smith's law fitted but due to the nature of the disease there is very little disuniformity. It is suggested that in cases of similar fast spreading diseases the plot size should not be fixed on the basis of variation between plants but on the basis of operational convenience for undertaking differential sprays.

69. ANALYSIS OF SOIL TEST CROP RESPONSE EXPERIMENTS WITH AUTOREGRESSIVE ERROR STRUCTURE

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Regression models are calibrated for each crop for prediction of yield and optimisation of nutrients in a given soil and agroclimatic situation. In a few situations, the response coefficients were found to be insensitive although the models were having a high and significant predictability. Based on the analysis of plotwise residues of four rice experiments in a vertisol, it was found that the residues were autocorrelated and hence the

regressions were inappropriate for further interpretations. The autocorrelations were tested using Durbin-Watson's test and the residues have been distributed with first-order autoregressive error structure. Hence, models which belonged to the general class of mixed Autoregressive Moving Average (ARMA) models of Box and Jenkins (1970) are calibrated for the rice residual data of four seasons. Based on the tests developed for predictive relationships by Nelson and Schwert (1982), the ARMA models of residues were compared and inferences are drawn about the usefulness of an autoregressive error model for STCR predictions.

70. ON OUTLIER DETECTION AND TESTING FOR ROBUST MODELING WITH SOIL TEST CROP RESPONSE DATA

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One of the objectives of Soil Test Crop Response (STCR) Correlation Project is to calibrate location specific crop-wise models of yield in terms of soil and fertiliser parameters, in order to make both yield prediction and nutrient optimisation. Statistical analysis of residues of a few sets of data has indicated that (i) a few observations were found to significantly contribute to the residual variance but had no influence on other parameters; and (ii) a few observations were found to significantly influence other parameters, although they had a smaller residual variance. Using the statistics as given by Cook (1977) and Andrews and Pregibon (1978), the influences of outlying observations based on standard STCR model are studied. An attempt has been made to identify and eliminate 'K-most' likely outliers in STCR data and calibrate robust multiple regression models which are free from both outliers and influential observations based on the methods as given by Gentleman and Wilk (1975a, 1975b and 1980).

71. CONSTRUCTION OF PARTIAL TRIALLEL CROSSES (PTC) FOR THE ESTIMATION OF GENETIC COMPONENTS OF VARIANCE

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The most often used mating designs, like Diallel provide unbiased

estimators for additive (σ_A^2) and dominance (σ_D^2) components of genetic variance in the absence of epistasis. However empirical evidence suggest that the absence of epistasis cannot always be taken for granted. In such situations the higher order mating designs like Trialallel and Double Crosses provide unbiased estimators for σ_A^2 and σ_D^2 besides the three first order epistatic components ($\sigma_{AA}^2, \sigma_{AD}^2, \sigma_{DD}^2$) and one of the second order epistatic components ($\sigma_{AAD}^2, \sigma_{ADD}^2, \sigma_{DDD}^2$). But the cost one has to pay for this additional information is enormous in the sense that these designs require too many crosses. Further, the structure of these mating designs are such that these designs provide only meagre degree of precision for main effects and two factor interaction components (which usually contains information on σ_A^2 and σ_D^2) and unwanted degree of precision for higher order interaction components (which usually contains information on epistatic components) and error component σ_e^2 . A solution to this paradoxical situation lies in taking only a sample of crosses out of all possible three-way or four-way crosses. Hinkelmann (1965) was the first to introduce the concept of PTC and provide PTC based on Extended Group Divisible Partially Balanced Incomplete Block Designs. In this investigation alternative methods of construction of PTC using BIBD and PBIBD (2) has been provided. It is worth noting that these PTC not only provides unbiased estimators for all those components estimable by full trialallel but also rectifies the structural imbalance and provide more precise estimators for σ_A^2 and σ_D^2 at the cost of the precision of epistatic components and error component. The parametric range of designs considered for construction of PTC in this investigation is as given below:

$$(A) \text{ BIBD} \quad : 6 \leq v \leq 25, \quad 7 \leq b \leq 60, \quad 3 \leq k \leq 5, \quad 2 \leq r \leq 10 \text{ \& } 1 \leq \lambda \leq 5.$$

$$(B) \text{ PBIBD}(2) : 6 \leq v \leq 25, \quad 3 \leq b \leq 80, \quad 3 \leq k \leq 5, \quad 2 \leq r \leq 10, \\ 0 \leq \lambda_1 \leq 10 \text{ and } 0 \leq \lambda_2 \leq 4.$$

72. PROBABILITY OF NEGATIVE ESTIMATES OF HERITABILITY IN ONE-WAY UNBALANCED RANDOM MODEL

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The heritability, a genetic parameter, is a non-negative value between zero and one. Negative estimates of the heritability are frequently obtained in animal breeding experiments. The probability of negative estimates of heritability has been derived by Gill and Jenson (1968) for balanced random models in normal populations. This paper derives the probability

of getting negative estimates of heritability in half sib populations one way unbalanced random model. An approximation for the same has also been obtained using the two moments approximation for the non-null distribution of between groups sum of squares by some constant times chi-square.

73. STABILITY OF SOME WHEAT VARIETIES IN TERAI SOILS OF WEST BENGAL

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The expression of a character in a genotype is dependent on the interaction of the genotype and environment. It is due to this reason that a high yielding genotype may not remain high yielding in all environments. Therefore, the stability in the performance of different characters in the context of different environments is an important criterion in discriminating genotypes. The methods suggested by Eberhart and Russel (1966) based on some modifications of Finlay and Wilkinson (1963) and by Freeman and Perkins (1971) for studying the adaptability of genotypes make possible the evaluation of their relative stability. In the present investigation, the data on four characters viz., yield/plant (gms), 100-grain wt. (gms), height (cms) and number of days to maturity of 19 wheat varieties grown in Terai soils of West Bengal under four different environments were utilized in studying the stability of the varieties assuming the model of Eberhart and Russel (1966). The wheat variety 'HD 2270' was found to fulfil to the greatest extent the requirements of a stable variety in respect of all the four characters and the variety 'HD 2285' was found to fulfil the same with respect to three of the four characters considered.

74. PATTERN OF CHARACTER ASSOCIATION IN SEGREGATING AND NON-SEGREGATING GENERATIONS OF A SELF-POLLINATED CROP FOR YIELD COMPONENTS

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Estimates of phenotypic and genotypic correlation coefficients among five characters namely plant height, number of grains per spike, grain weight of three spikes, 100 grain weight and yield per plant in F_1 (Non-segregating) and F_2 (Segregating) populations were obtained in a self

pollinated crop of bread wheat (*Triticum, aestivum* L. em. Thell). The genotypic values, in general were greater than the phenotypic values and their directions were the same. Due to non-availability of appropriate test statistic for testing the significance of genotypic correlation coefficients, use of Z-transformation is suggested for testing significant differences between genotypic correlations to detect the validity of the association at genotypic level.

75. CONSTRAINTS IMPEDING MILK YIELD OF CROSS-BRED COWS IN A HILLY AREA

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In this paper an attempt has been made to determine the contributions of feed, management and other factors which influence the lactation yield of crossbred cows following causal modelling and production function methodologies, utilising data collected in the project 'pilot survey to study the performance of crossbred cattle under village conditions, Palampur area, (H.P.)'. It was seen that feed intake and housing conditions had a high direct effect on lactation yield. Feeding practices and stall area could not contribute to lactation yield.

76. ESTIMATION OF LACTATION YIELD USING LACTATION LENGTH AS AUXILIARY VARIABLE

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An attempt has been made to estimate lactation yield of cross bred cows using lactation length as an auxiliary variable and compare efficiency of various estimators of total lactation yield. The data on two cross bred cows viz. karan swiss and karan fries were taken from NDRI records for the period 1977-82. Simple random estimate, ratio and separate ratio estimates were compared for their efficiency. Separate ratio estimate was found most efficient estimator which was about 100 percent more efficient for karan swiss and 38 percent more efficient for karan fries compared to simple random estimate. The correlation coefficients between lactation yield and lactation length were worked out to 0.6495 for karan swiss and 0.5176 for karan fries which were found positive and highly significant. Analysis of variance of groups of lactation length showed significant effect on lactation yield. It was concluded that to get quicker estimates of lactation yield of cows separate ratio estimate using order of lactation as

stratum and lactation length as auxiliary variable could be tried to improve upon the simple estimate. Further it was concluded that lactation yield of cows having longer lactation length would be more than those having shorter lactation length.

77. STUDIES ON THE INFLUENCE OF ENVIRONMENTAL FACTORS UPON LACTATION MILK YIELD IN SAHIWAL COWS

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A study, on the milk production as influenced by some of the non-genetic factors in Sahiwal breed, was made. The influence of lactation, herd and age at first calving was found significant while the effect of season of calving period was found non-significant on the milk production. The average first lactation milk yield was 2170.17 ± 22.72 kgs with coefficient of variation 21.53 per cent. The heritability estimate of first lactation milk yield, obtained by half sib correlation method, was 0.146 ± 0.049 . The significant heritability estimate of first lactation milk yield suggests that further improvement in this trait can be brought by selection coupled with better care and management of Sahiwal breed.

78. ON AGE-SPECIFIC PREMIUM RATES FOR CATTLE AND BUFFALO INSURANCE

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Recognising the need for obtaining age-specific fertility and mortality rates in cattle and buffaloes of different breeds, the Indian Agricultural Statistics Research Institute has conducted a series of surveys in different agro-climatic regions of the country during the period 1974-81. The estimates of mortality rates of either sex obtained in these surveys were utilised in estimating premium rates for bovine insurance. A working formula was evolved for calculation of net and gross annual premium rates chargeable for a one year policy for different insured values and for different levels of mortality. These rates for different age groups are discussed only for Haryana breed of cattle and Murrah breed of buffaloes found in Punjab and compared with those charged by General Insurance Corporation of India (G.I.C.) on the basis of assumed mortality rate of about 2 percent per annum. The premium rates based on actual mortality for lower age groups upto 3 years were higher as compared to those charged by G.I.C. while in the higher age groups it was more than those of G.I.C. in 70 percent of the cases.

79. OPTIMUM RATION FOR BOVINES

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IASRI, New Delhi

Objective functions were formulated to evolve the least cost combination of feeds through linear programming techniques for different categories of cattle and buffaloes in four different zones viz, north, south, east and west into which the country was broadly divided. Separate constraints for the nutrient requirements were put on green-fodder, dry fodder and concentrates included in the feeding schedule and optimum solution obtained. The cost on feed was estimated on the price level for the year 1980-81. The quantities of constituting feeds were expressed as percentages of total quantity to be fed. It was observed that sugarcane-tops amongst greens, maize straw as dry fodder and gram as concentrate have constituted larger portion of total quantity of feed for bovines in north, east and south zones whereas in west zone, these were maize as green, lucerne and maize straw as dry fodder and gram as concentrate. The difference between least cost of feed over the zones was less than a rupee in all cases except in the case of buffalo bull and dry, adults and heifers in case of cattle. It was observed that in case of lactating buffaloes yielding upto 8 kg. milk per day and in all lactating cows, the difference in least cost over zones varied between 50 paise to one rupee while it was more than one rupee for buffaloes yielding more than 20 kg. milk per day. In case of buffaloes yielding 8 to 20 kg. milk per day, difference in the least cost over zones increased as the percentage of fat increased.

80. ON EFFICIENT USE OF LABOUR IN POULTRY KEEPING

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The study on utilisation of labour in poultry keeping was made using survey data collected from commercial poultry farms in Hoshiarpur district of Punjab and Delhi area. A method to work out norms on labour inputs was developed for properly channelising the available labour. Under the conditions prevailing in the area, about 60 layers can generate one hour of employment for one adult person per day in the farms where only family labour is utilised.

81. LABOUR UTILIZATION IN MAINTENANCE OF CATTLE
IN A RURAL AREA OF WEST BENGAL

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Labour being an important component for maintenance of cattle was

studied in detail utilizing data collected in a survey "Economics of raising cattle in a rural area of West Bengal, 1979" by IASRI. The input of different categories of labour was expressed in standard man hours and different categories of animals in standard animals. A crossbred cow in milk was considered as a standard animal and all other categories of animals were converted to standard animal utilizing multiple regression and feed-ratio method. Different categories of labour were converted to standard man labour on the basis of wage rates. Of the 384 households studied, about 73 per cent had family labour, 23 per cent both paid and family labour and 4 per cent only paid labour. About 2.2 standard man hours were utilized per standard animal per day. Of the total quantum of labour about 49 per cent was in the form of man labour, 43 per cent woman labour and 8 per cent child labour. Seasonal variation in labour input and norms for some items of labour were also studied.

82. DISTRICTWISE ESTIMATES OF MILK PRODUCTION, GUJARAT, 1983-84

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The number of cross-bred cows were estimated for the first time in Gujarat state during 1983-84. Their number in-milk constitutes to 74.3% of such cows. The estimate of number of indigenous cows during 1983-84 was 9.9 lakhs which is 7.0% less than the corresponding estimate of previous year. The maximum number of such cows are in Kachchh District, while, the least in Kheda District. Besides, 55.1% of milch indigenous cows were in-milk. The estimate of number of buffaloes in-milk in Gujarat were estimated to be 15.7 lakhs which was 15.4% more than the similar estimate of previous year. The highest number of in-milk buffaloes were in Kheda followed by Mahesana, while their number was the lowest in Kachchh District. The estimate of number of adult goats during 1983-84 in Gujarat was 21.1 lakhs as against the similar estimate of 20.9 lakhs during previous year. The maximum number of adult goats were in Kachchh and lowest in Kheda District during 1983-84. The estimate of milk yield per day per cross-bred cow during 1983-84 was about 3 times that of the indigenous cow. Milk yield per day per buffalo in milk has risen at an average rate of 1.25% from 1977 onwards. Mahesana District is having the best buffaloes, as their average milk production per day was the highest. However, in Panchmahal District it is just the reverse. The overall milk production in Gujarat during 1983-84 has increased by 24% over previous year. This increase is mainly attributed to two fold increase viz. in number of animals as well as their milk yield per day. About 2/3rd of the total milk

production is from buffaloes during 1983-84 as well as during previous year. The per capita availability of milk per day in Gujarat has improved from 173 grams during 1980-81 to 228 grams during 1983-84.

83. DISTRIBUTION OF NODULE FORMATION IN CHICKPEA (*CICER ARIETINUM L.*)

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It is well known that the number of nodules formed on the roots of a cultivar varies from plant to plant. A field experiment conducted during 1984-85 winter season at Banaras Hindu University to find out the distribution of nodules from plant to plant in chickpea (*Cicer arietinum L.*) and to pick up the right time for counting the nodules for further studies revealed that number of nodules follow Normal Distribution. It was also concluded with the help of Time Series Analysis that nodules should be counted at the end of 10th week after sowing which is also pod formation stage of the crop instead of at the end of 6th week (flowering stage) which is the general practice among the Microbiologists as nodules were maximum in number with least coefficient of variation at the end of 10th week.

84. A STUDY OF THE TREND OF FERTILISER CONSUMPTION IN ASSAM

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An attempt has been made to study the trend of consumption of fertiliser in Assam from 1971-72 to 1981-82. Data on consumption of N, P_2O_5 and K_2O in Assam for the entire period under study were collected from secondary sources and were analysed by fitting appropriate trend equations. Consumption levels were found to have assumed quadratic trend. While a declining trend in consumption of N, P_2O_5 and K_2O was observed in the initial period, in the later period it assumed a highly increasing trend. The increase, however, failed to keep pace with that at all India level. Per hectare consumption of fertiliser in the State appeared to be extremely low. Consumption ratios of N and P_2O_5 in relation to K_2O were far from satisfactory. To achieve the desired ratio, the relative consumption of P_2O_5 had to be increased.

85. EVALUATING RESPONSE TO FERTILIZERS : MULTI-NUTRIENTS ANALYSIS

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Building and choice of response models to predict future responses to multinutrients fertilizer, being important steps in fertilizer use research, has been discussed in the present paper. Lie-big's law of the minimum which is a simple, logical and efficient predictor of crop response to fertilization is considered. A statistical method is reported for fitting the law by least squares regression to yield responses to two essential factors, with optional inclusion of a limit to maximum yield. To evaluate the merits of the response model, a comparative study has been made with other models such as quadratic, linear-plateau and inverse quadratic. Techniques for fitting, parameter estimation, and economic interpretations are described. The proposed model may be recognised as an appropriate working model for describing and interpreting fertilizer response, identifying nutrients limiting yield and estimating the return from added nutrients. For multi-nutrient experiments a complete factorial experiment with a number of levels of each nutrient is considered to be the best design for both evaluating the model and the optimal nutrient levels.

86. EFFICIENCY OF ROCK PHOSPHATIC FERTILIZERS ON PADDY IN DIFFERENT TRACTS OF BIHAR REGION

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To get some definite idea of the use of rock Phosphate (Singhbhum) as compared to single super phosphate for increasing the yield, statistical studies on the experiments conducted at Patna, Kanke and Sabour in Bihar region were made. Effect of Singhbhum rock phosphate on Paddy yield varied on different soils and this gave an increasing trend particularly in sandy loam soil at Sabour whereas at Patna and Kanke the effect was not significant. Sabour is in gangetic tract and the moisture in soil is always present to absorb the P_2O_5 from rock phosphate. With the dose 22.5 Kg P_2O_5 /ha beneficial and non-beneficial rock phosphates gave 22% and 17% increase in yield as compared to super phosphate.

87. ECONOMICS OF FERTILIZER APPLICATION FROM 'ON FARM TRIALS' TO MUSTARD CROP

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The study of data of experiments on mustard crop conducted on cultivators' fields under All India Co-ordinated Agronomic Research Project during 1977-78 to 1982-83 in the three states of U. P., Rajasthan and Haryana has shown that the scope and extent of fertilizer use that would bring equitable profits to farmers has been quite substantial. On the basis of average responses obtained for various fertilizer doses it was found that though the total net returns increased with the increase in the cost of fertilizer applied, the percent net profit decreased in each of the three states. U. P. and Haryana gave higher percent net profit as well as higher total net profit as compared to Rajasthan. Taking the percent net profit into consideration, it was found that fertilizer application at the lowest level of 20 Kg N/ha was the most remunerative in U. P. and Haryana whereas in Rajasthan a combined dose of $N_{40}P_{20}$ was more remunerative than others. Thus a marginal and a small farmer with limited resources can earn more profit on mustard by investing less on fertilizers.

88. YIELD TRENDS OF GROUNDNUT IN INDIA OVER THE LAST 3 DECADES

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Oilseeds occupy an important position in the agricultural economy of our country, these being the major source of fats and oils and for providing an essential raw material for soap and varnishing industries. Fats and oils constitute a concentrated source of calories and help to reduce the total bulk of food needed to meet calory requirements. Currently about 14 million hectares are planted with major oilseeds like groundnut, castor seed, rapeseed, mustard and linseed compared to 38 million hectare under rice and 23 million hectare under wheat. An attempt, to study yield trends of groundnut over last 30 years, has been made with a view to examine whether the production have remained steady or increased and to predict the production of these crops in the coming years. For this purpose three models have been fitted viz. linear, quadratic and Cobb-Douglas with years as the independent variable and production as the dependent variable. It was observed that among the functions fitted, the Cobb-Douglas was found to be the best, this function explaining about

70 per cent of the total variation. This function was used to forecast the production of groundnut for future years.

89. A STUDY OF ASSOCIATION BETWEEN HYV WHEAT SEED SOURCE AND SIZE OF HOLDING

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Once the high yielding varieties programme (HYVP) had spread to substantial proportion of the crop area in the country a number of queries were put forth by the planners and policy makers namely—has the HYVP been taken up by all types of farmers, whether the associated package of improved practices have been adopted as per the recommended levels, what are the constraints in the spread of the programme and in the adoption of the improved practices etc. Of the various inputs, seed is one of the most crucial and important constituent. Also seed obtainable from institutional sources is of assured quality. In the present study the extent of adoption of institutional seed over time and space has been investigated, with the help of data collected on wheat crop under the IASRI project on sampling investigations into HYVP during the period 1974-75 to 1979-80. Out of the 25 districts studied in as many as 15 districts less than 30 percent of the area under HYV wheat was sown with institutional seed in each of the six years. In only four districts 50 percent or more of the area under HYV wheat was sown with seeds obtained from institutional sources. Also, the proportion of area under HYV wheat sown with institutional source did not show any specific trend with the size of holding in any of the district in all the years.

90. CROP PRODUCTION DIFFERENTIALS—A CASE STUDY OF SOME SELECTED FACTORS IN EASTERN UTTAR PRADESH

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The present paper attempts to examine the various districts and the whole of eastern Uttar Pradesh; with regard to crop production differentials, for important cereal (wheat and rice) and noncereal (Sugar cane) crops, by running linear regressions to the respective time-series (1966-67 through 1981-82) data of three selected indicator variables, viz. (i) area under High Yielding Varieties (H.Y.Vs.) (ii) consumption of nitrogenous/phosphoric/potassic fertilizers and (iii) the per hectare yield. The eastern

Uttar Pradesh as a whole, recorded an average per annum growth rate of 37.15 percent and 46.69 percent for area under H.Y.V. of wheat and rice; 21.88 percent, 16.50 percent and 8.73 percent for consumption of Nitrogenous, phosphoric and potassic fertilizers; and 2.94 percent, 3.68 percent and 0.25 percent for per hectare yield of wheat, rice and sugarcane; respectively.

91. TRENDS IN SUGAR RECOVERY IN UTTAR PRADESH

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Of the acreage under cultivation of about 13.28 million hectares in the world, India's contribution was 21.4 per cent during 1979-80. U. P. being the major sugarcane growing state of India occupies about 1.36 million hectares of which 47 percent falls under Western region and 17 and 15 percent in Eastern and Central regions. The average sugar recovery per cent of sugar from cane is the supermost factor which give rise to fluctuations in its productions and determining its cost. This paper aims at analysing the trend values in average sugar recovery per cent of sugar from cane for Western, Eastern and Central regions and U. P. as whole during 1970-71 to 1980-81. The analysis revealed that percent sugar recovery from cane in Western region were found to be higher than that of U. P. State as whole. The average sugar recovery from cane in this region varied from 9.01 per cent to 10.15 per cent during 11 years study and did not remain stable over years. Between Eastern and Central Regions the trend indicated almost an identical pattern of sugar recovery. During 1973-74, the steep decline in sugar recovery in all the regions of the State caused due to the late harvest of the crop. Maximum trend in sugar recovery in the three respective regions and in U. P. State were observed to be 10.15, 9.29, 9.79, and 9.74 during the year 1979-80. The average sugar recovery from cane during 1977-78 being record production period in Western Region contributing 69 per cent towards the production of U. P. State reduced as the whole production available in this particular period could not be utilised.

92. ACREAGE RESPONSE OF SUGARCANE IN THE STATE OF TAMIL NADU

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The present study is an attempt to investigate the role of various factors

affecting the acreage under sugarcane. The study has been undertaken for the state of Tamil Nadu which has highest productivity/hectare of sugarcane in India. To study the effect of price and non-price variables on acreage and production of sugarcane, data on area and farm harvest price of sugarcane and farm harvest price of its competing crop (paddy) for the 30 years period 1950-51 to 1979-80 have been utilised. Nerlovian Adjustment Model has been used for the analysis. The analysis has been carried out independently for each of the three major sugarcane growing regions viz. Carnatic, Central and South and also for the state as a whole. The entire period under study has been divided into two periods namely : Pre-high yielding Varieties Period : 1950-51 to 1964-65 and green revolution period : 1965-66 to 1979-80 while performing the analysis. The results show that for the entire period of 30 years the price variable has highly significant positive coefficient for all the regions as well as the state as a whole; indicating that farmers do respond to the changing prices in acreage allocation. During the pre-high yielding variety era the price effect is not strong enough to influence the acreage. In the green revolution period 1965-66 to 1979-80 the price variable is positively responded by farmers in their acreage allocation decision in the state as a whole and all the regions except Carnatic region which shows non-significant price effect. The relative price variable does not appear to have any influence on acreage allocation in any of the regions or the state during all the three periods with the exception of Central region. Wherein the relative price exerts positive significant effect for the entire period.

93. CONSUMPTION PATTERN OF 'FOOD' AND 'NON-FOOD' ITEMS IN THE O. R. P. VILLAGES AROUND KARNAL (HARYANA)

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The study on consumption pattern of 'food' and 'non-food' items in the O. R. P. villages around Karnal was undertaken to estimate the extent of malnutrition in the families belonging to different size of holding i.e. landless labourers, marginal, small, lower medium, upper medium and large farmers. Multi-stage stratified random sampling design was adopted for the purpose of selecting sample households. The family budget data of 115 sample households belonging to different categories were analysed to achieve the objective of the study. It was observed that the average per capita monthly expenditure was highest for the upper medium categories of households. About 49 to 63 per cent of the total expenditure was incurred on food items alone. The expenditure on milk and milk products

was observed to be lowest in case of landless families and the highest in the upper medium categories of households. The average per capita daily consumption of calories was lowest in the landless households and highest in the lower medium families. The landless and marginal categories of households were consuming less than the minimum requirement of 2400 calories. It was further noticed that the largest source of energy for almost all the categories of households was cereals. The next important sources of energy were "milk and milk products" and "sugar and Jaggery".

94. TRENDS AND VARIABILITY IN AREA, PRODUCTION, PRODUCTIVITY AND PRICES OF SUGARCANE, ITS COMPETING CROPS AND GUR IN INDIA

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A study was planned and designed with the objective of examining the trends in area, production, productivity and prices of sugarcane, its competing crops and *gur* in India during the period 1950-51 to 1979-80. Linear and exponential equations were fitted for computing the growth rates. Variability in area, production and other included variables was estimated by computing variability coefficients. The analysis indicated that at all India level, area under sugarcane increased annually at the rate of 2.01% and yield at 1.15% during the period under review. Production has increased at the rate of 3.16 per cent per annum. If these growth rates are maintained one may expect the production of sugarcane to go up by about 4.5 million tonnes per year. Statewise analysis indicated that growth rate of production was highest in Tamil Nadu (6.89%) followed by Karnataka, Maharashtra, Punjab, Andhra Pradesh, Uttar Pradesh and Bihar. Most of the tropical states had growth rates of area, production and prices higher than those of sub-tropical states. The states having high growth rates of cane or *gur* price also had high growth rates of area and/or production. The states with higher growth rates of competing crops assumed lower growth rates of area and/or production. The variability in area, production, productivity and prices was observed to be higher in the states having higher growth rates of these variables. The projected values of area, production and productivity of sugarcane showed an increasing pattern.

95. IMPACT OF CHANGE IN SIZE OF HOLDINGS ON THE WAGES OF AGRICULTURAL LABOURERS IN DELHI

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IARI

and

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Agriculture in India contributes about 40% of the Gross National Product and gives employment to about 70% of the labour force. According to the 1981 census, the working population of India is estimated to be about 38% of the total population of the country. It was felt to study the impact of change in size of holdings on the wages and living conditions of the agricultural labourers in Delhi. For this purpose, the data collected under the projects; "A Study on the effect of drought on agricultural production during Kharif (1979-80) and its possible impact, on the subsequent rabi crops in Delhi" and the Pilot sample survey "To study the impact of new technology on crop production, its disposal and employment in agriculture in Delhi" conducted by I. A. S. R. I. New Delhi, was utilized. The study revealed that with the decrease in average size of holdings under different size classes in Delhi, the number of agricultural labourers is increasing every year at an alarming rate. On the other hand, the average number of casual labourers employed per hectare of the holding was 1.27 and 2.13 persons during Kharif and rabi season of 1978-79, respectively. Of the nearly 26 and 64 mandays spent per hectare of the holding during kharif and rabi, about 16, 3, 7 and 47, 3, 14 were contributed by family members, permanent labourers and casual labourers, respectively, in the respective seasons. The average amount spent on human labour per hectare of the holding ranged between Rs. 214 and Rs. 115 during kharif and between Rs. 1008 and Rs. 352 during rabi over the different holding size classes.

96. FACTORS AFFECTING AREA ALLOCATION UNDER PURNA COMMAND AREA

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The study was conducted to examine the factors responsible for area allocation under purna Command area, which covers Parbhani and Nanded districts of Marathwada region. The Purna Irrigation Project commenced during 1962-63. Taking this a threshold the Nerlovian price lag

model has been used as a statistical tool for studying the area response for specially the farmers tendency to allocate area under particular crop. The analysis was based on twenty years data from 1960-61 to 1980-81. The study indicated that inspite of Irrigation facilities prevailing in the two districts of Marathwada region the farmer's tendency towards area allocation is mostly on traditional rather than commercial i.e. they allocate the area on the basis of previous years area and not on the basis of price even for major crops of the districts.

97. TRENDS IN AREA, PRODUCTION AND PRODUCTIVITY OF SUGARCANE IN MAHARASHTRA—A STUDY BASED ON IMPORTANT DISTRICTS.

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The trends in area, production and productivity of sugarcane were studied in important sugarcane growing districts and Maharashtra state as a whole according to the phases of development. The exponential trend equation $Y = AB^x$ was used to obtain compound growth rates taking years as an independent variable and index numbers of area, production and productivity as dependent variables. The study has revealed that the productivity of the state is more or less constant however, high fluctuations are in acreage and production. As the fluctuation in production are mainly due to fluctuations in acreage, efforts to stabilise the acreage and improve the productivity are required to be made.

98. LAND USE CAPABILITY AND LAND UTILIZATION PATTERNS IN ORISSA

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The study was undertaken in 1978-79 with a view to examining land use capability and land utilization pattern in the farms of Badasahi Block of Orissa. The study sample was selected using the two stage random sampling technique. The villages formed the first and the operational holdings the second unit of sampling. They provided a random sample of 32 marginal, 29 small, 25 medium and 22 large holdings. The study brought out that size groups of farms were significantly different in respect of operational holdings. Land use capability under different crops increased with the increase in size of farms. During *kharif* season, the most dominant crop was local *sali* rice followed by HYV rice in all the farm groups.

In *rabi* season, the most important crop was mustard in marginal and large holdings and HYV wheat in medium farms. This position was shared by HYV wheat, greengram (unirrigated) and mustard in small farms. No significant difference was found among the size classes of farms in respect of cropping intensity. Only marginal farms were statistically different from others from the view point of farm income.

99. AN ANALYSIS OF SEASONAL VARIABILITY OF RAINFALL AND CROP YIELDS IN TRIBAL DISTRICT OF EASTERN MADHYA PRADESH

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The analysis of rainfall and crop yields of Sidhi, Shahdol and Seoni districts call for scientific crop system for both the crop seasons in a year. There was higher rainfall and crop yield variability in Sidhi and Shahdol than Seoni district. Rainfall variability in *rabi* season was larger than that of *kharif* season whereas yield variability was larger in *kharif* crops. Paddy, Jowar, Tur and Kodo Kutki appear to be well adopted to the natural pattern of rainfall in *kharif*, whereas oil seeds seems to be the only potential crops for *rabi* season. The researches have come up with scientific crops sequence that leads to double cropping in these districts.

100. FACTOR ANALYSIS TO MEASURE REGIONAL DISPARITY IN HOUSEHOLD CONSUMPTION PATTERN IN PUNJAB

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An attempt has been made to investigate the regional disparity in household expenditure pattern of farm and non farm population in Kandi Tract as compared to rural population of Punjab. The objective of present analysis is to determine the number of factors with their respective share in explaining expenditure pattern for each category of population. Twenty two variables broadly categorised into three groups; namely, family size and its composition, different food and non food commodity groups and other socio economic characters of the family such as age and education of head were employed in the analysis. Secondary data related to these variables were obtained from N.S.S.O. 28th round (state sample) for rural population of Punjab and from Economics and Sociology Department, P.A.U. Ludhiana for farm and non farm families of Kandi Tract for the year 1979-80. Factors were extracted using Principle Axis method and rotated factor loadings were obtained using varimax method of rota-

tion. The analysis revealed that inter family variation in household expenditure of rural population can be explained up to 66 percent with 6 factors, namely, income, young family, necessities, adult family, age of head, education of head and luxuries respectively. Here, income factor alone accounts for 26 percent of variation. Only 3 factors could be detected in case of both farm and non farm families of Kandi Tract and they explained roughly 43 percent and 46 percent of the variation. Here, again income factors was most predominant and explained alone 29 percent and 33 percent of the variation in the inter family expenditure respectively. Number of factors extracted was less in case of Kandi Tract, thus emphasising lack of awackening about government development programmes in this region. The result clearly points out that inter family variations in this region cannot be explained meaningfully with income or total expenditure (as proxy for income) alone and they can be improved further by including more variables representing, for examples, size and composition of family, age and education of head and number of earners in the family.

101. STRUCTURAL ANALYSIS AND ROLE OF CONSUMER'S PREFERENCE IN MEAT MARKETING

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Demand structure and services desired by the consumers through their preferences are studied in this paper. Informations concerning to consumer's attitude towards meat marketing, reasons for their preferences and types of services preferred were collected and analysed by Mahalanobis D^2 and Cluster Analysis Techniques. From present investigation, one of the findings is that household's food habits are highly associated with the household size, its age and sex-composition besides the household income. In order to derive maximum possible information from selected clusters of respondents and their sequence of preferences, their responses were coded and presented in a matrix form and square of distances between two preferences were measured and analysed. Identification and analysis of constraints which influenced meat consumption were made and their relationship with consumption pattern, type of service, and other socio-economic vectors were derived.

102. A STUDY OF INCOME AND EXPENDITURE OF RURAL LABOUR HOUSEHOLDS IN DIFFERENT REGIONS OF THE COUNTRY

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In order to collect reliable data on income, expenditure, etc. of rural labour households the first labour inquiry was conducted by the National Sample Survey Organisation during 1950-51 and which was followed by similar enquiries after every five year. In the present study the income and consumption expenditure of different regions of the country are compared on the basis of labour enquiry 1974-75. For this comparison the country has been divided into five zones. These results show that the average size of the rural labour households is of the same order throughout the country. The average annual income per rural labour household is highest in the northern zone and is about 2.5 times the average annual income per rural labour household in the central zone which is lowest. The consumption expenditure is also highest in the northern zone and it is of the same order in all other zones. In eastern zone it is lowest, though not significantly different. But the percentage expenditure on food articles is highest about 83% in the southern zone. All these results indicate that the condition of the rural labour is in general quite poor and most of their earnings are spent on food.

103. THREE DECADES OF AGRICULTURE IN RAJASTHAN

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The progress in Agriculture from 1952-53 to 1981-82 have been studied. An attempt have been made to study the direct and indirect role of irrigation on the level of production in the state. Major Food Crops, Oil Seed and Pulses have been analysed separately. The analysis revealed that the growth rate of major food and oil-seed crops in area and production are significant under irrigated conditions. The linear growth rate model revealed that the growth rate of area, production and productivity food grains are 1.5, 3.2 and 1.6 percent respectively while that of oilseeds are 1.9, 5.2 and 2.1 respectively. The growth rate of area, production and productivity are maximum for wheat in food grains and for ground-nut in oil-seeds. The growth rates of Kharif pulses in area, production and productivity are 1.8, 1.3 and -0.5 percent respectively while that of rabi pulses it is 13.1, 23.1 and 2.9 percent respectively. The area under food

crops have increased by 80 percent and that of oil-seeds by 140 percent due to better irrigation facilities in the state during the last three decades.

104. CROP INSURANCE

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Crop insurance provides some relief to cultivators and to the financial institutions also because atleast partial recovery of loan is possible when the cultivators receive indemnities in the event of crop failure. Although there are many causes of crop failure the important ones are (i) Drought (moisture stress) (ii) Incidence of pest and diseases. Now-a-days many plant protection measures are available which can protect the crop from pests and diseases. There are no protective measures against occurrence of drought. The present scheme of crop insurance is crop loan insurance. Important features of crop insurance scheme are (1) Area approach (2) Subsidy to small and marginal farmers. Two considerations are involved in fixing the rate of premium (i) Non-indemnifiable limit (ii) Variation in yearly average yields. From the point of view of economic justice 100% subsidy in respect premium of crop insurance to small and marginal farmers is necessary. It seems that no separate crop cutting experiments are necessary but data of crop cutting experiments from general crop estimation surveys can be utilised for Paisevari and crop insurance also. For preparation of better estimates of crop production it is necessary to build up estimates in for categories viz. Hy/HYV irrigated; Hy/HYV un-irrigated, Traditional irrigated and Traditional un-irrigated.

The stratification may be irrigated and unirrigated for paddy, wheat and rabi jowar whereas Hybrid and Traditional varieties for Bajra and Kharif jowar.

NEWS AND NOTES

1. Dr. B.B.P.S. Goel, Agricultural Statistician, FAO (U.N.), Kathmandu, Nepal, has been elected as an Honorary Member of the International Statistical Institute, Netherlands. Dr. Goel is a Life Member and a Member of the Executive Council of the Society.
2. Dr. Randhir Singh, a Life Member of the Society joined as Sr. Professor of Sample Survey Methodology (Scientist S-3) at the Indian Agricultural Statistics Research Institute, New Delhi.
3. Dr. (Ms) Ranjana Agarwal, a Life Member of the Society joined as Scientist S-3 at the Indian Agricultural Statistics Research Institute, New Delhi.
4. Dr. A. K. Srivastava, Scientist (S-3), I.A.S.R.I., New Delhi was deputed for a training programme at University of Michigan, Ann Arbor, U.S.A. under an UNDP/FAO Programme. Dr. Srivastava is a Life Member of the Society.

mation μ_i . If $\mu_i = \mu$ for all i , the design is called efficiency balanced (EB) design.

Most of the work on PEB designs in literature have been devoted to the constructions and analysis of these designs. Recently, various properties on parameters of PEB designs have been studied by Kageyama and Puri (1985). In this paper, some structural properties of PEB designs are presented. These properties characterize some block structure of the designs. Results of Baksalary *et al.* (1980) for EB designs turn out to be the particular cases of our results.

58. ON CONSTRUCTION OF BALANCED ARRAYS

B. L. MISRA

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Rafter and Seiden (Annals of Statistics, Vol. 2, No. 6, 1974), have given several results on the theory and construction of balanced arrays. They have mentioned that the problem of construction of these arrays is very complex. In this paper, five results on non-degenerate balanced arrays have been obtained by a very simple method of construction. These balanced arrays are of strength two and three with symbols two/three.

59. SYMMETRICAL FACTORIAL STRIP TYPE SWITCH OVER DESIGNS

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NDRI, Karnal

The cross over designs have been used in several fields of research notably in nutrition experiments with dairy cattle, in clinical trails, in psychological experiments, in long term agricultural field experiments and in bioassays. These designs have however remained limited to the study of single factor ever since they were evolved. Just like experimentation in agriculture, factorial type of investigation is also useful for animal experimentation. At present no work in this regard is available in the literature. In this paper an attempt has been made to obtain factorial type switch over designs having arrangement of factors in the form of strips just like strip plot design in agriculture experimentation. Two factors at same levels have been considered. A method of construction of such designs has been described followed by a suitable method of its analysis for two situations (i) with the assumption of residual effect of factors and (ii) without any assumption of residual effect of the factors.

60. ESTIMATION OF MISSING OBSERVATIONS IN EXPERIMENTAL DESIGNS

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Estimation of missing observations has been a long standing problem in experimental designs associated with the analysis of non-orthogonal data. Literature shows that some attempts have been made to solve this problem. In this paper a simple and systematic alternative procedure has been developed based on Analysis of Variance (ANOVA) approach. An attempt has been made for estimating the missing observations for Randomized Block Design (RBD) and Latin Square Design (LSD). Some numerical examples are illustrated.

61. ON THE ANALYSIS OF TWO WAY CLASSIFICATION WITH UNEQUAL SUB CLASS FREQUENCIES

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IVRI, Izatnagar (U. P.)

Expression for the upper bound for interaction sum of squares in two-way unbalanced classification is modified on the lines suggested by Singh (1985) and compared numerically with the upper bound derived by Federer and Zelen (1966) and the least squares procedure. This expression for the upper bound gives the value of the interaction sum of squares more close to the exact value than that of Federer and Zelen (1966). By using the upper bound obtained here for the interaction sum of square, an indirect approach for analysis of two way classification with unequal sub class frequencies is suggested without going for matrix inversion.

62. ASYMMETRICAL FACTORIAL CHANGE-OVER DESIGNS

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This paper deals with asymmetrical factorial split type change over designs with v levels of the main factor and 2 or 3 levels of the sub-factor. Appropriate designs as also their analysis is presented in presence or absence of first order residual effects. All the variances of elementary contrasts of direct and residual effects are obtained.