

## ABSTRACTS OF PAPERS\*

### SECTION : A

#### 1. COMPARISON OF DOUBLE SAMPLING ESTIMATORS

D. N. SHAH and M. R. GUPTA

*Sardar Patel University, Vallabh Vidyanagar-388 120*

In double sampling, when the two samples are drawn independently, the modified regression estimators obtained by combining the information from both the samples are compared with the conventional regression estimators. The two cases are considered i.e. (i) when the regression coefficient  $\beta$  is known and (ii) when it is not known. It is established that modified regression estimators are superior to conventional regression estimators in both the above mentioned cases.

#### 2. A STUDY OF SECOND ORDER APPROXIMATION OF SOME PRODUCT TYPE ESTIMATORS

P. C. GUPTA and N. H. KOTHWALA

*South Gujarat University, Surat*

It is known that the ratio method of estimation provides a more efficient estimator of the population parameter than the mean per unit estimator in any sampling design provided there is high positive correlation. But we come across situations when this correlation is negative. Murthy (1964) suggested the product estimator for such situations. It is proposed to study the second order approximation of the various product type estimators. The estimators included in this study are due to Murthy

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(1978), Srivastava (1967), Reddy (1973), Gupta (1978), Sahai (1979) and Adhvaryu and Gupta (1983). Their efficiencies have been compared with the help of live data and it was observed that estimator due to Adhvaryu and Gupta excels. Further, the bias, variance and MSE of these estimators have been tabulated for different values of parameters in fairly wide range. This helps to choose a suitable strategy for a given situation. Multivariate extensions of the results have been carried out, wherever possible.

### 3. A STUDY OF SECOND ORDER APPROXIMATION OF SOME RATIO TYPE ESTIMATORS

N. H. KOTHWALA and P. C. GUPTA  
*South Gujarat University, Surat*

It is well established that use of auxiliary information in building estimators always lead to increase in the efficiencies of the estimators. Ratio and ratiotype estimators have been frequently used in practice when the correlation between the character under study and the auxiliary characters is positive and satisfies certain conditions. The effect of second order approximation have not been studied in the literature except for the conventional Ratio estimator and Srivastava (1967) estimator. In the present study, we have obtained the second order approximations for the bias, variance and mean square errors of various estimators viz. Ratio, Srivastava (1967), Reddy (1978), Gupta (1978) Sahai (1979), and Adhvaryu and Gupta (1983). Their efficiencies have been compared with the help of live data and it was found that the estimator due to Adhvaryu and Gupta (1983) performs well as compared to others. Further, the efficiencies of these estimators for different values of parameters in fairly wide range have been tabulated which enable us to choose the optimum strategy in a given situation. The multivariate extension of above results have also been carried out, wherever possible.

### 4. A MODIFICATION TO THE PPs ESTIMATOR UNDER THE 'WITH-REPLACEMENT' SAMPLING SCHEME

D. M. KAWATHEKAR and S. G. PRABHU AJGAONKAR  
*Marathwada University, Aurangabad*

By transformation on the study variate, an estimator of the population total is suggested under the 'with replacement' Sampling Scheme. This estimator is found to be more efficient than the PPs estimator. An empirical study is included to illustrate the theory.

## 5. SEQUENTIAL ESTIMATION IN THREE DIMENSIONAL SPACE

R. P. GOSWAMI and F. S. CHAUDHARY  
*Haryana Agricultural University, Hissar*

Estimation of population size is discussed when units are migratory and freely moving. Assuming that the probability of inclusion is proportional to volume or surface in a three-dimensional population, some estimators alongwith their variances are discussed. Comparative studies with two and one dimensional spaces have been made and to examine its efficacy over other methods, some empirical studies are also made.

## 6. ESTIMATION OF INVERSE PARAMETERS IN NORMAL POPULATION USING THE KNOWLEDGE OF COEFFICIENT OF VARIATION

H. P. SINGH  
*J.N.K.V.V., Jabalpur*

and

L. N. UPADHYAYA  
*Indian School of Mines, Dhanabad*

This paper deals with the problem of estimating inverse parameters of normal population using the knowledge of coefficient of variation. An unbiased estimator is proposed and its properties are studied. Minimum mean squared error is also proposed.

## 7. ESTIMATION OF POPULATION MEAN IN SUCCESSIVE SAMPLING USING PARTIAL INFORMATION ON AUXILIARY CHARACTER

B. V. S. SISODIA  
*Rajendra Agricultural University, Pusa, Bihar*

and

H. SINGH  
*Metallurgical and Engineering Consultants (India) Limited,  
Ranchi-834 002*

In many practical situations, the information on auxiliary character may be available only on the units selected in the sample/at the previous

occasion. The estimation procedures utilising such partial information on auxiliary character has been attempted here. Sen (1971) made an attempt to use such information to improve the efficiency of the estimator by combining two different estimates viz. double sampling ratio estimate and double sampling regression estimate based on matched portion of the sample with simple mean per unit estimate on the second occasion based on un-matched portion of the sample under certain approximation. Here, the efficiency of these estimators has been investigated after relaxing some of the approximations. A new estimator is also proposed by combining a regression cum ratio-type estimator of population mean on the second occasion from the matched portion of the samples and simple mean per unit estimate on the second occasion based on un-matched portion and its properties are studied. Finally, the gains in efficiency of these estimators over mean per unit estimates are worked out for different values of  $P_0$ ,  $P_1$  and  $K$ , where  $P_0$  is the correlation between the auxiliary character and the character under study at first occasion,  $P_1$  is the correlation coefficient between the character under study at first and second occasion, and between character under study at second occasion and auxiliary character, and  $K$  is the ratio of the C.V. of auxiliary character and character under study. It has been found that the proposed estimator may be preferred to that of Sen's multivariate double sampling ratio estimate ( $\bar{y}'_{2R}$ ) for higher values of  $P_1$  and moderate value of  $P_0$  in the situations where the values of  $K \leq .5$ . For other situation where  $K > .5$  the  $\bar{y}'_{2R}$  is the best choice. It has also been observed that the proposed estimator and  $\bar{y}'_{2R}$  both are preferable to Sen's multivariate double sampling regression estimator for higher values of  $P_1$  and  $P_0$ .

## 8. COMPOSITE ESTIMATOR OF THE POPULATION MEAN

H. SINGH

*Metallurgical and Engineering Consultants (India) Limited,  
Ranchi-834002*

and

B. V. S. SISODIA

*Rajendra Agricultural University, Pusa, Bihar*

A composite estimator of the population mean for the character under study on the second occasion in successive sampling has been developed by combining (i) a ratio type estimator (due to Chakrabarty, 1979) based on matched units and (ii) an independent per unit estimate of the population mean based on new units drawn afresh on the second occasion. It

is assumed that C. V. of the character under study remains constant over occasions. It has been examined that the variance of the proposed estimator and the estimator developed by Jessen (1942) by combining (i) a double sampling regression estimator of population mean based on matched units and (ii) an independent estimate of population mean based on unmatched units are same. However, the proposed estimator may be preferred to the estimator developed by Jessen as it is simple and easy to deal with in practice in view of the practical considerations.

#### 9. ROBUST ESTIMATION IN STRATIFIED SAMPLING UNDER SIZE STRATIFICATION USING PREDICTION APPROACH

RAJU SINGH

*Bihar University, Muzaffarpur*

B. V. S. SISODIA

*R.A.U., Pusa*

and

R. B. SINGH

*Bihar University, Muzaffarpur*

For estimating population mean or total in finite population sampling the correctness of the results in prediction theory depends, on the validity of the super population probability model but perfect specification of such model is never accomplished in practice. Royall and Herson (1973) established that the separate ratio estimator was robust in stratified balanced sampling under size stratification in the sense that it protected against model failure without loss of efficiency. In the present paper an attempt has been made to develop a best linear unbiased estimator of population total using prediction approach. It has been found that the proposed BLUE estimator was more efficient than separate ratio estimator but the former is less robust in stratified balanced sampling. It has been also shown that for appropriate choice of weight to be used in estimating the regression coefficient of the model the proposed BLUE estimator became robust and as precise as separate ratio estimator in stratified balanced sampling. The robustness of usual combined ratio estimator in stratified sampling is also studied. The problems of optimum allocation and of unbalanced sample are discussed.

#### 10. UNBIASED ESTIMATION OF FINITE POPULATION VARIANCE USING AUXILIARY INFORMATION

S. M. SHAH and HEMLATA R. PATEL

*Sardar Patel University, Vallabh Vidyanagar*

A general unbiased estimator of some function of population values,

using auxiliary information is suggested. As particular cases of this general result, unbiased ratio and product type estimators of the population variance  $\sigma_y^2$  are obtained in this paper.

### 11. IMPROVED ESTIMATION IN TWO-PHASE AND SUCCESSIVE SAMPLING

S. K. SRIVASTAVA and H. S. JHAJJ  
*Punjabi University, Patiala*

For two-phase sampling and successive sampling improved estimators are suggested for estimating the mean of a finite population. The class of estimators considered is the two-phase sampling analogue of the class defined by Srivastava and Jhaji (1981, *Biometrika* 68) for the single phase sampling. Large sample expressions for the variance of the suggested estimators are obtained. Expressions by which the variances of the proposed estimators are smaller than that of the conventional estimators are also given. The results of two-phase sampling are then used to obtain an estimator of the population mean on current occasion in successive sampling.

### 12. UNEQUAL CLUSTER SAMPLING FOR FIXED SAMPLE SIZE

P. C. MEHROTRA  
*IASRI, New Delhi-12*

In this paper a sampling procedure in unequal cluster sampling for fixed sample size, when the number of units in the initial sample of selected clusters exceeds the planned size of units has been proposed. A scheme for discarding the excess number of clusters from the initial sample of clusters has been presented. The suggested procedure, taking into account simplicity and practical feasibility, can be used in uni-stage unequal cluster sampling design for arriving at the fixed sample size of elements. It has been also empirically demonstrated that the obvious reduction in the variance efficiency of the proposed estimator on account of the decrease in the sample size compared to that of the initially selected usual uni-stage unequal cluster of a relatively larger size is compensated by its increased cost efficiency.

### 13. ON THE EFFICIENCY OF PPS SAMPLING FOR MULTIPLE CHARACTERISTICS

N. S. MANGAT, M. L. BANSAL and BALWANT SINGH  
*Punjab Agricultural University, Ludhiana*

Rao (1966) has proposed an alternative estimator of the population total for the characteristics unrelated to the selection probabilities, corresponding to Rao, Hartley and Cochran's (RHC) (1962) scheme. The behaviour of this estimator has been investigated under modified RHC schemes given by Singh and Lal (1978) and Mehta (1982). The estimator is biased. The expression for bias comes out to be the same as under usual RHC scheme. However, the variance expressions under these three schemes differ from one another. Keeping this in view variances have been compared under super-population model considered by Rao (1966). The conditions for the efficiency of the estimator for the three schemes have been derived. It is noted that when random groups are of equal size (an integer), these schemes are equally efficient.

### 14. CLASS OF ALMOST UNBIASED DUAL TO PRODUCT ESTIMATOR IN SAMPLE SURVEY

K. S. KUSHWAHA  
*JNKV, Jabalpur*

This paper proposes a general class of almost unbiased ratio type estimators alternative to product estimators for estimating the finite population mean  $Y$  using Jack-knife technique envisaged by Quenouille (1956). The expressions for the bias and mean squared error (M.S.E.) of the proposed class of estimators are obtained to the first degree of approximation. The uniformly minimum variance unbiased (U.M.V.U) estimator is also identified. Discussions are made under simple random sampling without replacement (SRSWOR) throughout the discussion.

### 15. ON EXTENDED GENERALISED CLASS FOR ANY SPECIFIED POPULATION PARAMETER(S) USING AUXILIARY CHARACTER

V. K. SINGH and D. SHUKLA  
*BHU, Varanasi*

Several attempts have already been made to define various kind of class

of estimators in sample surveys, specially with the assistance of auxiliary information. Srivastava (1971) have proposed a general class in the form of function of auxiliary character and the same was further extended by Srivastava and Jhajj (1980, 81) with the simultaneous consideration of mean and variance of the auxiliary character. The estimators of the type  $T_1 = W\bar{y}$ ,  $T_2 = Ws^2$ ,  $T_3 = W_1\bar{y} + W_2$ ,  $T_4 = W_1s^2 + W_2$  were not supposed to be included in above mentioned classes. Later, Singh and Upadhaya (1985) have put on useful contribution in this line. This paper presents an extended generalised class containing all such  $T_1, T_2, T_3, T_4$  type estimators and results in terms of less m.s.e. than all earlier proposed with certain constraint conditions.

## 16. STRATIFIED SAMPLING OVER TWO OCCASIONS

SAVITA JAIN and JAI P. GUPTA

*Punjab Agricultural University, Ludhiana 141004*

In this paper, separate and combined regression estimators alongwith their variances and estimate of variances for stratified sampling over two occasions have been studied.

## 17. A STUDY ON THE PREDICTION OF YIELD OF STICK LAC

D. C. MATHUR, B. H. SINGH and S. C. SETHI

*IASRI, New Delhi-12*

Lac is an important cash crop, mainly cultivated by tribals living in relatively backward areas in the states of Bihar, M.P., Orissa, West Bengal and U.P. It is also of considerable economic importance from the export point of view. So the reliable estimates of total lac crop production is extremely important for determining the prices and export-import policies. In the past prediction estimates were based on eye-estimates, personal judgement of agricultural officials and final crop cutting experiments. A need was therefore felt to develop a method to predict the yield objectively. In this paper an attempt has been made to study the relationship between the yield of stick lac and different morphological characters such as girth of the tree, number of shoots encrusted with lac, total length of encrustation and weight of shoots with lac measured at the time of crop cutting with a view to predict the yield of stick lac. A multistage random sampling technique was used for selection of trees. Data from 140, 240, 220 trees were collected from Dudhi Tehsil of Mirzapur district (U.P.) during Baisakhi 1984, Katki 1984 and Baisakhi 1985 respectively for the



study. Multiple regression analysis of yield on morphological characters was applied for fitting regression models taking yield as dependent variable and morphological characters as the independent variables in original, logarithmic, square root, quadratic and reciprocal scales. The quadratic model was found to be the most superior one for predicting the lac yield. Stepwise regression technique was applied to identify the significant characters in predicting the lac yield.

18. A STUDY ON YIELD OF PADDY UNDER FLOOD-AFFECTED AND UNAFFECTED AREAS IN UTTAR PRADESH

JAGMOHAN SINGH, O. P. KATHURIA and A. K. BANERJEE  
*IASRI, New Delhi-12*

The loss of agriculture crops depends upon the intensity of floods with which the particular crop is affected. A study to this effect was carried out on paddy crop cultivated in the flood-affected areas and in the areas not affected by flood during the kharif season and on wheat crop sown in the subsequent rabi season in some randomly selected villages of four tehsils of Faizabad district by utilising the data collected on occurrence of flood, inputs and yield obtained in flood-affected and unaffected fields of selected cultivators, under the project, "Pilot Sample Survey to study the impact of flood on agricultural production in a region of Uttar Pradesh" conducted by Indian Agricultural Statistics Research Institute, New Delhi during the year 1981-82.

The study revealed that the average yield from the unaffected fields was significantly higher in case of paddy crop (32.1 Qtl/hect.) than that of flood affected fields (18.7 Qtl./hect.). The study also revealed that though difference in yield of wheat is not very significant in case of flood affected and unaffected areas, yet the area under wheat cultivation is significantly higher in flood affected areas in subsequent rabi season in most of the sampled villages. This is due to the reason that silt-deposit and moisture contents available after occurrence of floods are utilized by the cultivators for the rabi crops.

19. GROWTH RATES OF AREA, PRODUCTION AND YIELD OF MAJOR OIL SEEDS IN UTTAR PRADESH

ANIL KUMAR and ASHOK KUMAR  
*K. A. Post graduate College, Allahabad*

The major oil seeds grown in Uttar Pradesh are mustard, linseed,

groundnut, til and castor, with mustard having the lion's share of the total hectareage and the aggregate production of these oil seeds. The state accounts for 24.28 percent of total area and contributes to the tune of 16.36 percent of the country's total production in respect of these oil seeds taken together. An attempt is made to examine the nature and extent of growth rates of each of these oil seed crops with regard to area, production and yield, in the State by running linear regressions to the respective time-series (simple indices with triennium average, ending 1963-64 as 100) data for the period 1961-62 to 1982-83. The findings are : (i) with regard to area, only mustard and linseed have resulted to positive growth rates; while groundnut, til and castor each to negative growth rate, (ii) the aggregate production of mustard and linseed each, has increased relatively at faster rate as compared to its yield, (iii) the crops showing positive growth in respect of all the three factors i.e. area, production and yield are mustard and linseed, while the crops with negative growth in these factors have been groundnut, til and castor, (iv) the crop mustard results to highest growth percentage for both the area and the aggregate production, while linseed in case of yield, and that (v) the average per annum growth rates of area, production and yield are worked out to be 7.40%, 14.34% and 0.60% for mustard; 3.16%, 2.54% and 2.05% for linseed, -0.71%, -3.86% and -1.29% for ground nut; -0.42%, -3.71% and -2.12% for til and -4.77%, -4.69% and -0.98% for castor, as against 2.34%, 0.60% and -0.91% for these oil seeds taken together.

## 20. TRENDS IN AREA, PRODUCTION AND PRODUCTIVITY OF CROPS IN MARATHWADA DIVISION

V. B. TAK and B. W. ASHTURKAR  
*M. A. U., Parbhani*

The trends in area, production and productivity of important crops were studied in Marathwada division of Maharashtra state during the year 1960-61 to 1980-81. The exponential trend equation  $Y = ab^x$  was used to obtain compound growth rates taking years as independent variable and index numbers of area, production and productivity as dependent variables. The study has revealed that area under Kharif jowar, rice, sugarcane has shown increasing trend. The study pertaining to changes in production of important crops in the division reveals that production of wheat, total cereals, total pulses, cotton and tur increases significantly. As regards productivity it is noticed that wheat, gram, groundnut, cotton, sugarcane, has shown significantly increased trend.

## 21. LIFE EXPECTANCY OF BOVINES IN RURAL AREAS OF ANDHRA PRADESH

T. B. JAIN  
*IASRI, New Delhi-12*

The I.A.S.R.I. has conducted a large scale sample survey in Vijayawada region of Andhra Pradesh for estimating age-specific fertility and mortality rates in cattle and buffaloes in Intensive Cattle Development (I.C.D.) area and in the adjoining area (non-I.C.D.). The estimates of mortality rates for non-descript bovines were utilized for construction of life tables. In this study the life expectancy of either sex of these bovines are compared over the two areas. Male cattle in both the areas had higher lifespan than females, but reverse was the case for buffaloes. The life expectancy of bovines was generally more in I.C.D. areas as compared to non-I.C.D. areas which reflects the desirable effect of better facilities available in the former area. Extension of development activities in non-I.C.D. area would help in providing proper health cover for more bovines under village conditions.

## 22. A STUDY ON ECONOMIC ASPECTS AND FACTORS EFFECTING THE COST OF CULTIVATION OF VEGETABLE CROPS /

SATYA PAL  
*IASRI, New Delhi-12*

Cultivation of vegetables involves several cost items, some contributing more percentage towards total cost than others. In the present study these cost factors are studied for their efficient use for maximum production, taking the cultivators following different management practices. The factors studied are human labour (own + hired), manure and fertilizers, irrigation (the factors constituting about 75% of the total cost of production per acre) production level and cost of production per unit produce. The study is based on comparing the cost of production and returns of different vegetable crops from different groups of cultivators following different management practices, utilising data from the survey on cost of cultivation of vegetable crops at Ahmadabad (Gujarat) and Delhi. The results reveal that vegetable cultivators below the efficiency line in different factors had high production cost and low level of production. While among the efficient cultivators, the input cost is minimum and net return is maximum for those who had high level of production. For the

cultivators who are rated as zero, not only the return is low but input cost is also very high. The results also show that the characters selected are indicators of efficiency and appropriate.

### 23. ESTIMATION OF VEGETABLE PRODUCTION FROM PARTIAL HARVESTS

SATYA PAL and A. K. SRIVASTAVA  
*IASRI, New Delhi-12*

Estimation of Crop production for crops with multiple harvests is somewhat more cumbersome than for single harvest crops. This is much more relevant for several vegetable crops with frequent pickings. According to usual crop cutting approach, the selected plot is observed for every picking. With harvesting period spanning over several weeks and frequent pickings after three to four days in the selected plots, the requirement of observing the selected fields for all the pickings restricts the sample size considerably. Procedures based on observing only partial harvests are likely to simplify the field work, in which movement of the enumerators may be less restricted, thereby increasing the sample size. In the present study an alternative based on double sampling technique, has been examined. For this purpose, the total yield in the plot has been taken as character under study while the yield in the partial harvests of different intervals having high correlation with total yield is considered as the auxiliary character. The data used for empirical illustration has been taken from a vegetable survey, conducted in Bangalore during (1971-74). A suitable choice of intervals of days, in which the crop cutting for various vegetable crops are to be done, has been investigated. The crops covered for this purpose are tomato, brinjal, lady's finger and beans.

### 24. SOME INVESTIGATIONS INTO SUITABLE SAMPLING DESIGN FOR ESTIMATION OF COST OF POULTRY AND EGGS

L.B.S. SOMAYAZULU and H. C. GUPTA  
*IASRI, New Delhi-12*

Sub samples are selected according to SRS, St. RS. and cluster sampling designs with different sampling fractions and different types of units and the maintenance cost of layers is calculated with SE's and compared with the population values to make inferences about the proper sampling design, sampling fraction and the type of unit.

## 25. STUDY ON THE GROWTH RATE OF YIELD RATE OF WHEAT PRODUCTION IN INDIA AND ITS MAJOR WHEAT PRODUCING STATES

T. RAI and V. P. N. SINGH  
IASRI, New Delhi-110012

Data on yield rate of wheat production are collected from the publication of Directorate of Economics and Statistics, Ministry of Agriculture, Govt. of India. Yield rate has been taken as a dependent variable ( $Y$ ) and years as a concomitant variable ( $t$ ) to work out the various growth rates for each plan and overall for All India and each state. The significance of differences are tested for equality of different growth rates calculated from different series by the method of regression analysis.

Regression of dependent variable on concomitant variable is a measure of amount by which the dependent variable changes correspondingly to a unit change in the concomitant variable. Since for bivariate normal distribution the simple linear regression estimate is unbiased and most efficient. Hence the present study is based on this technique to know the change in yield rate of wheat production w.r.t a unit change in time. In its effort the four major wheat producing states namely Punjab, Haryana, Uttar Pradesh and Bihar are included under study for the comparison of the character among themselves and also with that of based on All India. Studies regarding the testing of equality of regression equations were made on a very limited scale. The present investigation is a pointer in this direction.

## 26. EVALUATION OF THE AMOUNT OF VARIATION IN THE YIELD OF RICE DUE TO RANDOM COMPONENTS

V. P. N. SINGH and TRIBHUWAN RAI  
IASRI, New Delhi-12

While studying the trend of yield of any crop, it is desirable to observe the change in the pattern of yield caused due to the affect of random components like flood, draught, favourable and unfavourable weather conditions etc. With this idea in view an attempt has been made to study the amount of variation due to these components in the yield of rice in four major rice producing states of India such as Andhra Pradesh, West Bengal, Bihar and Uttar Pradesh. The data on yield of rice in kg/ha for 35 years from 1950-51 to 1984-85 is taken from the reports of "Area and

Production of Principal Crops in India" published by Directorate of Economics and Statistics, Department Agriculture and Co-operation, Ministry of Agriculture, Government of India. The pattern of the data on observation indicates an increasing trend in all the states included for the study but at some stages sudden fall is also noticed. In Andhra Pradesh the yield 1657 kg/ha in the year 1975-76 suddenly falls to 1383 kg/ha in the year 1976-77 while that of 1442 kg/ha in the year 1980-81 comes down to 1120 kg/ha in the succeeding years in case of West Bengal. These fluctuations occur more frequently in Bihar and Uttar Pradesh e.g. the yield in Bihar during the years 1957-58, 1966-67, 1979-80 are 470, 366 and 705 kg/ha respectively as compared to that of 762, 812 and 984 kg/ha respectively in the previous years. Similarly in case of Uttar Pradesh the yields during the years 1965-66, 1966-67 and 1979-80 are 557, 453, 505 kgs/ha, though the corresponding figures in the previous years are 747, 557 and 1159 kgs/ha respectively. The differences between the two variances  $V_k$  and  $V_{k+1}$  where  $V_k$  is the variance of the  $k$ th difference,  $k = 1, 2, 3, \dots$  are tested by the test of significance and 0.0514, 0.0895, 0.1788 and 0.1629 are the coefficients of random variability calculated for the states Andhra Pradesh, West Bengal, Bihar and Uttar Pradesh respectively. This clearly shows that the yields of rice is affected by the random components.

## 27. INVESTIGATIONS INTO CONTRIBUTION OF AREA, YIELD AND THEIR INTERACTION TO GROWTH IN PRODUCTION OF GROUNDNUT

P. C. MEHROTRA and JAGMOHAN SINGH  
*IASRI, New Delhi-12*

Data on area, average yield and production of groundnut for the period 1949-50 to 1983-84 were analysed at the All India level to study the growth in production of groundnut and the relative contribution of area, average yield and their interaction to this growth. The principal finding was that the area was the main contributing factor (98.5 per cent) while average yield and interaction of area and average yield contribution was negligible being 1 per cent and 0.5 per cent respectively over the period studied. Year-wise results revealed haphazard behaviour of the contribution of productivity. It was also observed that the growth of production has been quite slow, the growth rate of production over the whole period being 2.5 per cent per annum.

## 28. INCOME, CONSUMPTION AND EMPLOYMENT (A STUDY OF GADDI TRIBE IN HIMACHAL PRADESH)

KAMLESH SINGH, H. R. SHARMA and S. K. CHOUHAN  
*Himachal Pradesh Krishi Vishva Vidyalyaya, Palampur*

The present study was conducted in Bharmaur Tehsil (Chamba district) which accounts for 99.72 per cent of the total gaddi tribe in the state. Utilising multi stage stratified random sampling technique, 150 households from 10 villages were selected. The study shows that gaddi tribe is mainly dependent on sheep and goat for their livelihood which contribute about 62.4 per cent of the total household income. Its contribution is as high as 75.3 per cent on large farms. Inequality in the consumption expenditure are more compared to income equality and income as well as consumption expenditure is more unequally distributed among small farms revealing the severity of poverty among this category of farms. About 67.7 per cent of the total man days available are utilised for sheep and goat rearing followed by 17.0 per cent of the man-days for off-farm services. About 93.8 per cent of the total man-days utilised for sheep and goat rearing are contributed by male labour whereas 70.8 per cent of total mandays utilised for crop production are contributed by female labour.

## 29. PREDICTION OF MILK YIELD IN WEST BENGAL

BALBIR SINGH, H. P. SINGH and B. H. SINGH  
*IASRI, New Delhi-12*

The availability of a reliable estimate of milk production well in advance, is of great importance for planning the breeding policies and giving loans in the animal husbandry sector according to the assessed demand for the period and to control the prevailing rates of milk and milk products. The estimates are also invariably helpful to the breeders and to the persons engaged in the work of preparation of animal feeds. An attempt has been made to develop a statistical model on feeds fed to animals and milk production on the data collected by I.A.S.R.I. under the survey, 'The study of impact of milk supply scheme on rural economy of milk shed areas of Greater Calcutta Milk Supply Scheme, Calcutta during 1976-77.' The vital independent factors in milk production are the number of animals in milk, breeds of the animals and the quantities of green and dry fodders and concentrate fed to the animals. Breeds of animals are not considered at this level as livestock population of West

Bengal comprises of mostly of non-descript animals. Linear and semi-quadratic models are fitted by adopting multiple regression technique. Positive and significant correlations are observed between milk yield of cows and buffaloes with other yield attributes. The study of linear model revealed that about 25 and 94 percent variation in milk yield of cows and buffaloes respectively could be controlled by the different contributing factors whereas in case of semi quadratic model 47 and 96 percent variation could be assessed during the period under observation. Semi-quadratic model is found to be the best fit predicting the milk yield on the basis of the available data under the survey.

### 30. A STUDY ON ROLE PLAYED BY LITERACY IN MILK PRODUCTION

BALBIR SINGH, JAGMOHAN SINGH and D. K. BHATIA  
*IASRI, New Delhi-12*

The literacy standard and technical know-how matters a lot in labour input and helps in reducing man hours in the milk-production and its disposal. A study to this effect was carried out on milk production, labour input and percent of literacy confined to the area of Nadia and 24 Pargna Distt. of the milk shed areas of Greater Calcutta Milk Supply Scheme, Calcutta, West Bengal. The study revealed that the marginal increase of literacy among working force contributed significantly in reducing the working hours utilised for the unit quantity of milk production.

### 31. SELECTION OF REGRESSION MODELS : AN INFORMATION THEORETIC APPROACH

J. P. SINGH and UMED SINGH  
*Haryana Agricultural University, Hissar*

The information theoretic concepts as illustrated in various measures, namely Shannon's entropy (1948), Kullback and Leibler's information or directed divergence (1951) and Kerridge's inaccuracy (1961) have found wide application in behavioural sciences. Recently, various papers have examined model selection through loss structure based on the Kullback-Leibler information measure (1951). Sawa (1978) has argued that this loss structure results in a trade off between parsimony (low model dimensionality) and goodness of fit ( $R^2$ ) to the data.

In the present paper it is argued that parsimony as reflected in the number of variables in the model is not encouraged by information



approach. However, like Sawa, the criterion results in trade off between parsimony and goodness of fit. For choosing among economic models, the information approach does not necessarily reject small models in favour of larger models having usually high  $R^2$ 's. Thus it is important, with a reasonable prior information, to take into account a priori theoretic economic logic for an economic model selection.

### 32. INFLATED MODIFIED POWER SERIES DISTRIBUTION AND SOME OF ITS APPLICATIONS

H. L. SHARMA

*J N Agricultural University, Adhartal, Jabalpur-482004*

In the present paper, the general expression for the correlation coefficient,  $\rho$ , between the number of boys and girls in a family, between the number of animals trapped and untrapped in an animal trapping experiment, between the surviving and non-surviving eggs laid down by an insect is obtained when  $N$ , the family size has a inflated modified power series distribution. This is then specialized to inflated generalized negative binomial, generalized Poisson and generalized logarithmic series distribution.

### 33. FITTING TWO PARAMETER DISCRETE DISTRIBUTIONS TO MIGRATION DATA HAVING ONE COMMON PARAMETER

H. L. SHARMA

*J N Krishi Vishwa Vidyalaya, Adhartal, Jabalpur-482004*

Fitting of two parameter discrete distributions to migration data having one common parameter are proposed in the paper. The distributions considered are the negative binomial, Neyman type A and Polya-Aeppli, all of which may arise when groups of individuals follow the Poisson distribution, but the individuals within the groups have their own distribution. It is found for the illustrative data that the distribution of individuals within groups is the same over data sets, though the distribution of groups varies. Comparisons between the data sets may then be facilitated. Also, the correlation coefficient between the number of migrants and non-migrants from a household has been determined in the case of negative binomial distribution.

34. ROBUSTNESS OF  $D^2$ -STATISTIC IN STUDYING  
DIVERGENCE BETWEEN DIFFERENT GENETIC  
GROUPS OF CROSSBRED CATTLE WITH  
UNEQUAL SIZES AND COVARIANCE  
MATRICES

U. C. JAISWAL

*Haryana Agricultural University, Hissar*

and

J. P. JAIN

*IASRI, New Delhi-12*

The classical Mahalanobis generalized distance squared statistic is generally used by researchers for measuring divergence between different genetic groups of crossbred cattle, without giving any regard to the structure of covariance matrices. This technique is strictly tenable when the covariance matrices of the groups are homogeneous. Accordingly in the present paper Mahalanobis  $D^2$ -statistic and  $D^{*2}$ -statistic based on mini-max criterion of classification suggested by Anderson and Bahadur (1962) are used to study the robustness of the former distance-squared statistic in studying divergence among different genetic groups. The closeness in their numerical values show that  $D^2$ -statistic can safely be used for measuring divergence among different genetic groups of crossbred cattle with heterogeneous covariance matrices and for unequal sample sizes.

35. TEST OF SIGNIFICANCE OF MULTIPLE CORRELATION  
COEFFICIENT 'R' AND CORRELATION RATIO ' $\eta$ ' BY  
OBSERVING THE VALUES OF  $R^2$  OR  $\eta^2$

V. P. N. SINGH

*IASRI, New Delhi-110012*

An attempt has been made to test the significance of multiple correlation coefficient and correlation ratio by observing the values of  $R^2$  or  $\eta^2$  presented in the tabular form instead of Computing  $F$  statistic and then comparing it by table values of  $F$ . The proposed method will be useful for the research workers.

### 36. DATA ANALYSIS OF CONSUMER'S PREFERENCE AND DEMAND IN MEAT MARKETING

J. S. BERWAL and F. S. CHAUDHARY  
*Haryana Agricultural University, Hissar*

An attempt is made to work out relationship between consumers preference and demand and to identify factors influencing meat consumption. Multi-dimensional qualitative factors influencing consumers preference such as socio-economic status, availability, marketing facility, supply, service, etc. were considered with Information Theoretic Approach. Techniques of analysis of variance, cluster analysis and Mahalanobis  $D^2$  were also used and significantly new results were derived. To derive maximum possible information from selected clusters of respondents, their sequence of preferences and coded responses were presented in a matrix and squares of distance between two preferences were measured and tested. By taking shift to meat consumption as an indicator of nutritional food consciousness demand analyses for different strata were made. Constraint analyses are also done for identification of factors influencing meat consumption and their relationship with respondents traits. Shift from cereal based to animal protein diet with increase in real income, high degree association between quality rich protein consumption and economic status; and nutritive values of meat and meat products and consumers quality consciousness were also examined.

### 37. A SIMPLE APPROACH FOR STABILITY ANALYSIS

N. Y. PALIMKAR, D. N. BORULKAR, P. K. JOSHI

and

S. R. NAGARGOJE

*Marathwada Agricultural University, Parbhani-431402*

Long term experiments means, the experiment which is laid out for every year on the same side with the same treatments for the same plot without disturbance in their layout. The research station or scheme conducting such type of experiment indicates the importance of the location and the importance of the experiments also.

A long range experiment of fertilizer is under experimentation at Cropping System Research Centre, Marathwada Agriculture University, Parbhani. The experiment started in 1979-80, for six years to find out the "stable treatment" for sorghum and wheat crops. A simple statistical

approach was tested in comparison with existing stability models and concluded that these enormous computations can be avoided by applying simple method for confirming the stability of a treatment. The results led to the same conclusion by both the methods/models. (i.e. Mean and variance and Eberhart and Russell's model).

### 38. STUDY OF EFFECT OF RAINFALL DISTRIBUTION ON GROUNDNUT (*ARACHIS HYPOGAEA* L.) YIELD AND ITS FORECAST

B. H. SINGH and S. R. BAPAT  
*IASRI, New Delhi-12*

Yield of groundnut crop is very much influenced by the environment especially rainfall distribution at different stages of crop growth. With a view to establish the relationship between rainfall and yield of groundnut which ultimately would have to be utilized for pre-harvest forecasting of groundnut yield, the data from 240 fields sampled randomly in Rajkot district of Gujarat state in kharif 1984 were examined and multiple regression technique was applied. The study revealed that more than 80% of the yield variation can be accounted for by the weather in the pre-flowering stage of crop growth. It was also observed that rainfall at pod development stage influenced the groundnut yield to an extent of 50 per cent.

### 39. USE OF JACKKNIFE IN THE ANALYSIS OF TOXICOLOGICAL DATA

K. K. SAXENA and O. P. SRIVASTAVA  
*H.A.U., Hissar*

Toxicological data, obtained from a bioassay based on quantal dose response, are usually in the form of percentage of responses. To analyse the data, the standard procedure is, fitting normal or logistic sigmoid curve [Finny (1978)]. The hypothesis tested is that the proportion of responses is same for all dose levels against a suitable alternative which is equivalent to zero slope. Salsburg (1971) discussed at length the loss in degrees of freedom by using usual-*t*-test in such cases. Starting with 4 or 5 dose levels of a drug administered on number of subjects, student's *t*-test ultimately depends on 2 or 3 d.f., respectively. The number of subjects, however large it may be, will not increase the degrees of freedom of *t*-test, if applied. Salsburg (1971) recommended the use of a test based on jackknife. In this paper the numerator of slope of regression is jack-

knifed [Arveson (1969), Quenouille (1949, 1956)] and the psuedo values are obtained in much simpler form. Based on these psuedo values, an approximate *t*-test is developed whose degrees of freedom does depend on the number of subjects.

#### 40. EMPLOYMENT GENERATION THROUGH POULTRY KEEPING IN URBAN VERSUS RURAL AREA

D. K. BHATIA, T. B. JAIN, JAGMOHAN SINGH and BALBIR SINGH  
*IASRI, New Delhi-12*

Majority of the population in India is rural based and their livelihood mainly depends upon agriculture. 52% of the rural households belong to the small and marginal farmers possessing less than 2 hectares of land. A large part of population remains either underemployed or unemployed throughout the year, without any opportunity to better their economic position. This study has revealed that in Punjab 46.6% of adult working force among men and 62.4% among females are not engaged with any subsidiary occupation. Also in Delhi 58.3% among men and 56.1% among females are not occupied with any subsidiary work. It also shows that it can generate one standard man's employment per day by looking after 58 standard birds for those households where only family labour is utilised in Punjab as well as in Delhi and it can generate one hour employment by looking after 76 standard birds per day during the year where only paid labour is utilised and 86 standard birds where both family labour and paid labour is utilised in Delhi (Urban)-area.

#### 41. TREND IN FERTILIZER CONSUMPTION IN VIDARBHA— A DISTRICTWISE ANALYSIS

M. R. ALSHI, S. W. JAHAGIRDAR and C. K. JOSHI  
*Punjabrao Krishi Vidyapeeth, Akola*

The main objective of the study was to examine the growth and variability in fertilizer consumption in Vidarbha utilising data for the period 1968-69 to 1984-85. The study revealed that the consumption of total fertilizers increased substantially during the period. During the decade 1968-78 there was a general increase in the level of per hectare fertilizer consumption in various districts. Interdistrict variation in per hectare fertilizer consumption reduced during the period 1968-74. In 1979-80, however, there was more variation in per hectare fertilizer consumption among different districts. There was a change in the ranking of districts

on the basis of per hectare fertilizer consumption in 1968-69 and 1979-80. In 1968-69 Wardha district ranked first followed by Nagpur and Bhandara districts. In 1979-80, however, the first three highest ranking districts were Nagpur, Buldana and Amravati. The study suggests that steps should be taken to identify the causes of variations in fertilizer consumption among districts and to reduce these variations in order to have a balanced growth in agricultural production in the area.

#### 42. A STUDY ON MILK PRODUCTION FUNCTIONS IN CALTTE AND BUFFALOES

BHUPAL SINGH and S. B. AGARWAL  
*National Dairy Research Institute, Karnal*

The present study was conducted to determine optimum combinations of fodders and feeds for different levels of milk production during the year 1984-85 in the rural areas of Karnal district (Haryana). Multi-stage-stratified random sampling design was adopted for the purpose of selecting ultimate sampling units in households. The information regarding input output data on milk yield, feed and fodders fed to the animals from 225 households spread over two clusters of three villages each in two developmental blocks of the district was collected for functional analysis.

The study revealed that a Haryana cow on an average was fed  $15.9 \pm 1.93$  kg of green fodder,  $9.3 \pm 0.93$  kg dry fodder and  $0.54 \pm 0.06$  kg concentrate to get  $3.93 \pm 0.31$  kg. of milk per day. Thus, in terms of nutrients a Haryana cow consumed  $0.59 \pm 0.11$  kg DCP and  $5.48 \pm 0.43$  kg TDN costing Rs.  $5.36 \pm 0.38$ . In case of cross bred cows the similar estimates were  $16.0 \pm 1.82$  kg green fodder,  $17.4 \pm 1.83$  kg dry fodder and  $1.04 \pm 0.11$  kg concentrate at a production level of  $5.07 \pm 0.44$  kg per day per animal. In terms of nutrients these estimates worked out to be  $0.63 \pm 0.06$  kg DCP and  $9.75 \pm 0.79$  kg TDN costing Rs.  $7.61 \pm 0.41$ . On the other hand, a buffalo on an average consumed  $30.4 \pm 1.38$  kg green fodder,  $14.3 \pm 0.74$  kg dry fodder and  $0.89 \pm 0.03$  kg concentrate to produce  $5.72 \pm 0.19$  kg milk per day. The nutritive values of these inputs were worked out to be  $0.95 \pm 0.04$  kg DCP and  $8.36 \pm 0.33$  kg TDN at a cost of Rs.  $7.34 \pm 0.20$ .

To estimate optimum combination of feeds and fodders for different levels of milk production, Cobb-Douglas and Quadratic functions were tried. Quadratic milk production function was found to have higher coefficient of determination both for cattle and buffaloes. The same was used for further interpretation of the results.

#### 43. IMPACT OF AREA, PRICE AND TIME ON THE PRODUCTION AND PRODUCTIVITY OF SUGARCANE IN INDIA

K. C. CHENNA RAYUDU, M. R. NAIDU  
*Agricultural College, Bapatla*

and

P. R. RAO  
*B. T. College, Mandanapalli*

The study extended to a period of 25 years (1960-61 to 1984-85) for which comparable data for production, productivity, area and prices of sugarcane in India were compiled from various sources. In order to study the impact of area, price and time on production and productivity, Cobb-Douglas functions were fitted to the data. Price was taken as lagged variable i.e. the impact of last year's price ( $X_{t-1}$ ) was studied in relation to the current year's production and productivity. The coefficient of determination ( $R^2$ ) was 0.85 indicating that 85% of the variance in logarithmic value of the productivity ( $y$ ) was associated with the explanatory variables included in the study. The elasticity for  $X_3$  variable was significant at 1% level indicating there by, that previous year price of sugarcane influenced current year productivity to a considerable extent. The coefficient of determination for production was also high and was 0.97 and significant at 1% level pointing that 97% of the variation in the production was explained by the explanatory variables included in the function. The elasticities of  $X_2$ , (area) and  $X_3$  (Price) variables were highly significant indicating that present year area under sugarcane and previous year price of sugarcane influenced current year total production to a considerable extent. It is concluded with a positive note that pegging the price of sugarcane at a fair level through the intraction of parity price theory and cost of production method may enhance the sugarcane area and production in India.

#### 44. GROWTH RATES, TRENDS, FLUCTUATIONS IN ACREAGE, PRODUCTION AND PRODUCTIVITY OF GROUNDNUT IN GUJARAT STATE

B. H. SINGH, S. M. G. SARAN, S. S. WALIA and D. C. MATHUR  
*IASRI, New Delhi-12*

The Present paper deals with growth rates, trends and fluctuations in

acreage, production and productivity of groundnut crop (*Arachis Hypogaea*) for the period 1953-54 to 1982-83 in Gujarat State. The period of 30 years have been broken up into three decades to make a more exhaustive study. In the present study the second degree polynomial equation is found to be the most suitable for calculating trends and exponential equation for growth rates. Analysis revealed that the highest productive growth rate of 8.17 percent was found in third decade (1973-74 to 1982-83) whereas higher variation in acreage i.e. 37.88 percent was observed in first decade 1953-54 to 1962-63. Thus, the results indicate that inspite of slight variation in acreage, except for few years, the production increased to a large extent with a advent of high yielding varieties, improved package of practices, minimum support price and awareness among the farmers for adoption of new technology. Further, trends were observed to be significantly increasing over the years with moderate year to year fluctuations.

#### 45. COMPARATIVE STUDY OF THE COST OF PRODUCTION OF FODDER CROPS IN DIFFERENT REGIONS

ANAND PRAKASH and K. K. TYAGI  
*IASRI, New Delhi-12*

The dairy industry has not made accelerated growth over the period of time for want of its certain minimum requirements and particularly on availability of green fodder round the year. Under the Intensive Cattle Development Programme introduced at district level by the State Govts the emphasis was on the promotion for use of better quality seeds of fodder crops. An essential pre-requisite to meet this objective for persuading the farmer has been the knowledge of the cost, involved on cultivation of fodder crops which is not available for any part of the country. Realising the need and examining the feasibility of collection of data through sample survey technique, the Indian Agricultural Statistics Research Institute had carried out pilot sample surveys of two types viz. surveys mainly concerned with the cost of cultivation and as forming a part of the survey for area and yield estimation. These pilot studies had been carried in rural areas of Karnal district of Haryana state and Jallander district of Punjab state in different years. In the present paper, an attempt has been made to study the cost aspect of fodder cultivation in relation of one region with the other. Based on data collected under these surveys, the respective estimates of cost of production per hectare of jowar, bajra, maize and berseem averaged Rs. 468, Rs. 370, Rs. 503 and Rs. 1680 in Karnal district while the corresponding respective estimates



for Jallander district are Rs. 1161, Rs. 1257, Rs. 1322 and Rs. 5475. The difference in the cost of production of fodder crops has been found explainable to some extent taking into consideration the expenditure incurred at different operations of cultivation on one hand and size of fields etc. on the other hand. The study by itself has also given a comparative picture of the cultivation practices followed in the two regions.

#### 46. PREDICTIONS OF MARINE-FISH LANDINGS IN INDIA

S. S. WALIA, B. H. SINGH and H. V. L. BATHLA  
*IASRI, New Delhi-12*

In the present study, Cobb-Douglas function  $Y = A \cdot B^t$  has been fitted with the available marine-fish landings data from different states for the period 1971-1981 to work out the growth rates in different states and by utilizing these growth rates an effort has been made to predict the Marine-fish landings by fitting the compound function  $\log \beta = \log \alpha + t \log (1 + B/100)$ , where  $\alpha$  is the base value of fish production,  $t$  is the time for which prediction is to be made and  $B$  is growth rate. The predicted values  $\beta$  of fish production have been worked out for different states up to 2000 A.D. The results showed that maximum increase in fish landings of the order of 243.2% is expected in West Bengal and Orissa (Combined) by 1990, 538.7% by 1995 and 1089.5% by 2000 A.D. (as compared to fish landings in 1981). The next in order i.e. increase of the order of 178.2% is expected to be observed in Andemans by 1990, 397.5% by 1995 and 789.9% by 2000 A.D. The minimum increase in fish landings of the order of 2.09% is expected in Pondicherry by 1990, 3.39% by 1995 and 4.78% by 2000 A.D.

#### 47. AN ANALYSIS ON THE AVAILABILITY OF FISH IN INDIA

H. B. CHOUDHRY and R. K. PANDEY  
*IASRI, New Delhi-12*

Fish production and consumption plays an important role in countries economy. More than 4 million people are directly or indirectly engaged in fish industry. India occupies the 7th place in fish production in the world but per capita availability is very low as compared to other countries of the world. The per capita availability is directly or indirectly associated with current prices of fish and income of the consumer. Three

variables viz. availability, prices and income has been taken to study net availability of fish. The time series data from 1951-52 to 1978-79 have been used for this purpose. Linear and Log linear models have been used to study the coefficients associated with the price variables. It is observed that price and per capita income explained 77 percent variation in the availability of fish in case of linear model and 73 percent variation in case of log-linear model. It may be concluded that with the future increase in per capita income the fish consumption may rise considerably.

#### 48. A STUDY ON LOCATIONAL DIFFERENCES OF RETAIL PRICES OF IMPORTANT VEGETABLE CROPS AND IDENTIFICATION OF FACTORS RESPONSIBLE FOR THESE DIFFERENCES

SATYA PAL  
*IASRI, New Delhi-12*

Retail prices vary substantially over different localities showing as an evidence to support the view that the retail vegetable trade is in-efficient and exploitative. It is argued that the retailer is able to extract an element of monopoly profit. Several reasons are assigned for this, relating mainly to demand conditions in each market. Income profile of the consumers residing in the locality is one of the important factors. Another factor is the tendency of the consumer not to move away from his locality market making the demand for his product more in-elastic. Extent of intra locality competition among retailers could also play a role in this context. In the present study price differentials are explained in terms of variables like transport charges, income level of the consumers, level of investment by the retailers, extent of competition among retailers etc. utilising data from vegetable survey for price spread at various stages in Delhi, conducted by IASRI, New Delhi.

The study showed that the retail vegetable trade was far from perfect. Wide variation in inter and intra locality prices were found. The retail price equations for different vegetables suggest that extent of intra locality competition among retailers and transportation cost were important determination of retail prices. Level of investment by the retailers exerted a positive influence but scale of operation was negatively associated. It is clearly indicated that retail price is influenced by the nature of the locality and characteristics of the retailers.

#### 49. EFFECT OF VARIOUS FACTORS ON SALE PRICE OF MILCH ANIMALS

S. B. AGARWAL, R. K. PATEL and C. B. SINGH  
*National Dairy Research Institute, Karnal (Haryana)*

The present study deals with the effect of genetic and non genetic factors on sale price of milch animals during auction on an organised farm. The data pertains to the period 1974 to 1981 for different breeds of cows and in different seasons of sale at NDRI, farm, Karnal. The two periods were March and September, while breeds were, indigenous cows viz; Tharparkar, Sahiwal and Red Sindhi and exotic cows included Brown Swiss, Holstein and Jersey crosses. The animals sold were categorised under the heads : (i) In milk and pregnant (ii) In milk and not pregnant (iii) Dry and pregnant and (iv) Dry and not pregnant. The average sale price of cows was generally more in March compared to September. The overall sale price of Jersey crosses was highest followed by brown swiss and Holstein crosses for NDRI farm, Karnal. Further the effects of seasons of sale, category of animal, reasons of sale, order of lactation and breed of cows on sale price of milch animals was also studied. These were found statistically significant.

#### 50. PERFORMANCE OF SEASAMUM IN MAJOR OIL SEED GROWING STATES IN INDIA 1970-71 TO 1980-81

P. R. WAGHMARE and V. B. TAK  
*Marathwada Agricultural University, Parbhani*

The area under cultivation of seasamum in the country is about 23.34 lakh hectares. It has experienced very small amount of change as compared to other oil seed crops. Due to present oil crises in the country changes in area, production and yield were studied for the last decade. The results of the analysis showed that, Uttar Pradesh, Andhra Pradesh, Rajasthan, Madhya Pradesh contributed nearly 70% of total area in the country, as against their contribution of production to 45 per cent, where as Gujarat, Karnataka, Maharashtra, Orissa and Tamilnadu contributed nearly 30 per cent in area and 45-50 per cent in production. The average yields in Uttar Pradesh was 113 kg/ha as against 570 kg/ha in West Bengal which contributes nearly 2 per cent in Area. The trends in area were positive and significant in case of Karnataka, Maharashtra, Orissa, Uttar Pradesh, and West Bengal where as the trends were negatively significant in case of Madhya Pradesh. The trends in Production were

significant in case of Karnataka, Maharashtra and West Bengal. Trends in yield were positive in Andhra Pradesh, Gujarat, Karnataka, Maharashtra and Tamilnadu but were non significant at 5 per cent level of significance. Hence, still better scope exists in uplifting the yield rate in Uttar Pradesh, Rajasthan, Madhya Pradesh, Andhra Pradesh and Maharashtra State.

### SECTION : B

#### 51. A METHOD FOR COMBINED ANALYSIS OF A GROUP OF SPLIT-PLOT DESIGNS WITH HETEROGENEOUS ERROR VARIANCES

K. C. BHUYAN

*Jahangirnagar University, Dhaka, Bangladesh*

The effects of heterogeneous error variances are most serious when the analysis of variance technique is to be used as a method of statistical inference in analysing a group of experiments. The problem is mainly due to the presence of places-treatments interaction. The presence of places treatments interaction indicates the unstability of the treatments over places. However, it may not be likely that all the treatments under study are unstable over the places. In such a situation the best thing to be done, is to select first, a group of treatments which are more or less stable overall experimental conditions and then to recommend the best group of treatments through pooled analysis. A method for selection of a group of whole-plot and sub-plot treatments which are stable over the places and exact method for testing homogeneity of treatment means, even with heterogeneous error variances, is described in this paper.

#### 52. SOME DESIGNS FOR LARGE TREATMENTS WITH TWO OR THREE REPLICATES ONLY

A. D. DAS

*BCK Viswavidyalaya, North Bengal Campus, Cooch Behar*

Sometimes the research workers in the experimental fields (e.g., plant breeders, agronomists, etc.), for comparing a relatively larger number of

treatments (varieties, crosses etc.) face difficulties in getting suitable plans of designs with reasonably small number (say, 2 or 3) of replication of treatments alongwith fairly practicable block sizes. Besides, even when the number of treatments is not too large, the available list of incomplete block designs may not include the number of treatments that the experimenter is actually interested in or may supply him with plans which require too many replications. As mentioned by Calinski (Biometrics; 1971), L.R. Verdooren, in the year 1966, could not find a suitable plan for comparing 18 varieties of wheat using 3 replicates only. Several such situations may be cited where the experimenters are unable to find appropriate designs for their experiments and compelled to use 'home-made' designs to deal with particular situations but the conclusions drawn out of them often remain unsatisfactory. An effort is, therefore, made in this paper to evolve some plans of designs with their analyses in general terms that could be used in the circumstances as above.

### 53. FREQUENCY DISTRIBUTION OF PLOT YIELDS IN NATURAL GRASSLANDS OF OUTER HIMALAYAS UNDER VARIOUS SLOPES

RAM BABU, M. C. AGARWAL and R. K. GUPTA

*Central Soil and Water Conservation Research and Training Institute  
(ICAR), Dehradun (UP)—248 195*

An attempt has been made to find out the nature of the frequency distribution of yields of various shapes of plots from  $1\text{m}^2$  to  $12\text{m}^2$  in natural grasslands of Outer Himalayas hills under six different slope classes (i.e. 10-15%, 15-25%, 25-35%, 35-50%, 50-100% and more than 100% slope). The plot size had been restricted to  $12\text{m}^2$  as few cases of bigger size were available for study. These frequency distribution has been analysed separately for individual year and as well as for the average yield of two consecutive years. The skewness and the kurtosis were estimated in each case and their significance tested. The theoretical normal curve was also fitted and chi-square test for goodness of fit was also carried out. The results indicate that there is a minimum plot size below which the assumption of normality is not followed and also indicate that more than  $8\text{m}^2$  plots follow the assumption of normal law in such lands. Hence it may be concluded that a plot of  $8\text{-}12\text{m}^2$  may be taken on such lands for conducting the field experiments.

## 54. BLOCKING VS COVARIANCE

G. C. CHAWLA  
*IASRI, New Delhi-12*

This paper deals with the reduction of experimental error by measuring one or more secondary characteristics (covariates) of the experimental units. A nuisance variable often terms as a covariate or a blocking factor rather than a treatment factor e.g. a previous lactation of dairy cows can be used alternatively as a nuisance variable for blocking. In such situations covariance analysis and block design are competitors in the efficiency matter. This work has been illustrated on the basis of analysis of experimental data.

## 55. GENERALIZED PARTIALLY BALANCED INCOMPLETE BLOCK DESIGNS

KISHORE SINHA  
*Birsa Agricultural University, Ranchi-834006*

The concept of Generalized partially balanced incomplete block (PBIB) design is introduced. Generalized PBIB designs are shown to be useful for the construction of balanced block designs, pairwise balanced designs, BIB designs and Optimum chemical balance weighing designs.

## 56. ANALYSIS OF UNIFORMITY TRIAL DATA WITH MUSTARD

P. R. KUMAR and N. P. SINGH  
*Haryana Agricultural University, Hisar-125004*

Efficient planning of a field experiment apart from other considerations like randomization, local control and replication, also depends upon suitable size and shape of plots and arrangement of these plots into block to suitable size and shape. Every experimental area has an inherent variation, i.e., soil variability because of which inspite of giving uniform treatment to the entire area the crop raised will have a variation in yield from plot to plot. This short of variation can be studied by the method of maximum curvature, fertility contour map, Smith's empirical relation between variance and size of the plot, intra class correlation, spatial correlation etc. In the present course of investigation, the analysis of uniformity trial data with mustard to find optimum size and shape of plots is carried out using Smith's empirical relation and spatial correlation analysis.

### 57. ANALYSIS OF TWO-WAY CLASSIFICATION WHEN ONE FACTOR HAS REPEATED MEASUREMENTS

B. SINGH and C. B. TIWARI  
*IVRI, Izatnagar 243122*

In two-way classification when one factor has repeated measurements (e.g. growth and feedlot experiments, digestibility/clinical or physiological trials, etc.), the mean square ratios do not follow the classical  $F$ -distribution even when the corresponding null hypotheses hold. It is because the observations at several time points are correlated with possibly different variances. This paper considers the case of two-way classification with proportionate cell frequencies having one repeated factor over time and obtains the exact and approximate null distributions of the appropriate mean square ratios for testing the main effects and their interactions. The desired expressions may also be used to study the effect of the inbuilt assumptions on the significance level of the usual ANOVA  $F$ -tests.

### 58. MODEL AND ANALYSIS OF INTERCROPPING EXPERIMENTAL DATA

M. NARAYANA REDDY and G. K. SHUKLA  
*IIT, Kanpur 16*

A model is proposed for assessing the yield advantages from the two crop intercropping system by considering the competition effects between the neighbouring rows. The proposed model, based on yields per row, is extended to the case when yields are recorded on the plot basis. Initially the model is developed to study the competition effects due to various crop geometries considering the first order dependence. The model includes the competition effects of inter and intra species. In estimating these parameters the errors are assumed to be dependent on the proportions of the component crop rows. The procedure of estimation is being developed and will be examined with simulated as well as actual experimental data. From the model the optimum crop geometry for different objectives like maximizing Land Equivalent Ratio (LER), or maximising total revenue, can be obtained. Further the effects of treatments like plant density, fertilizers etc. can be studied by making the competition coefficients as functions of these inputs,

## 59. UNIFORMITY TRIAL IN BAJRA

U. VERMA, P. D. PURI, L. S. KAUSHIK and H. P. S. SANGWAN  
*Haryana Agricultural University, Hisar 125004*

An uniformity trial on Bajra *Pennisetum typhoides* showed that the Coefficient of variation decreased with an increase in plot size in either direction but the decrease was more rapid along the N-S direction. For all plot sizes, the CV generally increased with an increase in block size. For any fixed size of block, elongated blocks in the E-W direction were able to reduce error to a greater extent than blocks elongated in the N-S direction. The relationship between plot size and CV was adequately described by Fairfield Smith's equation, however, it was not so useful for the relationship between block size and CV. For a given experimental area, the efficiency of the smallest plot was the highest. Randomized Block Design proved more efficient in reducing the experimental error than Completely Randomized Design. Latin Square Design, confounded Design and Lattice Designs were found to be advantageous over RBD.

60. A COMPARATIVE STUDY OF NITROGEN FERTILIZERS,  
AMMONIUM SULPHATE AND UREA AT A CONSTANT  
LEVEL AND DIFFERENT LEVELS ON THE YIELD  
OF PADDY

S. M. G. SARAN, B. H. SINGH and D. C. MATHUR  
*IASRI, New-Delhi-12*

Two field experiments on Dular (medium) variety of paddy were conducted during 1966 to 1970 in Randomised Block Design (R.B.D.) at State Agricultural Farm, Midnapore with the objectives (i) to study the relationship between yield and different source of nitrogen at a constant level 22.4 kg/ha by fitting quadratic curves (ii) to compare the efficiency of Urea and Ammonium sulphate at different levels of nitrogen and (iii) to know the best use of nitrogen source by giving the additional net profit on physical production of paddy. The results showed that application of nitrogen as Ammonium Sulphate and Urea at the rate of 66.2 kg/ha. gave the maximum additional respective profit of Rs. 1928 and Rs. 983 over control. So far efficiency of Urea and ammonium sulphate was concerned the treatment difference was found highly significant.



### 61. INTERCROPPING DATA ANALYSIS THROUGH THE METHOD OF RANKING

P. P. RAO and P. N. BHARGAVA  
*IASRI, New Delhi-12*

For the analysis of intercropping data, the approach adopted in the past was converting the yield of component crops into uni-variate or applying the usual bi-variate analysis technique. These methods have some limitations. In the present paper some of the limitations have been discussed and a distribution free method through ranking is proposed. The test statistic 'C' is also given. The significance of the C indicates that the mean ranks obtained by the treatments is not due to chance. Any pair of treatment mean ranks may be compared by student-t test. This method is also extended for the groups of experiments. In the mixed crop experiments which is generally of replacement series nature the bi-variate method of analysis will not be of use. For these situations, the proposed method of analysis will be more useful. The details of the methodology of these experiments are discussed in the present paper and illustrated through an example.

### 62. A—OPTIMAL INCOMPLETE BLOCK DESIGNS FOR COMPARING TREATMENTS WITH A CONTROL

A. DEY and ASHISH DAS  
*IASRI, New Delhi*

In the paper the A-Optimality of Augmented BIB (ABIB) designs has been studied. The major emphasis is on the designs with  $t = 1$  and 2 where  $t$  denotes the number of control treatments in each block. Families of BIB designs leading to A-Optimal ABIB designs for  $t = 2$  are identified. For any  $t \geq 1$ , two series of A-optimal ABIB designs are discovered. A catalogue of A-optimal ABIB designs for  $t = 1, 2$  is also provided.

### 63. TWO-LEVEL DIALLEL EXPERIMENTS WITH PARENTS INCLUDED

J. S. YADAV and A. S. ARYA  
*Haryana Agricultural University, Hissar-125 004*

Diallel cross experiments have been regarded to be important tools in analysing the general potential of a line and in evaluating the best com-

bination of crossing material in plant breeding programme. Lately Hinkelmann (1974) discussed two-level diallel experiments which are capable of furnishing the information on combining abilities of lines on intra as well as inter population level. He considered an experiment in which only the  $F_1$ s, within and between populations, were evaluated in completely randomized design ignoring the parents. However, the inclusion of parents is desirable because it provides a means of estimating hybrid vigour directly from the specific combining ability effects. The present study refers to a two-level diallel experiment laid down in randomized block design with the inclusion of the parents. The analysis has been given for fixed and random effect model and has been illustrated with live data on wheat.

#### 64. ON THE ESTIMATION OF GENETIC COMPONENTS OF VARIANCE FOR PARTIAL TRIALLEL CROSSES (I)

K. N. PONNUSWAMY

*University of Madras*

and

A. SUBBARAYAN

*Presidency College, Madras*

Genetic parameters such as additive ( $\sigma_A^2$ ), dominance ( $\sigma_D^2$ ) and epistatic components of variance ( $\sigma_I^2$ ) are of utmost importance to the breeders, as they enable them to understand the nature of gene action and help them in developing suitable hybrids or synthesis strains. Various Mating Designs have been developed for providing unbiased estimators for one or more of these genetic components of variance. Rawlings and Cockerham (1962 a, b) introduced the Triallel and Double Cross Mating Designs and gave the method of analysis. They have shown that these designs can provide unbiased estimators for 6 genetic components namely,  $\sigma_A^2$ ,  $\sigma_D^2$ ,  $\sigma_{AA}^2$ ,  $\sigma_{AD}^2$ ,  $\sigma_{DD}^2$  and any one of  $\sigma_{AAA}^2$ ,  $\sigma_{AAD}^2$ ,  $\sigma_{ADD}^2$ , and  $\sigma_{DDD}^2$ . It may be noted that these higher order mating designs require three crop seasons and involve too many crosses. Ponnuswamy (1971) gave an alternative method of analysis for Triallel Crosses. With a view to overcome the problem of too many crosses in Triallel, Hinkelmann (1965) introduced the concept of Partial Triallel Crosses (PTC) and gave a method of constructing PTC using GPIB Designs. His PTC designs can provide estimates only for the three design components namely,  $\sigma_h^2$ ,  $\sigma_g^2$  and  $\sigma_{gh}$  only. Radhakrishnan (1981) has shown that meaningful genetic interpretation can be made only when all the ten design components, namely,  $\sigma_h^2$ ,  $\sigma_g^2$ ,  $\sigma_{gh}$ ,

$\sigma_d^2$ ,  $\sigma_{ds}$ ,  $\sigma_s^2$ ,  $\sigma_{ss}$ ,  $\sigma_t^2$ ,  $\sigma_{tt}$  and  $\sigma_e^2$  are estimable from the Triallel data. Ponnuswamy and Subbarayan (1985) gave the method of construction of PTC (I) and PTC (II) through BIBD and PBIBD (2) respectively. Srinivasan and Ponnuswamy (1985), Srinivasan (1986) have shown, through simulation study, that the method of estimation using the quadratic estimators based on the covariance structure, provides better estimators for the design and genetic components than the estimators based on Quadratic Least Square theory as developed by Yuan, C. H. (1978) in the sense of minimum mean squared error.

In this paper an attempt has been made to estimate the design and genetic components of variance for the PTC (I) developed through BIBD using Hinkelmann's model based on the covariance structure.

#### 65. MISSING TECHNIQUE IN TRIALLEL CROSSES

BHAGIRATH LAL and L. S. KAUSHIK  
*Haryana Agricultural University, Hissar*

At present, the missing plot technique in triallel crosses is either not used or if used, the missing observation is estimated by the standard formula of the design used without caring for its consequence on the estimate of genetic parameters. In the present paper, the method of analysis of triallel crosses for missing data has been presented. The formulae for estimating the genetic parameters, the variances due to estimates of parameters and for obtaining the sum of squares due to various components have been given. The method has also been illustrated through an example.

#### 66. PROBIT ANALYSIS IN MUTAGEN TREATED SEEDS OF INDIAN SENNA

SRIKANT SHARMA and J. R. BAHL  
*Central Institute of Medicinal and Aromatic Plants, Lucknow*

Seeds of Indian Senna (*Cassia angustifolia* Vahl.) were exposed to gamma rays ranging from 200-700 Gy at equal interval of 100 Gy and to a combination of gamma rays ranging from 200-500 Gy with 0.2% EMS for six hours to determine the mutagenic response and to find an optimum dose of gamma rays for inducing mutations. In each treatment, fifty seeds were incubated at a temperature of  $25 \pm 1^\circ\text{C}$  in petridishes with three replications. The doses of gamma rays were found to be directly proportional to the biological damages measured in terms of reduction

in germination, root length and shoot length. Treatment differences were found to be significant at  $p < .01$  and the mean values of each treatment differed significantly from that of the untreated seeds in all other characters excepting in root length (lower doses of gamma rays only). The median lethal dose and  $LD_{30}$ , wherever necessary, were found out by probit analysis using the linear relationship  $y = a + bx$  between the dose ( $x$ ) and transform of the probability of response ( $y$ ). The  $LD_{50}$  values for shoot length were calculated as 681.3 Gy and 433.9 Gy for gamma rays and combined treatment respectively while the  $LD_{30}$  values of 339.3 Gy and 527.8 Gy in gamma rays and 308.9 Gy and 434 Gy in combined treatment were found out respectively for germination and root length.

#### 67. APPROPRIATE NUMBER OF REPLICATIONS IN SUGARCANE EXPERIMENTATION

B. H. SINGH, S. K. BHATNAGAR and CHANDRAHAS  
*IASRI, New Delhi-12*

Field experiments carefully designed and planned are conducted to provide accurate information on the effect of treatments. Sometimes it happens that the experimenter is unable to get the valid inference due to inadequate number of replications for the experiment for the purpose of detecting true difference between the treatment means. An attempt has been made to study the number of replications required for detecting the true difference between treatment means in sugarcane yield. The data from 15 experiments on sugarcane conducted in Randomized Block Design (RBD) during 1974-78 at I.I.S.R., Lucknow were utilised for the study. It is concluded from the results that recommended number of replications in R.B.D. while attempting different treatments in the field will remain useful for the experimenter and he may detect the true difference between means at the required level of significance by making use of One-Tailed and Two-Tailed tests.

#### 68. ON THE PROBABILITY OF NEGATIVE ESTIMATE OF THE GROUP VARIANCE COMPONENT IN ONE-WAY UNBALANCED RANDOM MODEL

B. SINGH  
*IVRI, Izatnagar-243122*

An expression for the probability of getting negative estimates of the

group variance component in one-way unbalanced random model has been obtained by using the Laguerre polynomials approximation for the non-null distribution of the analysis of variance  $F$ -ratio. It is found that the probability of the negative estimate of the group variance component increases with the variability among the group sizes and decreases with the ratio of variance components in the model.

#### 69. POWER OF A SOMETIMES POOL TEST PROCEDURE IN A MIXED MODEL ANALYSIS OF VARIANCE

KRIPA SHANKER

*J. N. Krishi Vishwa-Vidyalyaya, Jabalpur (M. P.)*

and

S. M. SHAH

*Sardar Patel University, Vallabh Vidyanagar (Gujarat)*

A sometimes pool test procedure involving the use of three preliminary tests of significance for testing a hypothesis in a mixed model analysis of variance for combination of crossed and nested classification has been developed. The series formulae for different power components of the test procedure have been derived.

#### 70. POWER OF AN ANALYSIS OF VARIANCE TEST PROCEDURE FOR A CONDITIONALLY SPECIFIED RANDOM MODEL WITH UNEQUAL SUB-CLASS NUMBERS

KRIPA SHANKER

*J. N. Krishi Vishwa-Vidyalyaya, Jabalpur-482 004*

In case of two-level nested random model analysis of variance (ANOVA) with unequal subclass numbers, the between-groups differences may be tested by dividing between—groups mean square by a pooled mean square obtained by pooling the sub-groups mean square with the sub-sub groups mean square when sub-groups differences are not significant. When sub-groups differences are significant, an approximate test of significance between groups is possible only by synthesizing a denominator mean square. In case of uncertainty about the existence of sub-groups differences, a preliminary test was carried out and a test procedure was developed. In this paper the formula for power of this ANOVA test procedure considering random linear model is derived. It is shown

that power formula derived by Bozivich et. al (1956) is a particular case of the formula derived in this paper.

### 71. BORDER EFFECT IN THRIPS COUNT OF AN INSECTICIDAL TRIAL OF HYBRID-4 COTTON

T. J. KHATRI and N. K. PATEL

*Gujarat Agricultural University, Navsari-396450*

The large variation in the treatments of the adjacent plots (e.g. spraying of insecticides and no spraying of insecticides) is likely to cause inter-plot competition, effecting treatment means (Fedsrer, 1974). The treatment effects obtained from such experiments are not free from border effect. It inflates the error estimate by increasing heterogeneity among plots, (Hutchinson and Panse, 1935). Multiple row plots with the centre rows for the estimation of yield are generally adopted in field trials to eliminate inter-plot competition component of variance from the experimental error variance. The elimination of inter-plot competition is accomplished by leaving non-experimental margin (border area) around net plot. The size (width) of margin usually varies with the kind of crop and nature of treatment. The present investigation on hybrid-4 cotton was undertaken with ten treatment combination of (i) number of border row(s) (no border, one, two, three and four border rows) on either side of the net plot and (ii) spraying levels (no spraying and recommended spraying) was conducted in a randomized block design with three replications on hybrid-4 cotton at college farm of N. M. College of Agriculture, Gujarat Agricultural University, Navsari; to assess the border effect in Thrips count in an insecticidal trial. The results lead to the conclusion that, three border rows on either side of the net plot are necessary to eliminate border influence for unbiased estimate of Thrips count in an insecticidal trial.

### 72. ECONOMICAL CONTROL MEASURES AGAINST ARHAR POD BORER COMPLEX IN MARATHWADA REGION OF MAHARASHTRA STATE

A. M. DEGAONKAR and J. S. KURTADIKAR

*A. R. S. Badnapur*

The Step-wise pooled analysis was applied to past historic multilocal data on economical control measures against arhar pod borer complex. In this experiment the chemicals used were (i) Karanja oil 0.2% + Soap 1% (ii) NSKE 5% + Soap 1% (iii) Neem leaves extract 5% (iv) BHC

10% dust (v) Endosulfan 0.07% and (vi) Untreated control. The data of economical control measures against arhar pod borer complex from 1979-80 to 1981-82 were used in pooled analysis. Two sprays of chemicals at fortnightly interval and four sprays of plant products at weekly interval starting from 50% flowering had been given. The pooled analysis of percentage pod damage by arhar pod borer complex for the years 1979-80, 1980-81 and 1981-82 were significant and all the treatments were significantly superior over control in reduction of pod damage. The treatment Endosulfan 0.07% was proved significantly superior over other treatments except karanja oil 0.2% during 1979-80. The pooled analysis of yield data for the year 1979-80 and 1980-81 were significant but there were no significant difference amongst various treatments during 1981-82. Treatment with 0.07% Endosulfan recorded significantly higher yield over other treatments during 1979-80 and 1980-81. The data of economics for the control of arhar pod borer complex alongwith cost details is presented. The treatment with Endosulfan 0.07% give maximum net profit (Rs. 1661/ha). However the cost benefit ratio was higher in case of BHC 10% dust. (1 : 12 : 06) followed by 0.07% Endosulfan (1 : 9 : 22) and neem leaves extract 5% (1 : 7 : 38).

### 73. IRRIGATION DEVELOPMENT IN MARATHWADA DIVISION OF MAHARASHTRA STATE

DR. V. B. TAK and DR. B. W. ASHTURKAR  
*Marathwada Agricultural University, Parbhani*

Adequate and timely supply of irrigation to crop is pre-requisite in agricultural production process, particularly in the areas where the rainfall is scanty and irregular. The canal is expected to play a dominant role in this regards. The study has pointed out in the Marathwada that, area under irrigation by different sources has significantly increased both in the state as well as in the division. Growth rates of irrigation through Government canals in the state increased at significant compound rate of 30.24 per annum. Similarly length of the canal significantly increased at a compound rate of 38.37 per cent. Analysis has also pointed out that there was no significant change in the share of average area of major irrigated crops to total cropped irrigated area over the period under study.

#### 74. FACTORS DISCRIMINATING THE YIELD OF WHEAT ON THE SOWING OF TREATED VERSUS UNTREATED SEED

SATYAPAL, T. RAI and V. P. N. SINGH  
*IASRI, New Delhi-12*

The statistical analysis of the data collected under the project "Sample Survey for Methodological Investigation into High Yielding Varieties Programme" conducted at Chittoorgarh and Jaipur districts of Rajasthan indicated a significant difference w.r.t. yield between the pattern of sowing of seed. Hence the present study is undertaken to know the causal factors responsible for the differential patterns. A function

$$Z = \sum_{i=1}^8 l_i x_i$$

is fitted, where  $Z$  is the total discriminant score on the yield of wheat due to sowing of treated vs untreated seed,  $l_i$ 's are the various discriminant function coefficients of  $x_i$ 's variables.

#### 75. MINIMUM SAMPLE SIZE FOR PROGENY EVALUATION IN SUGARCANE

P. K. BAJPAI, B. K. TRIPATHI and S. S. GILL  
*Indian Institute of Sugarcane Research, Lucknow-226 002*

An experiment was conducted at the Institute farm in order to study the sample size for estimating mean and variance of cane weight, Stalk number, Cane height, brin and cane diameter in three families of Sugarcane seedlings. For each variable ten samples were drawn randomly for each of the following sizes viz., 10, 20, 30, 40, 50, 60, 70, 80, and 90 seedlings. Mean and variance were estimated from each of the sample. The absolute difference between sample estimate and population parameter was expressed relative to population parameter according to equations :

$$\Delta \bar{x} = 100 \frac{|\bar{x} - \mu|}{\mu} \text{ and } \Delta s^2 = 100 \frac{|s^2 - \delta^2|}{\delta^2}$$

The occurrence of  $\Delta \bar{x}$  and  $\Delta s^2$  below pre-determined critical levels were plotted against cumulative frequencies sample size for minimum error and 10 percent margin of error with 95 percent confidence were



obtained. It is concluded that sample size of 60 seedlings per family will be sufficient for the estimation of mean and variance of all traits studied.

## 76. ROLE OF AREA AND YIELD ON PRODUCTION OF RICE

JAGMOHAN SINGH and A. S. GUPTA  
*IASRI, New Delhi-12*

Contributions of area, average yield in Kg./hectare singly or jointly in the growth of rice production during five year plan periods, starting from the base year 1949-50 to 1984-85 is studied for the States of Punjab and Uttar Pradesh. The study revealed that the factor affecting the increase in yield of rice was mainly area being 84% and 75% in Punjab and Uttar Pradesh respectively. This factor contributed 24% and 26% increase in Punjab and Uttar Pradesh respectively over the period under study. The productivity factor behaved haphazardly over the years under study.

## 77. USE OF ANCILLARY INFORMATION IN IMPROVING ESTIMATES OF AVERAGE YIELD OF CROPS

S. S. GUPTA and P. C. MEHROTRA  
*IASRI, New Delhi-12*

Use of ancillary information, in sampling investigations, which is either already available or is obtainable at a nominal cost without enhancing the overall cost, under certain conditions is well known. In this paper an attempt has been made to utilize the information on production of a crop collected by enquiry from a large sample and yield data obtained from a smaller sample through the usual crop cutting experiments technique. For working out the estimate of average yield the double sampling technique has been utilized. The suggested method could be utilized with advantage for working out estimates of yield rates of crops at micro-levels as well as for minor crops for which generally no estimates are prepared or the estimates worked out are by and large of low precision mainly on account of smaller size of the sample available under the normal series of crop cutting experiments.

## 78. ESTIMATION OF LOSSES CAUSED BY FLOODS IN AGRICULTURAL PRODUCTION

MANISHA GUPTA, O. P. KATHURIA and A. K. BANERJEE

The estimation of crop area affected by floods and the extent of crop

damage available are generally based on visual assessment by persons of repute at the village level like patwari, village pradhan etc. Being subjective such estimates are generally not reliable. The present paper deals with the problem of estimation of losses caused by floods in agricultural production by utilising the data collected by the Indian Agricultural Statistics Research Institute, New Delhi under the project "Pilot Sample Survey to study the impact of floods on agricultural production in a region of Uttar Pradesh". The study attempts to estimate the area affected and the loss of inputs and other assets of the cultivators selected under the above mentioned project in Faizabad district of Uttar Pradesh during kharif 1981-82. Three estimators were attempted to arrive at an estimator at the district level. The results of analysis of the data show that the estimates of area affected by floods in the district was only of the order of 4 to 5 per cent in comparison to total area figures supplied by the State authorities. Since the technique of collapsed strata was used the estimated variance were slightly higher. The estimates of loss on livestock, machinery, input material etc. was of a low order. The classification of villages into intensity of low, medium and high order of floods was not different from one another since the classification was based on the effect of previous year floods in the district. The clustering of villages adopted under the project was effective.

#### 79. IMPACT OF OCCURRENCE OF FLOOD AT VARIOUS STAGES OF CROP-GROWTH

JAGMOHAN SINGH and O. P. KATHURIA  
*IASRI, New Delhi-12*

The crop-stage at which flood occurs is an important factor in determining its effect on the yield. A study to this effect has been carried out on paddy and Arhar crops cultivated in the selected villages of Faizabad district. The data collected under the project, "Pilot sample survey to study the impact of flood on agricultural production in a region of Uttar Pradesh" was utilized for the purpose. The study revealed that in case of paddy crop, average yield was 9.68 Qts./acre and 7.02 Qts./acre where flood occurred at preflowering and tillering stages respectively, as compared to average yield of paddy in unaffected fields being 12.19 Qts./acre. About 4.5% of the area under paddy affected during tillering stage did not yield any paddy. As compared to average yield of 3.01 Qts./acre, the yield of Arhar crop on occurrence of flood at its preflowering and Tillering stages was only 1.28 Qts./acre and 0.13 Qts./acre respectively, whereas the productivity in case of unaffected fields was 2.06 Qts./acre in

Bikapur tehsil of Faizabad district. 17% and 88% of the area under Arhar crop affected by flood respectively during preflowering and tillering stages of crop growth did not yield any produce.

#### 80. ESTIMATION OF AREA AND PRODUCTIVITY OF SEVERAL CROPS GROWN TOGETHER IN THE SAME FIELD

P. C. MEHROTRA and V. S. RUSTOGI  
*IASRI, New Delhi-12*

Mixed cropping is a common practice all over India. Consequent to the introduction of modern agricultural technology including high yield potential fertilizer responsive new varieties of crops the technique of mixed cultivation has undergone change and alongwith it the ratio of different crops has also changed. The allocation of gross area of a crop mixture to its different components crops is done either at source i.e., at the field level or at the district level. For apportioning the gross area of a crop mixture to its component crops a number of procedures are followed viz; apportioning (i) in proportion to the number of rows under each constituent crop, in case the crops are grown in rows; (ii) by eye estimation, (iii) on the basis of seed rates of different constituents etc. Also, component crop(s) occupying a negligible area or area below a certain minimum, is ignored and is assigned to major crops. Furthermore, different states practice different procedures for the apportionment of crop mixture which too are not followed uniformly by the field agency even within the same region (district/state). All the above procedures are highly subjective as also the apportioning ratios fixed have undergone change over the time. It is, therefore, imperative that an objective approach to this problem is developed which could easily fit into the normal system of collection of agricultural statistics. In this paper an attempt in that direction has been made by suitably adjusting the programme of normal series of crop cutting experiments.

#### 81. AN EMPIRICAL STUDY ON THE USE OF AUXILIARY VARIABLES IN SAMPLING AND ESTIMATION

V. S. RUSTOGI, CHANDRA SINGH and M. S. NARANG  
*IASRI, New Delhi-12*

An attempt has been made by carrying out empirical studies by using three auxiliary variables in all combinations of their roles. The variables

considered are total fertilizer consumption ( $N + P + K$ ) ( $X_1$ ) area under rice ( $X_2$ ) and total production of rice ( $X_3$ ) for the year 1982-83 for each of the 48 districts in the plains of Uttar Pradesh. The character under study is the total rice production during 1983-84 ( $Y$ ). The estimates are based on stratified random sampling and on probability proportional to size without replacement (PPSWOR) besides the ratio estimator. The variables of all these estimators have been calculated and the percentage gains in efficiency with respect to simple random sampling without replacement (SRSWOR) have been worked out. It has been observed that (i) estimators using auxiliary variables/variable are more efficient than the estimators based on SRSWOR, (ii) the auxiliary variable ( $X_1$ ) is best suited for stratification,  $X_2$  for constructing ratio estimator and  $X_3$  for selection, (iii) in the class of estimators using two auxiliary variables either for stratification or selection or for estimation, estimators using one auxiliary for selection of units with PPSWOR and another for estimation have the least variance, (iv) when all the three auxiliary variables have been used in their different roles, the estimator using auxiliary variable,  $X_1$ , for stratification, variable  $X_2$  for estimation (ratio estimator) and variable  $X_3$  for selection with Rao, Hartley and Cochran (PPSWOR) procedure yields the maximum percentage gain in efficiency over SRSWOR than all the other estimators considered.

## 82. APPLICATION OF CHI-SQUARE FOR ANALYSS OF CLASSIFIED DATA ON DEATH FREQUENCIES

S.N. ARYA

*I.A.S.R.I., New Delhi-12*

Well known among the several applications of Chi-square is its use in the statistical analysis of two-way classified data. In this study, data on the frequencies of deaths in young buffaloes, secured from a mortality survey in Vijayawada ICDP area of Andhra Pradesh, were analysed and interpreted in respect of cause of death and sex/breed differences. The data were shaped into  $2 \times 7$  contingency tables separately for graded and non-descript buffaloes with sex as one classification and cause of death as the other. Chi-squares were worked out by the formula of Brandt and Snedecor for the two cases. Each of these was found to be non-significant at probability level of .05 and hence the data were combined over sexes. The association (or otherwise) between breed and cause of death was then investigated by obtaining  $\chi^2$  (6 d.f.) for the pooled data. This was highly significant ( $P < .001$ )—thus providing evidence that the observed departures from independence are not ascribable to chance.

Further, it is observed that, in comparison with non-descript buffaloes graded animals were much more susceptible to pneumonia while they had a smaller chance of dying from worm infestation.

### 83. GENERAL UNBIASED MODIFIED PRODUCT TYPE ESTIMATOR

M. N. PATEL

*Sir P. P. Institute of Science, Bhavnagar, Gujarat*

A change of origin and scale transformation in ratio and difference estimation in sampling design was considered by Mohanty and Das (1971), Srivenkataraman (1978), Srivenkataraman and Srinath (1982). An unbiased product type estimator is suggested by Murthy (1964). Using transformation involving change of origin and scale in the variables and following Hartley and Ross (1954) method the general unbiased modified product type estimator is suggested. Some special estimators as particular cases of this suggested estimator is discussed in this paper.

### 84. FRACTIONATION IN SENSORY EVALUATION

S. C. RAI

*IASRI, New Delhi-12*

In Sensory evaluation the number of samples a judge can assess is often limited by sensory fatigue and it is also very difficult to obtain the satisfactory quantitative measures of sensory characters. The technique of rank analysis is generally employed in such cases. Experiments for sensory evaluation are mostly wearying to the judges when the number of objects required to be compared are large and judges may not always be able to take correct decisions while comparing them and this will adversely affect the experimental results. In this paper, a statistical procedure for comparing the performance of a new product with the existing products on the basis of sensory characters, has been developed by fractionating triad comparisons. A test statistic has been evolved for testing the null hypothesis of equality of treatment effects and the null distribution of the test statistic has been worked out. The procedure is quite simple and is based on a distribution-free test requiring only ordinal scale measurement.

85. TREND STUDIES IN ECONOMIC VARIABLES—NON  
PARAMETRIC TESTSS. C. RAI and SHANTI SARUP  
*IASRI, New Delhi-12*

A large number of distribution-free tests have been developed by various researchers to test the hypothesis of randomness of a series of  $N$  observations i.e. the hypothesis that  $N$  independent random variables have the same continuous distribution function. Rank correlation test is generally considered the most efficient test against normal trend alternatives but some other tests are also quite useful in situations where speed and simplicity in calculations are important. In this paper we have discussed a class of simple randomization test for study of trend in location parameters. A test has also been developed for study of trends in dispersion of time series and cross-sectional data. Procedures have been explained by taking data on per capita income of the different States of the country through 1970-71 to 1979-80.

86. POPULATION DYNAMICS OF GOATS AND ITS ROLE IN  
INDIA'S ECONOMYC. B. TIWARI, RAJENDRA PRAKASH and B. SINGH  
*IVRI, Izatnagar*

An attempt has been made to examine the four growth models, proposed by Dandekar [(1980, J.I.S. Ag. Eco., 35 (2)] to fit the goat population for 21 years from 1963 to 1983. The projections of the populations of Goats for the year 1990, 1995 and 2000 A.D. has also been worked out using the best fit model. The power of determination has been taken as the basis for selecting the best fit model. The contribution of Goats in India's economy through milk and meat has been studied.

## 87. A STUDY ON SHIFT IN PRODUCTIVITY OF RED GRAM

SHANTI SARUP and R. K. PANDEY  
*IASRI, New Delhi-12*

Red gram covers about 2.7 m ha., i.e. 11.5 percent of all pulses in the country and contributes over 17 percent towards their production. Maharashtra, Uttar Pradesh, Madhya Pradesh, Karnataka, Andhra Pradesh, Gujarat and Bihar are the chief red gram producing states of the

country. This paper aims at studying the regional disparity and shifts in productivity of this crop. Trend values for the initial and end years have been estimated by fitting a function of the form  $y = a + bt$  utilizing the time series data on productivity (kg/ha) through 1961-62 to 1979-80.

The analysis reveals that the yield rate of this crop varied from 301 kg/ha in Karnataka to 827 kg/ha in Uttar Pradesh during 1961-62. Yield rates (kg/ha) in the states of Andhra Pradesh, Karnataka, Maharashtra, Rajasthan and Tamil Nadu were observed to be lower as compared to the All India average of 612 kg/ha in 1961-62. Later in 1979-80, when the national average yield rate of red gram increased to 729 kg/ha, the states averages varied from 342 kg/ha in Rajasthan to 1380 kg/ha in Uttar Pradesh. Among the above mentioned low productivity states in 1961-62 none of the states could improve its productivity level to move above the All-India average position by 1979-80. On the other hand, among the high productivity states, the states of Madhya Pradesh and Orissa drifted below the All-India average in 1979-80. Thus it becomes evident that there has not been any perceptible improvement in the productivity level of this crop during this period. The productivity level of this crop is observed to be double in Uttar Pradesh compared to national average and the same is about four times compared to the productivity level in Rajasthan. This indicates the extent of regional variation existing among different states in the country.

## 88. ESTIMATING THE BY-PRODUCTS OF SUGAR-CANE

K. K. TYAGI, P. C. MBHROTRA and S. K. RAHEJA  
*IASRI, New Delhi-12*

The uses of by-products of foodgrains and other crops like sugarcane call for reliable information on the availability of these by-products which form one of the most important source of feed for cattle and as raw material for many industries. Currently, production estimates of by-products of some of the crops, particularly food crops are obtained as the product of grain production and straw/stalk to grain ratio. However, it is well known that by-products to main product ratio varied not only from crop to crop but also from one variety to another for the same crop. Furthermore, this ratio for a given crop variety varies over different agro-climatic regions. The development and introduction of new high yield fertilizer responsive short duration varieties is an important factor affecting the ratio between the main product and by-products. Importance of estimates of by-products and the variability in the ratio of by-products to main product on account of a multiplicity of factors clearly points to the

need of building up of reliable estimates of by-products/ratio of by products. For this purpose, it would be necessary to plan and conduct sample surveys and develop suitable procedures of estimation. However, planning and conducting of special surveys exclusively for this purpose would not be feasible in view of the enormous cost of such an exercise on regular basis. One possible alternative for this purpose would be to suitably integrate this aspect with the normal series of crop cutting experiments which are conducted regularly on a large number of crops covering almost the entire country. In this paper, an attempt has been made to work out the ratio of by-product(s) to main product for sugarcane crop. The two main by-products of sugarcane plant are sugarcane tops and trash. It was seen that the sugarcane tops to sugarcane ratio was 0.36 and sugarcane leaves to sugarcane ratio was 0.12. Further these ratios were highly variable ranging from 0.20 to 0.50 and from 0.10 to 0.20 respectively.

#### 89. A STUDY OF REGIONAL DISTRIBUTION AND GROWTH ANALYSIS OF AREA, PRODUCTION AND YIELD OF RICE IN RICE ZONE OF MADHYA PRADESH

M. A. ALI, K. L. RATHOD and A. K. SINGH  
*Zonal Agricultural Research Station (JNKVV), Raipur*

An attempt has been made to examine the regional disparity as well as the inter-district disparity in the distribution and growth pattern of area, production and yield of rice in the rice zone of M.P. The time-series data regarding area, production and average yield of the crop for the period from 1961-62 to 1980-81 in different regions—Chhattisgarh Plains, Northern Hill and Bastar Plateau—of the rice zone and separately for their constituent districts alongwith the State of M.P. as a whole have been studied using coefficient of variation and linear growth models.

#### 90. FACTORS AFFECTING THE EXPENDITURE ON MILK AND MILK PRODUCTS IN HARYANA STATE

D. K. JAIN and R. K. PATEL  
*National Dairy Research Institute, Karnal-1*

The Study examines the effect of various factors on the consumption pattern of milk and milk products in Haryana State, NSS 32nd round data on consumer expenditure for 4253 rural and 1671 urban households pertaining to the period 1977-78 formed the basis of the study. Stepwise regression (forward selection) procedure was used to find out the deter-



minants of expenditure on various milk items. The per capita expenditure on cereals, pulses, sugar and gur, salt, spices, other food and non-food were observed to be positive determinants while the per capita expenditure on edible oils, meat, fish and eggs had a negative and significant impact on the per capita expenditure on milk and milk products. The average education score of the earners showed a positive and significant impact. The age of the main earner of the household did not show any impact on the expenditure pattern of milk items.

### 91. NORMATIVE PROMOTION OF CROP PRODUCTION AND LIVESTOCK ACTIVITIES—A KEY TO HELP PRODUCTION ON MARGINAL FARMS

S. L. GUPTA

*K. A. Postgraduate College, Allahabad*

The present paper examines some aspects of normative promotion of crop production and livestock activities which are of direct and immediate relevance from the stand point of increased Farm Business Income (F. B. I.) on marginal farms utilising data for three agricultural years (1976-79) collected regularly at the interval of about 20-25 days from the 79 farmers of the below 1 hectare size group. The selection of the sample farmers was made randomly from the randomly selected 6 villages in C. D. Block, Soraon, District Allahabad, U. P. For the prerogative financing to marginal farmers, the marginal value productivity (MVP) of each activity is to be considered. For example, a hectare of Potato promises to add the total F. B. I. by Rs 4186.99 and Rs 2347.38 on stratum II and III conditions respectively. Similarly under stratum II a she-buffalo adds F. B. I. by Rs 340.93 per year. Sheep and goats are reportedly found profitable. Pigs are suggestive still in more number particularly when availability of the crop loan is an increasing limitation as a pig adds F. B. I. by Rs 133.08 per year. At the level of marginal farmers the growing of grain fodder in Kharif season purposely for farm bullocks, is irksome as to have one quintal of green fodder a farmer has to sacrifice Rs 24.38 from the total F. B. I. under stratum II, while in other stratum conditions of capital it accounts to decrease the F. B. I. by Rs 17.18 against each quintal production of green fodder. The MVP of Zaid land suggest that one hectare mm of secured Zaid Water adds Rs 1.89 towards F. B. I. against the sacrifice of Rs 0.28 only.

## 92. A CRITICAL METHOD OF DETECTION OF DEGREE OF AGRICULTURAL EFFICIENCY

S. L. DESHPANDE  
P. K. V. AKOLA (M. S.)

An attempt has been made to develop a model for detection of degree of agricultural efficiency. The crop productivities per hectare are considered as the quantitative basis for the measurement of agricultural efficiency. Models have been developed to work out agricultural efficiency, output efficiency, efficiency-index of energy inputs and degree of agriculture efficiency.

It was tested by considering the published time series data for the period 1968 to 1978 on productivity of crops, energy inputs for each districts in Vidarbha region of Maharashtra State. This model was observed to be applicable and gave better results for the detection of degree of agricultural efficiency. The analytical results through this model indicated degree of agricultural efficiency higher in Buldana, Akola, Amravati, Yavatmal and Wardha districts and low in Nagpur, Bhandara and Chandrapur district.

## 93. CAUSES AND CURE FOR YIELD GAPS IN SHIVALIK FOOTHILL REGION

Y. AGNIHOTRI, S. P. MITTAL and PRATAP SINGH  
*Central Soil and Water Conservation Research and Training Institute,  
Research Centre, Chandigarh-160019*

The rainfed areas, forming 72 percent of the country's cultivated land, contribute nearly 40 percent of the total food grain production. The yield levels of all the crops are lower in Shivalik foot hill region as compared to other rainfed areas. Three factors namely (i) Lack of irrigation facilities (ii) age old agronomic practices and (iii) non adoption of soil and water conservation measures have been identified to be responsible for low crop yields in this region. Based on the research findings and the trials conducted in farmers' fields, the paper analyses the impact of different factors on crop yields obtained in Shivalik foothill region and suggests the remedial measures to reduce the yield gaps. Rain water harvesting and the use of stored rain water for supplemental irrigation at presowing increased wheat, taramira, mustard and gram yields by 198, 53, 46 and 23 percent over control. Land levelling, use of seeds of im-

proved varieties, application of fertilizer and timely weeding resulted in 165 to 229, 79 to 150, 21 to 34 and 77 to 108 percent increase in yield of major crops respectively. In addition to improved agronomic practices, adoption of soil and water conservation measures increased maize yield by 23 to 41 percent. It is brought out that the yield in Shivalik foothills can be reduced by harnessing surplus rain water, use of improved agronomic practices and adoption of proper soil and water conservation measures.

#### 94. BIDI TOBACCO YIELD GAP AT FIELD LEVEL IN GUJARAT

N. M. PATEL

*Gujarat Agricultural University, Anand Campus, Anand*

More than 80 per cent of bidi tobacco is produced by Gujarat from an area of about 90,000 hectares. The yield level of tobacco has increased from 719 kg/ha during 1951-56 to 1697 kg/ha during 1980-85. However, there is a wide gap between potential yield of bidi tobacco and actual yield realized by the farmers in Gujarat (Patel, 1977). The information on yield gap at field level (i. e. among various categories of farms) and input factors actually responsible for such gap in bidi tobacco is not available. This paper deals with this aspects for bidi tobacco grown in Gujarat. The data collected by the All India Co-ordinated Research Project on Tobacco, GAU, Anand Campus, Anand on "Economics of tobacco production in Middle Gujarat" during the years 1978-79 through 1984-85 (except 1982-83) were utilized for the purpose. There were 164 cultivators under study during 1978-79 and thereafter 600 cultivators were studied every year. The information relating to bidi tobacco cultivators was used in the present study. The cultivators (farms) were classified into four categories according to their size of land holdings, viz., marginal (below 1 ha); small (1 to less than 2 ha); medium (2 and less than 3 ha) and large (3 ha and above). The results revealed that the average yield of bidi tobacco increased with the increase in farm size, which varied from 1529 kg/ha on marginal farm to 1820 kg/ha on large farm. The overall average for all farms was 1733 kg/ha being 1.01 per cent more than the state average yield of 1715 kg/ha. There was a yield gap of 291 kg/ha between marginal and large farms; 155 kg/ha between small and large farms and 123 kg/ha between medium and large farms.

## 95. YIELD GAPS IN COTTON PRODUCTION IN MAHARASHTRA

A. M. DEGAONKAR and D. R. BADGIRE  
*Cotton Research Station, Nanded (Maharashtra)*

Two major gaps i.e. one reflecting the differences between biologically possible and potential yield level (research gap) and the other stemming from a difference between potential and actual farm yields (extension gap) are now well recognised. An appreciable headway has already been made through developing improved varieties and better management technology in improving the potential yield levels but there is considerable scope to improve productivity level of cotton crop. Better results can be achieved through the close coordination of the physiologists and the plant breeders to identify the basic factors influencing the photosynthetic process as well as the apportionment of its products in vegetative and reproductive parts so that effective procedures may be devised to improve the economy of total biomass production as well as harvest index of cultivars under the prevailing cotton growing conditions. There is also need for the development of low-cost and labour intensive technology which must ensure stability of performance and returns to the marginal and poor farmers. The prevailing wide gap between the potential and actual farm yields need to be narrowed down to increase the cotton production in the state. The unrealized potential is tremendous. There is need to strengthen the extension agencies so that large number of demonstration trials are conducted at farmers fields to convince them about the advantages of adopting the new technology.

## 96. INCOME IN RURAL AREAS AND TIME SPENT

B. C. SAXENA and ASHOK KUMAR  
*IASRI, New Delhi*

Based on a large scale sample survey undertaken by IASRI (1976, 80) in Chingleput District of Tamil Nadu, estimates of average income and time spent by a worker were worked out in different agricultural holdings at two points of time, with reasonable degree of precision. It was of interest to examine whether the income of a worker is increasing directly in proportion to the time spent by him in different occupations and if so, the extent of relationship between these two parameters. On working out the correlation between time spent and income, it was found that the income of non-milk producers in comparison with milk producers

was more related with the time spent. Further, in both types of households, the correlation was higher in landless class in comparison with other class of farmers. In dairying, especially, a worker now spending hardly 9 hours a week could fetch same income as received by him on earlier occasion by spending as much as 15 hours a week.

#### 97. A STUDY ON SUCCESSIVE SAMPLING

S.S. SHASTRI

*I.A.S.R.I. New Delhi-12*

The paper deals with the general case of matching and unmatching units on three occasions. A sample of ' $n$ ' units is drawn on each occasion. These  $n$  units are split into three sets of units. The first set consists of  $n_1$  units matched on all the three occasions. The second set consists of two parts and each of the part is matched with one of the remaining two occasions. The third set consists of fresh units  $u$  on each occasion. A linear estimator for the current occasion utilising the entire information along with its expression for variance has been obtained. The scheme gives rise to number of particular cases in which either of these matching portions between various occasions are zero or equal. These particular cases are also discussed.

#### 98. AN ESTIMATORY FOR THE RATIO (PRODUCT) OF TWO POPULATION PARAMETERS

SUKHMINDER SINGH

*PAU, Ludhiana-141004*

A new ratio (product) estimator for estimating the ratio (product) of two population totals (or means) using auxiliary information on another variable is suggested. Its bias and mean square error to the order of  $n^{-1}$  are obtained and the efficiency of the developed estimator is compared with the conventional ratio (product) estimator and the estimator suggested by Singh (1965). The proposed estimator turns out to be of more practical utility. Results are also extended to double sampling.

#### 99. A NEW SAMPLING SCHEME

BALWANT SINGH and S. K. SINGAL

*Punjab Agricultural University, Ludhiana-141 004*

A sampling scheme has been defined to select a sample with varying

probability and without replacement. The scheme consists of selecting a sample of size  $n$  Units from a population having  $N$  Units, with initial probability of selection  $P_i, i = 1, 2, \dots, N: \sum P_i = 1$ . Here first  $n - 1$  units are selected using simple random sampling without replacement (SRSWOR) and  $n$ th unit i.e. last unit is selected with probability proportional to size. An unbiased estimate for population mean and its variance alongwith estimate of variance are given. The suggested scheme has been shown empirically more efficient than the MIDZUNO system of sampling with regards to estimate given by Horvitz-Thompson.

#### 100. VARIANCE IN SQUARE AND CUBIC LATTICE SAMPLING

N. P. SINGH and F. S. CHAUDHARY  
*Haryana Agricultural University, Hissar.*

Jessen (1975) discussed various estimators in square and cubic lattice sampling designs but the expressions of variance of some of these estimators were not derived. In this paper, some schemes which are considered as generalized probability sampling with marginal constraints are presented with sample selection procedures and variances are derived. It has been shown further that the estimators given by Jessen are its particular cases. General ideas with underlying stratification criterion of two or three factors are discussed with examples.

#### 101. A RECENT STATISTICAL TECHNIQUE TO ANALYSE MULTIVARIATE UNBALANCED DATA

S. C. AGARWAL and P. N. BHAT  
*IVRI, Izatnagar-243122*

This paper provides an explicit algorithm for the full rank (cell means) model technique, with its multivariate extension, which is reported in recent statistical literature to be superior to the traditional least squares method of fitting constants for unbalanced data analysis. This would enable the researchers, particularly engaged in animal breeding programmes where data is commonly unbalanced (non-orthogonal), to adopt the recent statistical technique so as to analyse their data with an easier interpretation.

## 102. RESTRICTED EXPLORATION OF SIMPLEX IN MIXTURE EXPERIMENTS

M. S. RAMACHANDRA MURTHY and J. S. MURTHY  
*Osmania University, Hyderabad-500007*

Experiments in which the response depends on the proportions but not on the amount of compositional variables are called experiments with mixtures. If there are  $q$  components and the proportion of the  $i$ th component is denoted by  $x_i$  ( $i = 1, 2, \dots, q$ ) then  $0 \leq x_i \leq 1$  and  $\sum_{i=1}^q x_i = 1$ .

The factor space is  $(q - 1)$  dimensional simplex. But practical considerations often require additional constraints like  $a_i \leq x_i \leq b_i$  on some or all the component proportions. The factor space, then, is a restricted region, a hyperpolyhedron, within the simplex. McLean and Anderson (1966), Saxena and Nigam (1977), Murthy and Murty (1983) and several others derived designs for exploring the restricted region of the simplex. In this paper, a method of constructing designs for restricted exploration of the simplex is presented in which the design points are uniformly distributed over the factor space. These designs are termed as parallel designs because the configurations of the design points result in geometric structures which are parallel. Expressions for  $A, D$  optimality criteria are derived in the case of a first order model.

## 103. ANALYSIS OF RAINFALL DATA FOR AGRICULTURAL PLANNING

V. B. SINGH  
*R.A. R. S. Tikamgarh, (M.P.)*

Generally people consider the average rainfall of the region as the base for deciding the cropping pattern. But it has been observed that the knowledge of annual rainfall is not very useful for deciding the cropping pattern. For example a heavy abnormal rainfall in a month or even in a week may show that year, as a year of average rainfall of a normal year if the distribution is uneven. It may completely damage the crop due to heavy rainfall at improper time, at the same time a dry spell may again damage the crops, even when the year may be of average rainfall. Weekly rainfall analysis would be more useful in better planning of cropping pattern, and for the estimation of proper time of sowing, cultural operations and irrigation of the crops grown in different seasons.

Keeping this in view, the probability and frequency analysis on the basis of weekly rainfall data has been presented for the Guna tehsil of Guna district representing the area of Bundelkhand region of Madhya Pradesh.

#### 104. ESTIMATES OF MILK PRODUCTION IN GUJARAT STATE

T. D. KHATRI

*Directorate of Animal Husbandry, Gujarat State*

The main findings of the sample survey (1984-85) are as follows :

Estimated number of households in Gujarat State was 62.02 lakhs as compared to 61.07 lakhs during previous year (1983-84). The proportion of households keeping bovines was 70.19% during 1984-85 as compared to 70.57% during 1983-84. The estimate of milch cross-bred cows during 1984-85 works out to be 18,574 as compared to 17,290. The estimate of indigenous milch cows has risen from 17.99 lakhs to 18.48 lakhs. The estimate of milch buffaloes was 25.03 lakhs, as compared to 24.66 lakhs during 1983-84. The estimate of adult female goats during 1984-85 works out to be 21.08 lakhs. The most frequent breed is kankrej among cows and Surati among buffaloes. Estimate of buffalo milk production/animal in-milk/day during 1984-85 works out to be 3.612 kg. as compared to 3.586 kg. during 1983-84 showing a marginal increase of 0.73%. Milk production/adult goat/day during 1984-85 works out to be 206 grammes as compared to 194 grammes during 1983-84 showing an increase of 6.19%. Total milk production in Gujarat has risen from 30.39 lakhs tonnes during 1983-84 to 32.39 lakh tonnes during 1984-85, showing an increase in milk production by 4.69%. The position of availability of milk per capita per day in Gujarat has slowly improved from 173 grammes during 1980-81 to 238 grammes during 1984-85.

#### 105. AN APPROACH FOR IDENTIFYING CAUSAL FACTORS FOR INTRA REGIONAL YIELD GAPS

R. C. GOLA, P. C. MEHROTRA and S. K. RAHEJA  
*IASRI, New Delhi-12*

An attempt has been made to identify and isolate the causal factors in yield variations and to investigate the constraints in their adoption. A long term approach, for identifying causal factors for intra-regional yield gaps, which could easily fit in with the existing frame work of yield



data collection on national scale on a regular basis has also been suggested.

#### 106. CONSTRUCTION OF NESTED PBIB DEISGNS

A. K. BANERJEE  
*IASRI, New Delhi*

and

U. S. DAS  
*Assam Agril. Univ., Jorhat*

This paper discusses several methods of construction of Nested Partially Balanced Incomplete Block (NPBIB) designs with two associate classes. The first method uses a known PBIB design to obtain the NPBIB design. The second method makes use of a suitable BIB design while a third method uses a resolvable solution of a PBIB design. A procedure of constructing NPBIB designs based on  $L_2$  scheme is also given.

#### 107. BAYES DISCRIMINATORY ANALYSIS IN CULLING DAIRY COWS FOR BREEDING

V. K. BHATIA, MAHESH KUMAR, P. K. MALHOTRA and PREM NARAIN  
*IASRI, New Delhi-12*

In animal breeding, genetic improvement in the productivity is achieved to some extent by retaining superior cows or disposing/culling unproductive cows. In other words these two terms 'retention' and 'culling' are part and parcel of the broad term longevity of the cow in a given herd. There are mainly two significant aspects of longevity in cattle breeding i.e. economic value and culling of unproductive cows for replacement by heifers. The milk producer makes continual decisions as to which cows he would cull to make way for heifer replacements. In such decisions, he needs careful examination of the various production and other characteristics of an animal at the end of the lactation for deciding whether the animal is to be retained or culled. In past, various statistical methodologies have been proposed for exploring the variables affecting the culling process of dairy cattle. Robertson (1966) had shown that culling of a cow could be regarded on the basis of truncation selection using a culling variate of which one component is the milk yield of the cow. Narain and Bhatia (1984) had studied the relationship between yield characteristics and survival of a cow in the herd. These studies however do not serve the very purpose of classifying the animal into two broad classes retention

and culling on the basis of characteristics observed at the end of particular order of lactation. In the present study use of Bayes discriminatory analysis is advocated for such a problem. The study not only helps in classifying the cow into two different classes but also helps in selecting an optimal subset from a set of possible informative variables affecting the culling process. The approach is probabilistic i.e. posterior probabilities estimated from the prior probabilities and observed data, are assigned to an animal. The statistical model used is mainly based on the assumption of independence between variables, but the concept of 'global association factor' can be taken into account to incorporate the effect of dependency amongst variables. The stepwise forward selection strategy has been employed for screening of the variables with the criteria of error rate. The validation has also been carried out by forming the allocation matrices.

108. ANNOTATED BIBLIOGRAPHY ON THE ROBUSTNESS  
STUDIES TO NON-NORMALITY IN VARIANCE  
COMPONENT MODELS

R. A. SINGHAL and C. B. TIWARI  
*IVRI, Izatnagar (UP)*

The bibliography provides abstracts of research contributions in random models for those situations when random effects are represented by non-normal populations. The annotations are for forty-five entries over the period 1947-86.

109. ON ESTIMATION OF ATTACK RATE OF F.M.D. IN  
FINITE POPULATION

RAJENDRA SINGH, C. B. TIWARI and A. K. MUKHOPADHYAYA  
*IVRI, Izatnagar (U.P.)*

A stochastic model was proposed to estimate the attack rate in Foot & Mouth Disease (FMD) out-break by selecting a random sample from the susceptible and infected population. The model was successfully used to estimate the attack rate of F.M.D. out-breaks in two organized farms i.e. Indo-Danish Project, Bangalore and I.V.R.I., Cattle Farm, Izatnagar. The period of epidemic was lowest for Haryana (10 days) followed by Jersey (14 days), Holstein-Friesian (20 days) and Brown Swiss (24 days) at I.V.R.I. Farm. The period of epidemic at Bangalore for Red-Dane was 16 days. The epidemic period was more in exotic breed than Haryana. Four days incubation period was appropriate to explain the process of

epidemic by the model. It was concluded that first peak of the attack rate was higher than the second one. The attack rate varied from 0.007 to 0.0191 in Red-Dane and 0.0075 to 0.0003 in all the breeds combined (Holstein Friesian, Brown Swiss, Jersey and Haryana) at four days incubation period.

110. AN IMPROVED ESTIMATOR FOR THE MEAN OF  
A SYMMETRICAL POPULATION

M. K. PANDE  
*Garhwal University*

In this paper, a class of estimators for the population mean is suggested. The estimator is found to be more efficient than the estimators of Sahai and Ray (1979) and Srivastava and Banarsi (1982).