

Abstracts of Papers

1. Improved Product Type Estimator

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An improved product type estimator of population mean has been worked out from the general class of biased product type estimators proposed by Sharma *et al.* (2007). Its large sample properties were compared with the conventional product estimator and the estimators proposed by Robson (1957), Singh (1989) and Dubey (1993). The proposed estimator performed better than the conventional product, Robson (1957), Singh (1989) and Dubey (1993) estimators according to mean squared error criterion. The performance of the proposed estimator of population mean over other estimators was demonstrated through empirical study.

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2. Analysis of Spatial Pattern of Population Distribution of Sugarcane Early Shoot Borer, *Chilo Infuscatellus* Snellen

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A measure of aggregation that is biologically sound and statistically valid is essential for the complete analysis of ecological data of insects. The distribution of insects in their habitat follows a characteristic pattern depending upon their inherent properties and habitat conditions (Iwao 1970). The spatial distribution of insect population produces real estimates of population densities and it is an essential component in pest management programme. Survey was conducted by Indian Institute of Sugarcane Research Bio Control Center -Nellore, AP in sugarcane command area of KCSF Ltd, Nellore during 2000-01 to determine the spatial distribution pattern of infestation of sugarcane Early Shoot Borer, *Chilo infuscatellus* Snellen. Unprotected commercial variety '87 A 298' was surveyed and twenty samples of 100 cane each were selected from May 2000 to October 2000. In each month, number of infested canes were counted and arranged in

frequency distribution. Mean (\bar{x}) and variance (S^2) were calculated. Therefore, spatial distribution of infestation of *Chilo infuscatellus* Snellen on sugarcane was studied using different statistical techniques.

Table 1. Parameters for aggregation index

Months	\bar{x}	S^2	K	X^*/\bar{x}	David and Moor index	Standard normal Variate (d)	Lexi's index	Lloyd's index of mean (X^*)
May	1.35	3.83	0.73	2.36	1.84	4.30	1.68	3.19
June	11.75	20.19	16.36	1.06	0.72	2.00	1.31	12.47
July	11.05	19.15	15.08	1.07	0.73	2.03	1.32	11.78
August	1.00	2.00	1.00	2.00	1.00	2.64	1.41	2.00
September	0.70	1.11	1.20	1.84	0.59	1.68	1.26	1.29
October	0.20	0.26	0.67	2.50	0.30	0.95	1.14	0.50

The variance values were more than mean number of infested cane of *Chilo infuscatellus* Snellen during all the months of observations indicating contagious manner of infestation of *Chilo infuscatellus* Snellen. The distribution parameter (K) values were > 1 in all the months (except May and October) indicating that the *Chilo infuscatellus* Snellen distribution was aggregated in nature (Southwood 1978). The patchiness index values varies from 1.06 to 2.5 (>1) which suggested aggregated nature of the distribution (Southwood 1978). In most of the months, the value of normal variable (d) is greater than 1.96 and positive, which showed the possibility of contagious nature of distribution. David and Moore's index values being > 0 and positive in all the months indicated that the distribution was neither random nor regular. Similarly, Lexi's index and Lloyd's index of mean were indicative of aggregation of *Chilo infuscatellus* Snellen. It is observed that infestation of *Chilo infuscatellus* Snellen, exhibited aggregated or contagious or clumped nature of distribution in the field. In order to further confirm the aggregated pattern of infestation of *Chilo infuscatellus* Snellen, Taylor's power law and Iwao's regression equation were calculated. The equation depicting variance-mean relationship is as follows.

Taylor's power law

$$S^2 = ab^{\bar{x}} \quad (1)$$

where $a = 1.7712$ is called sampling factor and $b = 1.0376$ is called aggregation factor. The values of a and b were worked out and are given above.

lwao's regression equation

$$x^* = \alpha + \beta \bar{x} \quad (2)$$

x^* is Lloyd's indices of mean crowding is defined as

$$x^* = \bar{x} + \frac{\bar{x}}{K} \quad \text{where } K = \frac{x^2}{S^2 - \bar{x}}$$

where the values of α and β were worked out by fitting equation (2) and are as follows

$$\alpha = 0.92124 \text{ and } \beta = 1.0001$$

The aggregation index b value and contagious regression coefficient β were 1.0376 and 1.0001 respectively. The values of b and β were greater than one. This indicated that the infestation of *Chilo infuscatellus* Snellen is over dispersed or clumped or aggregated in nature of distribution.

3. Use of Auxiliary Variate to Improve the Precision of Estimates at Current Occasion in Two-occasion Rotation Patterns

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The present work deals with the problem of estimation of population mean of study character when it is changing over time. In this work, an attempt has been made to utilize the varying (dynamic) auxiliary variate at both the occasions, to improve the precision of estimates at current occasion in two-occasion successive (rotation) sampling. Chain-type difference estimator has been proposed. The practicability of the proposed estimator has been discussed. The proposed estimator is compared with the sample mean estimator when there is no matching and the optimum successive sampling estimator when no additional auxiliary information has been used. Optimum replacement policy is also discussed. Extensive simulation studies have been carried out to evaluate the relative performance of the proposed estimator, using some real data example. Simulation results suggest that the proposed estimator is highly precise.

4. Robust Estimation in Stratified Sampling under General Linear Super-population Model

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Pereira and Rodrigues (1983) generalized and unified the results of the theory of linear prediction in survey sampling under general linear model. This paper extends their results to stratified sampling following the work of Royall and Herson (1973b) under general linear super-population model when regression coefficients of the model are common across the strata. Robustness of the linear predictor of the population total is studied. Special cases of general linear model are described as an example to illustrate the results.

5. On Preliminary Test Estimator by Exploring Correlation Models in Repeated Surveys

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In repeated surveys, the correlation structure between the values of the same characteristics under interest between any two occasions plays an important role in improving the estimates of population parameters on the current occasion. Various correlation structures were assumed in literature (Yates 1949, Patterson 1950, Tikkiwal 1951, Singh 1968) and the improved estimators were developed for the current occasion. In the present paper, these correlation structures were explored by using test of significance and consequently a preliminary test estimator (PTE) of population parameter is developed for current occasion. A case of three occasions are considered for simplicity. The properties of PTE are studied and its efficiency is evaluated with usual estimators. It has been found that under certain situations, PTE performed well over usual estimators.

6. Weather Based Sugarcane Yield Prediction Model for the State of Uttar Pradesh

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A weather interactive model for predicting sugarcane yield for the state of Uttar Pradesh was

developed using 20 years (1980-99) productivity database for Uttar Pradesh and weather database for Lucknow. The monthly average of weather parameters such as maximum (Tmax) and minimum (Tmin) temperature, morning (RH7) and afternoon (RH14) relative humidity, rainfall (Rain) and range of temperature (Trange) were used from April to September. Three models were developed. Model 1 includes weather parameters Tmin, RH7, RH14, Rain and Trange. Model 2 is based on Tmax, Tmin, RH7, RH14, Rain and Trange. Model 3 included Tmax, Tmin, RH7, RH14 and Rain. These multiple regression models were developed using generated variables for each weather parameter based on respective correlation coefficients of individual weather parameters with yield during April to September. The models were updated for each year for predicting the yield in the following year. The coefficients of determination of these models were found to be significant at 1%. The models were validated from 2000-01 to 2005-06 sugarcane crop seasons. Model 3 was found best with Root Mean Square Error (RMSE) as 11.51%.

7. On Methods of Estimation of Small Area Statistics in Repeated Surveys

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In decentralized planning process for socio-economic development of the country, one is faced with the problem of producing statistics for local areas e.g. blocks, panchayats, villages, groups of wards in a city etc. Domain studies are quite common in sample surveys where small parts of the population are the domains of interest. A special feature of domain studies is that surveys are not planned specifically for estimating domain parameters but they are developed on the basis of available sample units in the respective domains. In this paper, some estimators of population mean for small area on current occasion (2nd occasion) in successive sampling over two occasions are developed using separate ratio-type estimator and combined ratio-type estimator. The Mean Square Error (MSE) of proposed estimators has been derived and their relative efficiencies have been worked out theoretically. The combined ratio-

type estimator has been found to be more efficient than separate ratio-type estimator under certain conditions. An empirical investigation has been carried out to demonstrate the results.

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8. Some Regression-Type Chain Estimators for Population Product Based on Two Auxiliary Variables in Double Sampling Scheme

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This paper proposes several regression-type chain estimators for estimating the product of two finite population means using two auxiliary variables in double sampling for SRSWOR scheme. Asymptotic properties of the constructed estimators have been studied and their performances are also examined under large sample approximations.

9. Growth Pattern of Male Japanese Quail under Indian Conditions

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The average body weight of four genotypes of Japanese quail viz. CARI Uttam × CARI Uttam, CARI Ujjwal × CARI Ujjwal, CARI Uttam × CARI Ujjwal and CARI Ujjwal × CARI Uttam maintained at this Institute were 22.60 ± 0.47 g, 24.07 ± 0.57 g, 22.30 ± 0.43 g, and 25.18 ± 0.53 g respectively at 1st week and attained 210.52 ± 1.95 g, 223.88 ± 2.71 g, 209.80 ± 2.24 g and 223.03 ± 2.21 g respectively at 10th week of age. Four growth models namely quadratic, modified exponential, logistic and Gompertz were fitted to their average weekly body weights. On the basis of three measures of goodness of fit namely R², mean square error and mean absolute error, Gompertz model was found best to describe the growth pattern of all these genotypes.

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10. A Study on Impact of Weather Parameters on Wheat Production

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Fisher (1924) studied the influence of rainfall on the yield of wheat and showed that it is total amount which influence the crop yields. Tippet (1929) subsequently applied the technique on sunshine distribution and found that sunshine has beneficial effect throughout the year on wheat. Normal, Lognormal and Pearson's type distribution were studied for each year separately for weather variables viz. maximum & minimum temperature, relative humidity, rainfall hour, wind velocity, pan evaporation and bright sunshine. We found that Normal distribution fitted only in case of maximum temperature for the year 1990 and 1993. Lognormal distribution fitted only in case of pan evaporation for the year 1998 and 2003 and sunshine (hours) for the year 1992 and 1995. Pearson's type I distribution fitted in all the years for all the weather variables except in few of cases. Pearson's type IV distribution fitted for the year 1992 in case of maximum temperature, 1994 in the minimum temperature, 1994 and 1998 in case of rainfall. Pearson's type II distribution fitted for the year 1994 in case of maximum temperature and for all the years for minimum temperature. Whereas Pearson's type VI distribution fitted for the year 1990 for pan evaporation and for all the years for rainfall.

11. A Comparative Study of Three Spatial Analysis Methods under the Backdrop of Real Life Rice Yield Data

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The experimental data on grain yields of rice (*Oryza sativa L.*) for the years 2000 and 2001 were analyzed using traditional Randomized Complete Block Design (RCBD) and three NN analyses methods viz. Papadakis (1937), Iterated Papadakis (Bartlett 1978) and Wilkinson *et al.* (1983). The presence of trend was observed in one block in 2000 but the blocks in 2001 were found to have no trends when tested by W-Test (Shapiro and Wilk 1965) and Mann's test. It was observed that after detrending using the above mentioned models, the relative

efficiency (RE) in case of Wilkinson model was in the range of 146% to 147% for the years 2000 and 2001, respectively. Iterated Papadakis method seems to be the most efficient in removing spatial trend in the field and had relative efficiencies ranging from 177% to 182.2% for the two years. Papadakis showed RE ranging from 173.2% to 178.2% for the two years. No significant changes in ranking of treatment means for Papadakis as well as iterated Papadakis methods was observed. Wilkinson model brought a major rearrangement of ranks. However, wide variation in ranks of top five varieties under trial was not observed.

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12. Pattern of Foot and Mouth Disease among Cattle in India

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On the basis of annual occurrence of Foot and Mouth Disease (FMD) among cattle in India 1991-2005, it was observed that the incidence and mortality rates followed quadratic trend of four to five years period. But the shape of quadratic trends of incidence rate and mortality rate are opposite to each other, the first being upward and second downward. The overall average incidence, mortality and fatality rates were 312.48 per million, 5.41 per million and 1.71% respectively during the period. The contribution of FMD in incidence of all diseases harming cattle population followed decreasing trend with five yearly averages 56.00%, 54.17% and 43.17% but registered the increasing trend in mortality (10.45%, 14.54% and 28.15%).

13. Non-linear Growth Studies for Forecasting Wheat (*Triticum Spp. L.*) Productivity in Bihar

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As wheat is important staple food crop, its demand increases with increasing population. Looking to this importance of wheat crop in Bihar, an attempt has been made to apply some non-linear mechanistic growth models to wheat productivity data in Bihar.

For this purpose the wheat productivity data of Bihar were collected from the Directorate of Economics and Statistics, Govt. of Bihar, Patna for the period from 1950-51 to 2004-05. The data of 1950-51 to 2003-04 were utilized for developing forecast model and remaining one year (2004-05) data kept for validation of forecast model. The data were subjected to fitted of three mechanistic growth models viz. Logistic, Gompertz and 4th Degree polynomial. The 4th Degree polynomial model was found suitable for complete Bihar state, along with the conformation of assumption involved. The rest models fit well but the normality assumption gets violated. The 4th Degree polynomial model obtained for Bihar as given below can be used to genes rate forecast.

$$Y_t = a + b t + c t^2 + d t^3 + e t^4$$

Coefficient data

$$\begin{aligned} a &= 0.811110 & b &= -0.07031973 \\ c &= 0.0052169965 & d &= -0.00010072329 \\ e &= 6.7187084 \text{ e-}007 & t &= 55 \text{ years} \end{aligned}$$

$$Y_t = 2.115131 \text{ MT/H}$$

This forecast value 2.115131 MT/H is very close to actual yield of 55th year (2004-05) (= 2.091MT/H).

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14. A Moment Method for Estimating Mean Fibre Weight in Jute Crop

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The present study proposes a method to estimate the mean weight of fibre on the basis of a specified number of Jute plants. Identification of these plants is made with the help of information on certain biometrical characteristics (such as plant height and base diameter) of Jute plants. These characteristics are supposed to be correlated with weight of Jute fibre. The proposed method of moments takes its origin in determining the weight w_j to be assigned to the fibre weight of j^{th} Jute plant ($j = 1, 2, \dots, n$). Following Arndit *et al.* (2006), these weights have been computed by solving the system of equations

$$\sum_{j=1}^J w_j \prod_{m=1}^M x_{jm}^{l_m} = \frac{1}{n} \sum_{i=1}^n \prod_{m=1}^M x_{im}^{l_m}$$

where $l_m \in (0, 1, 2, \dots, d)$ such that $\sum l_m \leq d$ and x_{im} is the measurement on m^{th} biometrical characteristics of i^{th} plant ($i = 1, 2, \dots, n$; $m = 1, 2, \dots, M$). In the present investigation, $d = 2$ which represents the order of approximating polynomial. Here, $J = {}^{M+d}C_d$ the right-hand sides of the above system of equations are the empirical moments that are obtained from the full sample and the left-hand sides are the approximating quadrature moments. For $M = 2$ and $d = 2$, we have $J = 6$ and hence there are six distinct moments of degree 2 or less. This system of equation can always be solved with no more than J positive weights w_j . In the present study, data on height (in feet), base diameter (in cms.) and weight (in grams) of fifty Jute plants (Capsulances) has been taken from the experiment conducted at Jute Agricultural Research Institute Farm, Barrackpore, West Bengal (Shukla 1965). The study reveals that an estimate of mean fibre weight can be obtained with the help of six (instead of fifty) Jute plants. The weighted average of fibre weights of six Jute plants is found to be 5.23 grams which is within 8% of the actual fibre weight computed on the basis of all the fifty Jute plants.

15. A Multivariate Approach for Parental Divergence and Heterosis in Dicoccum Wheat Yield

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In order to find out the relationship between genetic divergence among the parents and heterosis for grain yield of dicoccum wheat, an investigation was made. The data were collected from Dr. Sanjaya Rajaram Wheat Laboratory MARS, UAS, Dharwad. To find the divergence among the genotypes Mahalanobis D^2 analysis and Tocher's method were carried out for clustering the genotypes. Two clusters were formed under both the conditions. Heterosis for grain yield over better parent carried out in both conditions to relate the parental divergence with heterosis. It was found that most of the heterotic crosses for grain yield over better parent could be obtained from the optimum divergent group of parents.

16. Livestock Production for Nutrition and Livelihood - Some Statistical Issues: A Case Study of Jharkhand State

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Livestock keeping in India is almost a rural occupation and a large percentage of people engaged in raising cattle, buffaloes, sheep, goats, pigs, poultry etc. belong to the poorer section of the rural community. Any attempt to improve the Livestock Development Programs will go on a long way in improving nutrition in general and providing livelihood to the rural masses in particular. It is more significant in Jharkhand where about 55-60% population belong to ST, SC and OBC, who are bracketed almost in BPL (Below Poverty Line) group and living in rural area. On account of undulating land, poor soil conditions, low level of irrigation, soil erosion and poor infrastructure etc., crop husbandry has not been able to attract youth that form two-third of the population. On the other hand, livestock has comparative advantage as it is their traditional occupation and does not require so much critical inputs. As also, Livestock Wealth of the state is highly impressive and vast potential for nutritional food, such as, milk and milk products, meat and eggs. Livestock also provides a variety of raw materials, viz. bones, hides and skins, hooves, hair, horns, dung etc. for industrial uses and can provide livelihood to small and marginal farmers and agricultural labourers. In this regard, animal husbandry statistics has significant role in planning and development of livestock production for nutrition and prosperity. In this process, some statistical issues standing in the way of development, have also been identified and will be discussed to find solution.

17. Forecasting of Crop Yield using Weather Parameters and Agricultural Inputs

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Pre-harvest forecast of crop yield is very useful for Government and planners in taking various policy decisions relating to procurement, storage, distribution, marketing, price, export-import, etc. The main factors affecting crop yield are weather variables and agricultural

inputs. Weather affects crop differently during different stages of crop growth. Thus, extent of weather influence on crop yield depends not only on the magnitude of weather variables but also on the distribution pattern of weather over the crop season which, as such, calls for the necessity of dividing the whole crop season into fine intervals. This will increase number of variables in the model and in turn a large number of model parameters will have to be evaluated from the data. This will require a long series of data for precise estimation of the parameters which may not be available in practice. Thus, a technique based on relatively smaller number of manageable parameters and at the same time taking care of entire weather distribution may solve the problem.

Therefore, a methodology has been developed to construct suitable weather indices which can be used in the model along with agricultural inputs and/or some variable representing trend for forecasting crop yield. To study the performance of the methodology, a study has been carried out for one important kharif crop (rice), one important rabi crop (wheat) and one long duration crop (sugarcane) in the state of Uttar Pradesh. District-wise data on area, production, productivity, per cent area under irrigation, fertilizer consumption and weekly data on weather variables namely, maximum and minimum temperature, relative humidity (morning) and rainfall were utilized in the study. Weekly weather data starting from a fortnight before sowing were used for rice and wheat whereas for sugarcane, fortnightly weather data starting from March were taken into consideration. Suitable models at district/agro-climatic zone level were developed using weather indices, year, previous year's yield, moving averages of yield, per cent area under irrigation and fertilizer consumption (N, P, K). Models were validated by comparing forecast of subsequently years (not included in the model development) with actual observed yield. Results indicated that reliable forecasts of rice and wheat can be obtained when crop is 11 weeks old i.e. around 2½ months before harvest and in middle of September i.e. around 5 months before harvest for sugarcane. The methodology is simple, adoptable, does not involve use of very detailed data collection/sophisticated statistical tools and at the same time it provides reasonably good forecast. The methodology is suitable at district, agro-climatic zone as well as state level.

18. A Ratio-cum-Product Estimator of Finite Population Mean in Stratified Random Sampling

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In this paper a ratio-cum-product estimator of finite population mean has been suggested in stratified random sampling using the information on coefficient of variation of auxiliary variate. Bias and mean squared error expressions of the suggested estimator are derived and compared with combined ratio estimator and estimator considered by Kadilar and Cingi (2003). An empirical study is also carried out to demonstrate the performance of the suggested estimator.

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19. An Index for Selecting Genotypes Simultaneously for High Yield and Stability under Incomplete Genotype \times Environment Data

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Several methods are available in literature that take care of yield and stability simultaneously when genotypes are grown over a number of environments and data is complete. However, in practice, incomplete data are observed due to reasons like insufficient seed, pests and disease, non-germination of seeds. A new family of simultaneous selection indices is proposed here, which can be used for selecting genotypes simultaneously for high yield and stability in incomplete data situations. The new indices are also tested for their performance on groundnut crop data.

20. A Study on Performance of Simultaneous Selection Indices against Missing Observations

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Several simultaneous selection indices are available to select varieties for both high yield and stability.

Performances of few such indices have been compared when data is complete, i.e., yield data of varieties across locations are available. However, under incomplete data situations performance of simultaneous selection indices have not yet been compared. In this study, we have compared the performance of several combined selection measures against missing observations and identified the measures, based on standard statistical techniques, that can select varieties simultaneously for both high yield and stability.

21. Application of Clustering Technique on AICRP Trial of Groundnut Data for Sub-zonalization

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Quite often, it is observed that varieties that are performing well in one part of a larger zone are unable to get selected in the other part of the same zone, may be due to high variation in environmental conditions within the zone. An attempt has been made to apply clustering technique to sub-zonalize the larger zone based on varietal performance observed across locations within the zone. Specific varieties that are high yielders as well as stable performers in the sub-zones have been identified.

22. Simplified Linear Invariant Estimators of Parameters of Log-Logistic Distribution under Type-II Left Censoring

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In life data analysis censoring occurs naturally or sometimes it is necessary to censor the data. In some situations it may be very difficult to observe life time data since from start of the experiment, we may start observing/recording of data after sometime as a result we lose some data in the beginning for this we call left censoring and under this situation here we consider the estimation aspect of the parameters. Best linear unbiased estimators (BLUE) are required to obtain Best linear invariant estimators (BLIE) as proposed by Mann. Lloyd's procedure requires full knowledge of expectations α_i and the covariance matrix B_i of the order statistics Y_i to obtain BLUE. Since it is very difficult to

determine the covariances we considered simple method proposed by Gupta for estimating the parameters and these estimators are called as simplified linear unbiased estimators (SLUE). By using these SLUE we obtained simplified linear invariant estimators (SLIE) for the parameters of log-logistic distribution under type-II left censoring. We studied the bias, variance and mean square errors of these estimators through simulation.

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23. Path Analysis in Vegetable Crops

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Present study is based on available data from AICRP on vegetable and AICRP on potato for morphological characters and yield of the selected vegetables such as chilli, tomato and potato for the year 2003-04. Path analysis for chilli yield revealed that fruit breadth, calyx length and single fruit weight had high direct effect on yield. The rest of characters had indirect influence on yield through fruit breadth. Plant height and fruit length had high negative direct effect on yield and almost nearer to its correlation coefficient. Path analysis for tomato yield revealed that out of twelve characters, number of primary and secondary branches, number of locules, number of clusters per plant and total fruit weight per plant exhibited high positive correlation on yield but only number of clusters per plant and number of secondary branches exhibited high positive direct effects on yield. All the other traits had positive and negative indirect influence on total yield through number of clusters per plant, number of secondary branches and number of locules, respectively. Path analysis for total tuber yield in potato revealed that average tuber weight and number of tubers per plant had high positive direct effect on tuber yield. Rest of the characters had indirect influence on tuber yield through average tuber yield and number of tubers per plant.

24. Models for Annual Egg Production of Kadakanath and its Crosses with CARI Red

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The daily egg production of Kadakanath and its crosses with CARI Red viz. Kadakanath × CARI Red

and CARI Red × Kadakanath were summarized at four weekly intervals from 20th to 72nd week of age (13 periods each of 28 days) as the chickens started egg laying during 20-24 wks of age. The average egg production of Kadakanath, Kadakanath × CARI Red and CARI Red × Kadakanath during first period of production were 0.03 ± 0.07 , 2.80 ± 0.57 and 4.00 ± 0.58 respectively. During second period it reached to 2.13 ± 0.44 , 10.4 ± 1.18 and 7.22 ± 0.90 respectively. These chickens attained highest production during 5th (37-40 wks), 6th (41-44 wks) and 6th (41-44 wks) period and corresponding average egg production were 17.05 ± 0.54 , 21.79 ± 0.40 and 19.72 ± 0.47 respectively. After attaining peak production the egg production decreased subsequently and reached 3.26 ± 0.42 , 11.40 ± 1.02 and 12.51 ± 0.81 respectively during last period (69-72 wks) of the study. Ten models were fitted to average four weekly egg production records. Logistic curvilinear, Adams-Bell and logistic-linear models were found best to describe the egg production curves of these respective genotypes.

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25. A Ratio-cum-Product Estimator of Finite Population Mean using Known Correlation Coefficient

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This paper proposes a ratio-cum-product estimator of finite population mean using information on population mean of auxiliary variate and correlation coefficient between study variate and auxiliary variate. It has been shown that the proposed estimator is more efficient than usual unbiased estimator, ratio estimator, product estimator and estimators proposed by Singh and Tailor (2003). An empirical study is also carried out to demonstrate the merits of the proposed estimator over other estimators.

26. A Note on Estimates of Women Work Force in India - NSS 61st Round

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Some observations, on the report "Participation of women in specified activities along with domestic duties 2004-05" – the fourth in the series of seven reports brought out on the results of the seventh quinquennial survey on employment and unemployment conducted by NSSO in its 61th round (July 2004 – June 2005) have been made in this paper. The broad design adopted for the survey was a stratified multi-stage random sampling design with villages (panchayat wards in Kerala) for rural areas and the NSSO Urban Frame Survey (UFS) blocks for urban areas as First Stage Units (FSUs), both rural and urban households as Ultimate Stage Units (USUs) and hamlet-groups / sub-blocks (i.e. the parts wherever formed within a large FSU) as the Intermediate Stage Units (ISUs). A total of 6,02,833 persons of 1,24,680 households from the 12,601 FSUs (including 2,04,808 persons of 45,374 households from the 4,602 FSUs in urban areas) of the selected sample could be surveyed. The estimates are based on the data relating to the participation in specific activities by the household members engaged in domestic duties according to the usual principal status. The percentages of the rural and urban women engaged in the domestic duties according to the usual principal status were 40 and 50, while those carrying out some economic activities in their both principal and subsidiary status were 37 and 18 respectively among the women of age 5 years & above in India. Broadly the following issues arising from the results of the above mentioned survey are raised:

1. Reliability of estimates
2. Use of previous survey information for the refinement of subsequent surveys
3. Use of IASRI findings for estimation of flow of women's participation in specified activities
4. A measure of impact/evaluation of Assistance Programmes on women's participation in specified activities

27. QTL Detection in Drought Stress in Maize

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The loci controlling quantitative traits are referred to as QTLs (Quantitative Trait Loci) and the procedure of finding and locating the QTLs are called QTL mapping. QTLs indicate the genomic regions controlling the expression of a specific quantitative trait, and are inferred from statistical analysis of genomic data in conjunction with phenotypic data. Detection of loci influencing the performance of maize in drought stress is difficult, particularly, in presence of QTL × Environment interaction. In the present investigation QTLs are mapped for drought stress in maize in presence of QTL × Environment interaction. For this purpose the mapping populations developed at CIMMYT and evaluated in India under AMBIONET (Asian Maize Biotechnology Network), Maize Genetic Unit, IARI have been used. QTL Mapper version 1.0 software was used for the analysis and significant QTL × Environment interaction has been found. The QTLs for different characters are detected in presence of QTL × Environment interaction by using Jackknife and Bayesian techniques.

28. Estimation of Agricultural Accidents in Madhya Pradesh

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In India about 234 million workers are engaged in Agricultural and allied activities. Traditional agriculture used mainly human and animal power sources. Due to modernization, however, mechanical and electrical power is used extensively for various operations. The population of tractors and power tillers has crossed 2.6 and 0.1 million respectively. Human power, apart from being a source of power for manually operated farm equipment and hand tools, is also used extensively for operating self-propelled and power operated agricultural machines. Improper and careless use of agricultural machinery has increased deaths and casualties due to agricultural accidents. Data on agricultural accidents and information on etiology of such accidents are not available and thus

30. Expert System on Wheat Crop Management : An IT based Tool for Transfer of Technology

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One of the significant achievements of research in the area of Information Technology has been the development of techniques, which allow the modeling of information at higher levels of abstraction. These techniques are embodied in languages or tools that allow building programs resembling human logic in their implementation. These programs, which emulate human expertise in well-defined problem domains, lead in the development of expert systems. In agriculture, Expert Systems can be used for extending the research to farmers and can work as a problem-solving tool for them. Expert systems on Agriculture could have a powerful mechanism with extensive potential to solve the problems related to agriculture. Expert System on Wheat Crop Management is one such example developed by the scientists of IASRI in collaboration with two premier institutions doing research on wheat namely DWR, Karnal and IARI, New Delhi. The system holds a collection of general principles that are potentially applied to solve a problem related to wheat crop management and extends large information to the wheat growing farmers.

31. A Contribution to Universally Optimal One Sided Neighbour Effect Design

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In an agricultural design of experiment, the treatment received by a plot may influence the other response on *the neighbouring plots of a same block or it may happen* to affect the response on the following plot. For example of the second condition, the tall varieties may affect the other crops grown on the neighbouring plots by their shades. Bailey (2003) has developed such design concerned with the study of one sided neighbour effect, under the above mentioned second condition. This paper gives a new series of Universally Optimal One-Sided Neighbour Effect Designs.

32. An Optimum Multivariate Stratified Sampling Design: Method of Pooled Variances

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Although, in stratified sampling design, Neyman allocation gives an estimate of the population parameter with maximum precision, there are certain limitations to its practical implementation. The most serious of all is the absence of the knowledge of the stratum standard deviations in which case it may turn out to be even poorer than the proportional allocation. When the strata standard deviations are unknown but we have an additional information about the equality of standard deviation between some of the strata, we can utilize this information to increase the precision of the estimate. Park *et al.* (2007) used this idea for obtaining a "Compromise Allocation in Univariate Stratified Sampling". In this paper, the idea of pooling of the standard deviations is used to work out an optimum allocation in multivariate stratified sampling. A simulation study is also performed to illustrate the method.

33. Weather based Forecast Models for Potato

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Validated forecasts of crop yield play key role in well-timed planning for storage, distribution, pricing, marketing, import-export, etc. Thus factors affecting crop yield necessitate forethought. The major causes of variability in crop-yield are technological factors (e.g. agricultural inputs etc.) and the weather. It has been observed that the technological factors increase yield smoothly through time and thus year-number (or some other appropriate function of time) can be used to study the overall effect of technological changes on yield. *Therefore, models based on weather-factors along with a variable year-number can provide reliable forecast of crop yield in advance of harvest.* Various weather-based models for several crops such as rice, wheat and sugarcane etc. have already been developed. In this paper an attempt has been made to develop forecast models for potato crop. Potato ranks fourth in importance after rice, wheat and maize. It is the only non-cereal crop that excels cereals in food value. The models for forecasting potato yield have been developed by using weekly weather data and the corresponding yield data.

The technique involved construction of suitable weather indices. These indices along with year-number (representing effect of technological factors) were used as regressors in the development of models. The stepwise regression technique was used for selection of important variables. These models have been developed for the district Agra (Uttar Pradesh) which has maximum contribution in terms of potato-production. The weekly data on the weather variables maximum temperature, minimum temperature, relative humidity at morning and evening pertaining to 36th to 45th standard meteorological weeks (smw) for the period 1971-72 to 1998-99 and the corresponding yield data were used for development of models. The models were validated for subsequent three years (not included in model development). It was found that the forecasts, two/three weeks in advance of harvest, can be obtained which are quite close to the respective observed ones in most of the cases.

34. Youden Square Designs for Complete Diallel Crosses

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Diallel cross experiments are used in plant and animal breeding to study the combining abilities of lines and crosses in an early generation. For 'p' inbred lines the number of diallel crosses in a complete diallel crosses (CDC) is $p(p-1)/2$ as per method-4 of Griffing (1956). With increase in number of lines or parents, the total number of crosses increases rapidly leading to larger intra-block variances of the randomized completed block designs so used. To overcome this problem incomplete block designs like Balanced Incomplete Block (BIB) and Partially Balanced Incomplete Block (PBIB) designs have been suggested by various workers (Aggarwal and Das 1987, 1990; Divecha and Ghosh 1994; Prasad and Gupta 2005 etc.). Sharma (2005) has suggested the use of lattice designs for the construction and analysis of blocked CDC. It has been shown that if the specific combining ability (sca) effects are ignored, lattice designs give rise to the optimal designs (efficiency 1.0 as compared to RBD). But for construction of CDC with the help of lattice designs the number of parents has to be a perfect square hence only a few designs are available. In this paper the construction and analysis of an incomplete block designs with the help of Youden Square Designs has been suggested for CDC. The suggested design also retains full efficiency i.e. 1.0 for comparisons of general combining ability (gca) effects,

if sca effects are ignored. Estimates of parameters of interest have been obtained by least squares technique and complete analysis has been done with the help of general procedure of incomplete block designs. The experimenter can screen a large number of lines with the help of proposed design. The complete list of possible designs up to number of parents 'p' = 40 has also been given in the form of a table.

35. A Study of Marketing of Milk through Cooperatives in India

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India is basically an agrarian economy with 72% of its total population residing in rural areas. Since crop sector, in most part of the country is dependent on whims of nature, so to augment the income, livelihood and nutritional security, most of the rural population takes refuge in livestock keeping and production of milk. Livestock contributes about 27 per cent to the GDP from agriculture. Milk is the largest contributor to agricultural GDP and it was more than Rs. 1,15,000 crores in 2004-05. The milk group comprises close to 70% of the output from livestock. Dairying offers a relatively stable stream of income as compared to crop cultivation. The scenario of daily rural milk production during 2004-05 indicated production of 2300 lakh kg /day of milk. Out of this, 48% (1100 lakh kg /day) is consumed in the village itself and the milk sold by rural producers into urban areas is the remaining 52% i.e. 1200 lakh kg /day. The marketable surplus handled by the unorganized sector is as high as 70% (830 lakh kg /day). Cooperatives handle 16% and private organized bodies account for the 14% of surplus. Dairying in India has broad social and economic dimensions. It involves tens of millions of small farmers, each with one or two animals. Dairy cooperatives generate employment opportunities for around 12.4 million farm families. In 2005-06, average daily cooperative milk marketing stood at 168.06 lakh litres; annual growth has averaged about 5.8 per cent compounded over the last five years. Dairy Cooperatives now market milk in all metros, major cities and more than 800 towns/cities. The present study has been undertaken with the objective of analysing the growth and performance of dairy cooperatives over the years in different states. The data has been collected from secondary sources, published by various agencies. The findings of the study will provide information regarding

the growth and performance of the milk cooperatives in different states of India.

36. Rainfall based Forecast Model for Rice Yield

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The forecast model for rice yield in Raipur district of Chhattisgarh is developed on time series data from 1970-71 to 1994-95 on the basis of amount of rainfall and number of rainy days besides linearly discriminated weather score, along with input variables as fertilizers nutrients (N, P & K) and trend. Keeping in view of the fluctuations in rice yield due to highly variable rainfall environment, the development of linearly discriminant weather score is confined to amount of rainfall and number of rainy days besides correlated weather variables in various phases of crop growth. The forecast model so developed is found to be adequate at the flowering stage and accounts for 89% of variation in rice yield due to linearly discriminated weather scores of all phases of crop growth except the early phase along with the fertilizer nutrient as Potash (K). The forecast value at this stage is found to be 1526 kg/ha which is very close to the observed value of rice yield i.e. 1524 kg/ha for the year 1995-96.

37. A Note on Bayes Estimator in Finite Population Sampling

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The design based properties of the Bayes estimator in the context of estimation of finite population mean have been studied. With the help of an empirical study it is shown that the usual estimator based on simple mean values compares favorably vis-à-vis the Bayes estimator in terms of the criterion of bias.

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38. Optimum Size and Shape of Plot for Field Experimentation on Irrigated Mulberry (*Morus alba L.*) in the Gangetic Plains of West Bengal

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A study was conducted at this Institute on optimum size and shape of plot for field experimentation on irrigated mulberry (*Morus alba L.*), a perennial only food tree/plant of *Bombyx mori L.*, the mulberry silkworm. The objective was to increase experimental precision of yield performance trial. For this, a big plot with well established mulberry plantation with variety S1635 having spacing of 60 × 60 cm² was taken. Individual plant wise data on leaf yield were collected from a sub-plot of 7.2 × 7.2 m² containing 144 (12 × 12) plants excluding borders of the main plot. This whole experimental area was divided in 144 basic units of size 0.36 m² each containing one plant. The variability in leaf yield among the basic units was measured using coefficient of variation (CV%). The CV% of leaf yield among different plots of all possible bigger sizes by combining the adjacent basic units was also calculated. Using the method of maximum curvature, it was observed that each plot for experimentation should have a size of at least 18 m² excluding the border plants provided the plantation, 60 × 60 cm², is of at least 2-year old. The variability was less for the plots having a shape of square or slight rectangle.

39. Growth of Important Crops in Karnataka: A Combined and District Level Analysis

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Agriculture is vast ecological system. Karnataka is predominantly an agriculture state. 24% of the total GDP comes from agriculture. 70% of the population still in rural areas is dependent on agriculture for their livelihood. The secondary data on area and production of agriculture, horticulture and plantations crops from 27 districts of Karnataka state have been collected for the year 1990 to 2004 (15 years) from the Department of Economics and Statistics, Bangalore. Agro products grown in an area of 107.90 lakh hectares and the production is 92 lakh mts. Horticulture crops grown in 14.27 lakh hectares and the production is 114.90 lakh

mts. The growth rate across the district was analyzed. The area under agriculture crop decreased, whereas the area under horticulture crops increased considerably. Horticulture area accounts for 15% of the State's gross cropped area. Total gross annual income from horticulture is Rs. 7152 crores which is 40% of the gross annual income from combined agriculture sector. Crop Growth Rate was estimated for different agriculture, horticulture and plantation groups and for individual crops. It was an area led growth in the case of fruits whereas in vegetables, it was primarily productivity led growth.

40. Training Impact on Data Analysis using Statistical Application Softwares

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Use of Information Technology in acquiring knowledge and skills has become an essential element in education and training. The use of computing and communication technology to enhance the efficacy of transaction and productivity is the driving force of this new era of social and economic transformation in the modern society called Information Society. Collection and generation of data and analysis are the major activities in Applied Statistics. Statistical analysis has become an integral part of almost all research programmes. The advances in computer technology lead to development of a number of Statistical Application Softwares. Software Package for Statistical Solutions (SPSS), MSTATC, MS Excel & Design were taught to 35 teachers for 5 days duration. Five staff members (starting from Research Associate to Professor cadre) from 7 Departments of Social Science were selected for the training programme, thus constituting a heterogeneous group. Respondents had an access to computer but were not aware of the statistical packages and also had poor knowledge about usage of statistical tools (tests). Knowledge about statistical tools and packages have improved significantly at the end of the training programme. Before the training, none of them were aware of MSTATC package. After the training 75% of them showed inclination towards this. 35% of the participants had poor knowledge about MS-Excel & SPSS (before the training) which has improved considerably. All of them showed interest in SPSS.

41. Some Investigations on Mixture Experiments in Agriculture

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A mixture experiment involves the study of performance of various mixtures formed by mixing two or more components called ingredients. Let x_i represents the proportion of i^{th} ingredient in a mixture, $0 \leq x_i \leq 1$,

$i = 1, \dots, q$ then in mixture experiments $\sum_{i=1}^q x_i = 1$, where

q is the number of components. In mixture experiments, the factors are ingredients of a mixture and their levels are not independent. Some of the situations in agriculture where these designs could be advantageously used are split application of fertilizers, intercropping experiments, sensory evaluation experiments, preparation of fertilizers, insecticides/pesticides mixtures, feeding trials in animal nutritional experiments, etc. Scheffe (1958, 1963) gave simplex lattice and simplex centroid designs for experiments with mixtures. In this article, an attempt has been made to compare the efficiencies between the designs given by Scheffe and some of the mixture experiments used in agriculture. Some efficient mixture designs have also been obtained by combinatorics.

42. Growth and Constraints of Tasar Raw Silk Production in Jharkhand

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Jharkhand remained the leading state of India in tasar raw silk production since independence due to availability of luxuriant forest having adequate food plants, long tradition of tasar culture with tribal families, presence of several clusters of handlooms producing tasar yarn & fabric and involvement of middlemen at different stages of production & marketing. On 15th Nov'2000 Jharkhand was carved out of Bihar and more than 90% of tasar cocoon producing area came under Jharkhand and more than 90% of looms went to Bihar. As such the production of undivided Bihar can be considered as the production of Jharkhand. Jharkhand contributed 34.29% of national production of tasar raw silk followed by Chhattisgarh - 31.43% and Orissa - 10%, whereas contribution of Bihar after its division remained to only 3.14%. Since

independence the tasar silk production in the state (united Bihar before Nov'2000 and thereafter Jharkhand) has seen several ups and downs though there existed plenty of natural resources and manpower. The lowest production was 43 MT in 1952-53 and highest of 438 MT in 1986-87 followed by persistent decline. Several developmental programmes were launched to accelerate the production but the growth rate could not be sustained. Tasar production trend needs to be examined in view of potentiality of rural employment. The investigation elaborates the growth pattern and the planners may utilize the information for future programmes. The present study is for the period of 1951-52 to 2006-07 and the data were collected from Technical and Annual Reports of Central Silk Board, Govt. of India. Based on mathematical trend the period was divided into three phases as phase I: 1951-52 to 1970-71, phase II: 1971-72 to 1990-91 and phase III: 1991-92 to 2006-07. The trend was also visualized for whole period of study i.e. 1951-52 to 2006-07. The growth behavior was analyzed with the help of exponential function $Y = a \cdot b^x$ using least square method. The trend analysis for the study periods were carried out using linear and non-linear models. It was observed that production trend was different for different time periods. The growth rate for phase I, II and III was 6.51%, 2.80% and -5.82%. On clubbing the three phases a slow growth rate of 1.82% was visible. The constraints for slow growth rate needs to be explored and explained for taking effective and corrective measures. The constraints are discontinuance of traditional seed system, inadequacies in the Government seed policy, decline in eco-race production due to over exploitation, low productivity of plantation raised under different schemes, deforestation, deficient extension support from Government organization for seed, technology and marketing, subsidiary nature of tasar industry, disinterested young generation due to low and unpredictable returns and poor exploitation of international markets. To address referred constraints of tasar silk industry there is a need to develop new strategies for reaching new height of production.

43. Analysis on Rice Area, Production and Productivity during 2002 Drought in different Districts of various States in India and Strategies for Increasing Rice Production

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Rice production in India declined from 93.3 million tons to 72.6 million tons during 2002 drought from previous year of maximum production. The decline in production was observed during both kharif and boro/summer season rice crops. The states like Punjab, Jharkhand, and other minor rice growing states and union territory like Arunachal Pradesh, Mizoram, Sikkim, Pondicherry, Goa, Andaman & Nicobar Islands, and Daman & Diu were not affected and had higher rice production. Boro/summer rice production also declined in almost all states due to lack of enough water in reservoirs. Districts wise data analyses shows that except in Punjab, drought affected the area, production and productivity in different districts in three different ways. Initial drought in June-July reduced the area and production both (Type I); mid season drought in August-September did not reduce the area but production and productivity were reduced (Type II). Both early and mid season drought affected the area, production and productivity (Type III). Type I drought was mainly in states of Andhra Pradesh, Karnataka, Tamil Nadu, Haryana, Uttarakhand, Western and Central Uttar Pradesh, Jharkhand, and West Bengal. Type II drought was in Chhattisgarh, Madhya Pradesh, Himachal Pradesh, Orissa, and Eastern Uttar Pradesh, and Type III was drought in Rajasthan. The districts with higher productivity level in each state have been identified. There is need to develop national, state and district level plans to mitigate the drought damage in future and produce enough rice to meet the consumers and export demands. Special package of seed, fertilizer, irrigation, pesticides, and implements should be provided in such districts. Large parboiling units need to be established in Assam for increasing boro rice acreage. Drought resistant varieties and its integrated crop production technology need to be implemented in each districts for household food security, and marketable surplus for urban consumers and export. Drought resistant variety like Vandana should be promoted on large scale through minikits. Hybrid rice has better drought resistance than conventional varieties and its seed production should be undertaken. SRI technology with hybrid rice needs promotion on large scale. Extensive farmers managed on-farm trials are needed to convince the large numbers of traditional farmers for new varieties and production technologies.