ABSTRACT OF PAPERS PRESENTFD AT THE SILVER JUBILEE AND 25TH ANNUAL GENERAL MEETING HELD AT NEW DELHI IN MARCH, 1972.

1. *Some Observations of Spoilt Designs*

   Prof. M.C. Chakrabarti, University of Bombay.

In a recent issue of the JRSS Vol. 134 Part 3 (1971), Hoyle includes under Spoilt Design, experiments with missing observations, extra observations, mixed-up observations and cases arising from combinations of these three basic situations. In this paper certain formulae in the analysis of Spoilt Designs have been established.

2. *The distribution of the mean of samples from truncated gamma distributions*

   P.V. Krishna Iyer, Department of Mathematics, University of Queensland, Brisbane.

In this paper, the distribution of the mean of random samples from truncated gamma (Pearson's Type III) distributions is derived using Dirichlet's multiple integral.

3. *Balanced Confounded Asymmetrical Factorial Design*

   B.N. Tyagi, Department of Agriculture, Uttar Pradesh, Lucknow.

The construction of balanced asymmetrical factorial designs (in incomplete blocks) has recently been tackled by a number of workers. However, the condition of balancing has required relatively large number of replication and size of the block has limited variation. In this paper, we have constructed a wide class of balanced asymmetrical factorial designs with varying block sizes not necessarily a proper fraction of total treatment combinations, in relatively smaller number of replications. We have made use of the group divisible designs. Balanced design for 4×2, 5×2, 6×2, 7×3 have been obtained with block sizes, 3, 4, 4, 6 respectively. Such designs were not available at all. The important feature of all such designs is that they are very easy from analysis point of view.

4. *Generating Function of Modified Branching Process*
U.G. Nadkarni, I.A.R.S., New Delhi.

In this paper, the probability of extinction of the population considered in an earlier paper on branching process (1964, J. I.S.A.S.) is further discussed for all non-negative values of α and β, the parameters of the process. The limiting form of the generating function as the number of generations become infinitely large is derived. And for $\beta \neq 0$, the process is further shown to be recurrent and strongly ergodic.

5. *On an Incomplete Block Design for Slope-Ratio Assays*
A.C. Kulshreshtha, Institute of Advanced Studies, Meerut University, Meerut.

When an incomplete block design is used for slope-ratio assays, the estimates of the two regression contrasts $(b_s,\ b_t)$ corresponding to two preparations (standard and test) are affected by the block differences. As the estimate of relative potency of the test preparation is obtained from the ratio $R = b_t/b_s$, the superiority of a design is sometimes, judged by the length of its fiducial intervals.

An incomplete block design for slope-ratio assays with even number of doses from each of the preparations is proposed. The proposed design is more efficient, as it provides shorter fiducial intervals for the estimate of relative potency, than the modified *BIB* design (Das and Kulkarni, 1966) and Randomized block design with equal replication of non-zero doses. A numerical example of a 9-point *SR-* assay on riboflavin content of yeast is given.

6. *On product method of estimation in sampling on successive occasions*
P.C. Gupta, Rajasthan University, Jaipur.

In repetitive surveys for estimating the same characteristic at different points of time, it is possible to use the information collected on previous occasion to improve up on the conventional estimators for the current period by using difference or regression method of estimation. Usually the correlation between such observations is positive but situations do exist when the value of a character under study at two successive occasions are negatively correlated *e.g.* the amount of fertilizer contents required by the soil in two successive seasons etc. In this note an attempt has been made to study the problem of estimating terms and relationship in a time series at two successive occasions, assuming throughout that the same character is to be studied on the occasions and the population size N remains

invariant. The problem of optimum allocation has been also considered. A successive sampling estimate, similar to one proposed by Avadhani (1963) has been suggested which is as efficient as usual successive sampling estimate provided (*i*) the correlation between the observations of two successive occasions is negative and is given by

$$\rho_{12} < -\frac{1}{2} \frac{c_1}{c_2}$$

where ρ_{12}, c_1, c_2 are the correlation coefficient between observation of these two occasions, coefficient of variation of first and second occasion respectively, (*ii*) the regression line passes through a small neighbourhood of the origin.

The use of such an estimate obviates the computational difficulties arising in conventional successive sampling estimates. The results, however, can be extended for any number of occasion.

7. A note on Ratio Method of Estimation in varying probability

P.C. Gupta, Rajasthan University, Jaipur.

The use of varying probability with replacement in the ratio method of estimation was suggested by Des Raj (1954). In the present note the use of two sampling schemes : (*i*) varying probability without replacement due to Horvitz-Thompson (1952) and (*ii*) Rao-Hartley Cochran's sampling scheme (1962), in ratio method of estimation has been made to improve the usual ratio estimate. A necessary condition for the proposed estimate based on sampling scheme (*i*) to be more efficient than Des Raj's estimate is obtained. Incidentally it is the same as obtained by Narain (1951) for PPSWOR estimate to be more efficient than PPSWR in a two-stage sampling design. Further it has been shown that the estimate based on scheme (*ii*) is always superior than that of Des Raj.

8. Construction of second order Rotatable Designs (SORD) for factors with increased number of levels.

T. K. Gupta, Department of Agricultural Statistics, Kalyani University.

3-level or 5-level SORD are obtained using the parametric relations of balance incomplete block (BIB) designs. There may arise situations where the factors should necessarily have increasing number of levels. We have discussed the problem of increasing the number of

levels in a given SORD by adding a few more design points. Thus 5-level SORD obtained through BIB design can be transformed into 7-level SORD by addition of $2v$ points where v is the number of factors under consideration. Similarly 5-level SORD can be obtained from 3-level SORD by adding a few points. The SORD thus obtained may have some practical importance in some industrial application.

9. *Four level second order rotatable designs from partially balanced arrays*
G.M. Saha and A.R. Das, I.A.R.S., New Delhi; Jute Tech. Res. Lab., Calcutta.

Conditions to be satisfied by two-symbol partially balanced arrays of strength two, to yield four-level second order rotatable designs (SORD) are derived. Application is then made to construct SORD from BIB designs through suitable augmentation of certain magnitude sets. A new series of four-level SORD for v factors from $v+1$ magnitude sets, when v is of the form s^2+s+1 (s being a prime or a prime power) is reported.

10. *On Simple random sampling, with replacement*
M.N. Deshpande, Institute of Sciences, Nagpur

In the paper following two classes of estimates are discussed.

$$C_1 = \left[\hat{\bar{y}}_\alpha = \left\{ \alpha E\left(\frac{1}{\alpha} \right) + \frac{1-\alpha}{E(d)} \right\} d \ y_d, \ \alpha \text{ is constant} \right]$$

$$C_2 = \left[\hat{\bar{y}}_\alpha = \left\{ \alpha E\left(\frac{1}{d} \right) + \frac{1-\alpha}{E(d)} \right\} d \ y_d, \alpha \text{ is function of } d \right]$$

Where d is number of distinct units in a sample. $\bar{Y}_a$ is sample mean of distinct units. Both C_1 and C_2 contain positively biased, negatively biased and unbiased estimates. In C_1 complete class of estimates is obtained. Interesting result is though H.T. estimate is member of C_1 it does not belong to complete class. Properties of class C_2 are also discussed in brief.

11. *On Regression Method of Estimation*
Padam Singh, I.A.R.S., New Delhi-12.

The precision of estimation of population characteristics in a finite population can be improved by utilizing the information on an

auxiliary variate, highly correlated with the character under study. In this context, the Ratio, Product and Regression method of estimation are well known. In this paper a quadratic regression estimator has been proposed which is of the form

$$\overline{Y}_{Qr} = \overline{Y}_n + \frac{m_{11}}{m_{02}} \left(\overline{X}_N - \overline{x}_n \right) + \left(\frac{m_{12}}{m_{04} - m^2_{02}} \right),$$

$$\left[N(\overline{x}_n) - (\overline{x}_n - \overline{X}_N)^2 \right].$$

with $V(\overline{Y}_{Qr}) = \frac{1}{m} \left[\mu_{20} - \frac{\mu_{11}^2}{\mu_{02}} - \frac{(\mu_{12})^2}{\mu_{01} - \mu_{02}^2} \right]$

under the assumption $\mu_{03} = 0$.

The proposed quadratic regression estimator is better than the linear regression estimator. Extensions are made to double sampling also.

12. Multipurpose Surveys on Successive Occasions
    D. Singh and R. Singh, I.A.R.S., New Delhi.

For populations which are subject to change from time to time, it is necessary to repeat surveys at some regular interval of time. Also while planning certain surveys, it is convenient, cheaper and sometime even necessary to include a number of related characters in a single enquiry. The experimenters interest in such cases would be to utilize the entire information available to obtain most precise estimates of different characters.

The major problem in such surveys is the lack of the knowledge correlation pattern between the values of different characters on different occasions. Many workers as Jesson (1942), Yates (1948), Patterson (1950), Tikkiwal (1965) and D. Singh (1968) have contributed to the theory of successive sampling under certain correlation patterns.

In the present investigation, we have developed the method of analysis for the general correlation pattern ρh (k) r (s) where

ρh (k) r (s) denotes the correlation co-efficient between the values of kth character on hth occasion and sth character on rth occasion.

$h, r = 1, 2 \ldots \ldots t$, t being No. of times the survey is repeated.

$k, s = 1, 2 \ldots \ldots c$, c being No. of characters observed on each occasion.

The results have been obtained for the sampling scheme when sampling units are either common to all occasions or appear only once in the sample. The results can be easily extended to other sampling schemes too. The results have been examined by applying to the data obtained through Agronomic and Agro-economic surveys of the I.A.D.P., District Aligarh., U.P. and as expected, it has been found that as the auxiliary information is increased, the efficiency of the estimates increases.

13. *A Class of Three-Replicate Three-Associate P.B.I.B. Designs*

G.M. Saha, I.A.R.S., New Delhi, and A. K. Mishra, Ranchi Agri. College, Kanke.

Saha and Das (1971) have constructed *p.b.i.b.* design of two and more associate classes through the use of confounded designs for 2^n factorials with $v = (n+1)C_2$, $b = (n+1)C_3$, $r = n-1$, $k = 3$ where v, b, r, k and λ have their usual meanings. By dualising these designs, a class of three-replicate three-associate *p.b.i.b.* design has been obtained with $v = (n+1)C_3$, $b = (n+1)C_3$, $r = 3$, $k = n-1$, for $n > 4$ where $n = 4$, the design becomes of two associate classes and for $n = 3$, the dualised design becomes a balanced incomplete block design. This can be taken to be a new class of designs in the sense that they are not included by Nair (1951) in his table of three-replicate three-associate *p.b.i.b.* designs. Secondly, the construction of these designs is very simple. The other parameters of these designs have been found out. An algorithm of writing directly the treatment numbers in blocks of the dualised designs has also been found out.

14. *Multifactor Mixture Experiments*

A.K. Nigam, Banaras Hindu University, Varanasi.

A new type of mixture experiments is defined wherein proportions of components of two or more factors are to be tested. The utility of such experiments is demonstrated through two examples. The two factor experiments have been dealt at length and a quadratic model for such experiments is considered. Design suitable for such experiments have also been discussed.

15. *Application of Lattice Sampling in Forestry*

A. Ghosal, C.S.I.R., New Delhi and A.B. Rudra, School of Forestry, Melbourne University.

A lattice sample $L(X_m, \Gamma)$ in which the members a sample observation X_n is a lattice with m nodes and a pattern. The nodes within the latitce are correlated, and the spatial correlation between two particular nodes can be estimated. The problem is one of estimating the group means of the lattice nodes from a sample observation $(L_1, L_2, \ldots\ldots L_n)$. The variance of the lattice may be expressed in the form

$$\text{Var } (\overline{x}) = A + \frac{\sigma^2}{m}(1 + \phi_m)$$

where $\overline{x}$ is the lattice mean, σ^2 the variance of observations, and ϕ_m a measure of spatial correlation.

A set of experiments was conducted in forestry, and the lattice mean estimated by using the above formula. In most of the cases it was possible to estimate the variance with reasonable precision. Comparison was also made with estimated values obtained by using the Fairfield Smith's formula.

16. On the problem of optimum stratification in socio-economic studies

Ravindra Singh, Punjab Agricultural University, Ludhiana.

The problem of dividing a population into L most homogeneous and non-overlappling groups with respect to a character x has been considered. For theoretical development the variable x is assumed to be continuous and following certain regularity conditions. Cum $\sqrt[3]{f(x)}$ rule has been suggested to obtain an approximate solution of the above problem. The paper concludes with a numerical illustration.

17. A Study of the Distribution of Rainfall in Raipur District with the help of Stochastic Models

P.N. Bhargava, P. Narain, Asha Pradhan & K.G. Aneja, I.A.R.S., New Delhi-12.

Of all the factors affecting agricultural production, the availability of water is undoubtedly the most important factor. In rainfed areas the failure of rain at the critical phase of the plant growth can cause permanent damage to the crop. Such damages can at best be minimised if the crop seasons are so adjusted that they coincide with the period having adequate rainfall. It is, therefore, necessary to investigate the behaviour of the occurrence of rainfall. Gabriel and Neumann (1962) found that a two-state

Markov chain gave a good description of the occurrence of rainfall during the rainy season. In the present investigation, therefore, the occurrence of rainfall in the 29 raingauge stations of Raipur district during the period 1st June to 30 September and spread over about 40 to 70 years has been studied in terms of such a stochastic model. It is assumed that the probability of rainfall on any day depends only on whether the previous day was wet or dry. A day is taken as dry if the amount of rainfall is found to be below 3 mm per day. On the contrary, it is taken as a wet day. The various properties of rainfall occurrence patterns have been investigated. On the average it has been found that the probability of a wet day following a dry day is 0·283 whereas the probability of a dry day following a wet day is 0·307. The system is found to settle down after about eight days, on the average, to a condition of statistical equilibrium in which the state occupation probabilities are independent of the initial conditions. It has also been found that the expected length of a dry spell is about 3·53 days whereas that of a wet spell is about 3·26 days. The weather cycle defined as a wet spell followed by a dry spell is, therefore, of the order of about 6·79 days. The distribution of the number of wet days as well as that of dry days has also been studied.

18. A Note on Use of Polar Co-ordinates in Sampling
S.N. Mukherjee, Directorate of Agriculture, West Bengal.

There are areas for which detailed survey maps are not available in proper scales. It is very difficult to take survey work in such areas. Some attempts have been made to apply sampling techniques in such areas by preparing substitute working maps. All the same, such areas present problems, especially if the terrain is difficult.

In usual crop cutting experiments, location of a cut is marked out on the basis of using co-ordinates. This involves two movements in two desired directions. Due to configuration of plots, this process often cannot lead to locating the exact points meant in the instructions. In big fields, especially with tall crops, the problem is more difficult.

There are cases where some effects radiate out from a central area. In such cases, not only distance from the central area but also directions may be of significance.

Keeping such cases in view, a pattern of possible uses of polar-co-ordinates for selection of and locating random samples has been

considered. Polar co-ordinates may be used for locating rectangular areas also.

If polar co-ordinates are to be used, it would be necessary to have equipments suitable for the purpose. Sets of apparatus that may be useful in applying polar co-ordinates in selection of samples, locating and marking out sample units on maps and fields have been discussed. In this set up, location of a sample point (which may be centre of a circle, corner of a grid, starting point of a line, etc., is obtained by reaching (directly or indirectly) a point which is at a desired distance (from the starting point) along a clearly indicated direction (given by the apparatus).

In many areas terraces are narrow and winding. It is not possible to apply standard practices of crop cutting experiments in such areas. All the same, yield estimation may be necessary for such areas. Even if cuts are taken, it is difficult to ascertain the area of the cut and marking out of desired areas for crop cutting experiments is also a difficult task. In this note, sets of apparatus have been discussed that may help in doing such work, at least in some cases.

Marking out of exactly desired rectangular arears for crop cutting experiments (or other purpose) in fields, especially having tall bushy crops, is not always easy even in plains. Difficulties increase with size of the rectangle. A simple set up has been considered for such cases.

19. *A Note on Component Sampling*

B.B.P.S. Goel, I.A.R.S., New Delhi & D. Singh, Ministry of Agriculture, New Delhi

In many situations the variable under-study consists of two more components and in order to measure the value of the variable under study, an observation is needed on each component for the units of the sample. The component observations are usually correlated among themselves. In such cases, the procedure of component sampling has been suggested according to which an observation is needed on only one of the component for each unit in the sample. In case of only two components, this procedure has been compared with that of unitary sampling in which all the components are to be measured. The relative efficiency of the procedure of component sampling depends upon the correlation coefficient between the components, on the cost structure as also on the variability of each component. For given cost structure and for given variability of

the components, the component sampling is superior to unitary sampling if the correlation coefficient between the components exceeds a certain value. An expression has been given for calculating this value. The procedure has been illustrated with the help of a numerical example.

20. Double Systematic Sampling with Varying Probabilities
Padam Singh & G. Sadasivan. I.A.R.S., New Delhi-12.

The method deals with a generalisation of *pps* systematic sampling one dimension to two sampling intervals. The results in the case of one random start and two random starts are presented. The efficiency of these procedures are compared with *pps* systematic sampling as well as the usual systematic sampling and simple random sampling. The selection procedure for our sampling scheme is as follows. Arrange the population in ascending order of magnitude with respect to the auxiliary variate x_i and divide the population units two parts under the restriction that the sampling interval in each part should be more than the maximum of x_i's in the respective part. Then the sample is selected from each part with the same or independent random starts. The method can be generalised to multiple *pps* systematic sampling in one dimension.

21. Index of Cost of Milk-Production
K.C. Raut, Shivtar Singh and H.B. Chaudhari, I.A.R.S., New Delhi-12.

Indices for agricultural commodities, prices, cost of living etc. are readily available but hardly such indices are worked out in the country for live-stock products and their cost of production. Non-availability of reliable and time-series data in a region is perhaps the main reason for not finding out an appropriate index of these items. Working out the index of cost of production of milk is not straight forward. There is an urgent need for working out such an index particularly because the dairy industries would like to know, in addition to the trend in milk production, the trend in the cost of production of milk from time to time in the area of milk collection to formulate a sound pricing policy. The cost of production of milk can be obtained in an objective manner only through large scale sample surveys, the technique of which has been evolved by the Institute of Agricultural Research Statistics. These surveys are however expensive and as such neither possible nor desirable to respeat year after year in an area. Once the survey is conducted for a period of two or three years in a given area it would be perhaps

sufficient to secure seasonal prices of feeds and fodders, wages of labour etc. during the next few years to work out in an appropriate manner an index of cost of production of milk, utilising the quantities of physical inputs and outputs estimated from the detailed enquiry. It would be desirable to repeat the detailed enquiry after a few years only when there would be change in the quantity and composition of inputs and outputs. The Institute of Agricultural Research Statistics has already initiated work in this direction.

In the paper different indices of feed cost which is the major component of cost of production of milk have been worked out for the years during which large scale surveys were carried out by the Institute following the available methods as well as their modified forms utilising the data collected in those surveys. The indices worked out have been compared to suggest an appropriate index to be used during the subsequent years after the completion of a detailed enquiry on the cost of production of milk.

22. *Integrated approach in sample surveys on Livestock products*
    J.S. Maini, D.V.S. Rao and V.V.R. Murty, I.A.R.S., New Delhi-12.

The institute had initiated during the Second Five Year Plan, a series of 'pilot' sample surveys on principal livestock products in typical tracts of the country with the objective of evolving suitable sampling methodology for estimation of annual output of the various products and for study of livestock practices. The sampling methodology evolved for each product is now being used by certain states for collection of statistics of each product on annual basis.

It is well known that integrated or multi-character approach in large scale sample surveys has specific advantage as compared to the single-character approach particularly from the cost point of view. With the object of exploring the possibility of integrating surveys on different livestock products, particularly milk and eggs, and thereby reducing the overall cost of the surveys on these products, the Institute had conducted additional pilot surveys in a few tracts during the Third Plan period using the integrated approach on milk and eggs. The data collected from such pilot surveys have been utilized to study the relative reduction in cost under the integrated approach as compared to single character approach. For this purpose, the cost of a survey under each of the methods has been worked out for estimating production of milk and eggs with a precision of 5 per cent. A comparison of the two methods showed that the relative reduction in cost was small for areas like Gujarat in which one of the product

(eggs in this case) is not important. In other areas where both the products are important the relative reduction in cost was much higher.

During the Fourth Plan period, similar pilot investigations using integrated approach and covering all the principal livestock products are being undertaken with a view to develop an integrated technique in such a way that information on output of a single product from a large sample is collected to provide estimate of this product with a fairly high precision, while similar information on other products is also collected from the same survey and from a smaller sample to estimate indices of changes in their production.

23. Measurement of the Impact of the Green Revolution

B. Nanjamma Chinnappa, Economics Department, University of Madras.

The object of the paper is to attempt to define the Green Revolution in India, delineate areas of its impact, and suggest means to measure its extent and intensity. The statistical studies suggested in this paper should help in obtaining an objective assessment of the progress of the green revolution and its impact, and indicate ways to hasten its effectiveness and remove the impediment to its growth.

24. Measurement of impact of Green Revolution

Rajinder Singh and H.K. Bal, Punjab Agricultural University, Ludhiana.

An attempt is made in this paper to measure the impact of green revolution on a variable Y_t by fitting an exponential growth function of the type $Y_t = AB^t$.

Where Y_t is the value of the variable in tth year, t_i time variable taking values $0, 1, 2, \ldots 15$ for the years 1949-50 to 1964-65. Differences between expected and observed values of Y_t are tested by non-parametric 'sign test' to see whether the impact is a positive or negative. It is observed that the incomes of all types of families large, medium or small have increased over this period of the impact of green revolution. We study in this connection whether the disparity of income distribution has increased or not by using the analysis of covariance. Results obtained are discussed in detail in the present paper.

25. A study of growth rates, area, production and productivity in Uttar Pradesh

B.N. Tyagi and K.P. Avasthy, Department of Agriculture, U.P., Lucknow.

The growth rates of area, production and productivity of important crops grown in Uttar Pradesh have been worked out for the period 1950 to 1970-71. A study of these growth rates at the district levels has shown considerable variations from district to district. Even among the various crops, the growth rate have been different. Wheat and rice have registered comparatively higher growth rate, particularly after 1966-67.

26. Changes in land use pattern and possibilities of extending cultivation in India

S.A. Khan, Patna University, Patna.

The paper purports to study the changes in the pattern of land utilisation in India during the period 1951-52 to 1966-67 and examines the possibilities of extending cultivation on hitherto uncultivated land. It is concluded that the apparant rise in the area under forest is not real. As a matter of fact the forest-area was found to be declining when necessary adjustments were made in the data. The area under forest in 1966-77 was much less than the recommended area. In case of other categories of land, land not available for cultivation and parmanent pasture and other grazing lands have shown an over all increase. On the other hand, area under culturable waste, miscellaneous tree crops and groves, current fallow and other fallow have declined. After critically examining these changes and highlighting the significance of fodder and domestic fuel supply to the rural India it is concluded that there is no scope of extending cultivation on areas under forest permanent pastures which are already considered inadequate. The cultivation may, however, be extended on some of culturable waste land besides current and other fallow lands.

27. Role of subjective probability in agricultural decisions

D. Mishra and D.K. Pandey, Patna University, Patna

Today agriculture in our country is not wholly dependent on nature because it has been influenced by the impact of green revolution and other scientific developments. Production of agricultural goods is also influenced by the market price which depends on the Government policies, actions taken by big farmers and the business organisations and its demand. Thus we see that the production of agricultural goods depends on decision taken by various groups of persons. All these decisions are not taken under the conditions of certainty but under the conditions of uncertainty *i.e.* depending on probability. In this paper it has been attempted to show that subjective probability is more helpful and more meaningful for such types of decisions.

28. *The prediction of correlated response in economic traits of Red Sindhi cattle*

P. Narain, R. Singh & A.K. Mishra, I.A.R.S., New Delhi-12.

For bringing about genetic improvement in cattle, one of the techniques is to select cows on the basis of their first lactation milk yield and select bulls on the basis of their progeny tests. Such a selection procedure practised in a given herd cannot only improve the first lactation milk yield but also bring about correlated genetic changes in other important characters such as length of lactation, milk yield per day of lactation and life-time milk production etc. However, this is only possible if these characters have a genetic correlation with the milk yield in first lactation. In fact in such characters as life-time milk production the direct selection based on it, is not practically feasible since the cows would have to be retained till they are alive. In such cases indirect genetic changes can be brought about in this character by selecting for characters which are measured early in the life of an animal. In the present paper, therefore, the magnitude and direction of the expected correlated responses in some of the desirable characters in Red Sindhi herd of cattle have been examined with the help of the data spread over about 20 years. It has been found that the genetic improvement in life-time production could be increased by about 8% if the selection is based either on the milk yield in first lactation or on the length of lactation. The results also indicated that the milk yield in first lactation can be increased by about 6% if the basis of selection is milk yield per day in first lactation, but for affecting indirect genetic improvement in milk yield per day in first lactation, the selection based on either milk yield in first lactation or length of first lactation is found to be inefficient.

29. *Technique of estimating optimum size and shape of plots from fertilizer trial data*

S. Ray, C.B. Sharma & V. Shukla, Institute of Horticultural Research, Bangalore.

A technique has been suggested to investigate the optimum size and shape of plots by using the yield data from fertilizer trial. This method is applicable for any crop and will overcome the problem of long time required exclusively for uniformity trial, specially in the case of perennial crops and it will be economic by saving a lot on land, labour and capital investments. The technique has been explained by tomato yield data collected from a fertilizer trial conducted at the Institute of Horticultural Research, Hessaraghatta.

30. *Economics of Milk Production by landless cattle owners and farmers of small, medium and large holdings*

K.C. Raut and Shivtar Singh, I.A.R.S., New Delhi-12

Various developmental measures are being taken to improve the economic status of landless cattle owners and the small and marginal farmers. It is observed that about three-fourths of cattle owners belong to these categories. Sale of milk is one of their major sources of income. If incentive price is offered for the milk produced by these cattle owners, it will improve their economic lot. It is generally agreed that cost of production should be one of the factors determining the price of milk to be offered to the producers. In this context, it is desirable that the economics of milk production by landless cattle owners, small and marginal farmers are worked out in different areas. An attempt has been made to work out the cost of production of milk by these class of producers along with the level of production and pattern of utilisation of milk etc., utilising the data collected through a large scale sample survey in Krishna delta area of Andhra Pradesh (1967-69).

In Krishna delta area about 22 per cent of the cattle owners are landless and other 55 per cent have land less than two hectares. The number of milch animals in a household increased with the size of holding. The cost of production of milk was minimum in the households of landless cattle owners when the family labour was either included or excluded, as compared to the farmers of different size of holdings. About 56 per cent of milk produced by landless cattle owners was sold, mostly to consumers directly and the remaining quantity being either consumed by the family or converted into milk products. Milch animals were underfed in respect DCP, although they were fed more TDN than the requirements. A detailed discussion has been made regarding the cost of milk production and its components, pattern of utilisation of milk, extent of feeding the animals etc. in the households of landless cattle owners and farmers of small, medium and large holdings.

31. *Improvement of collection of data on inputs and outputs by survey method*

Bhagat Singh, I.A.R.S., New Delhi-12.

Survey method of data collection is resorted to by researchers for quicker results at lower cost tolerating certain amount of response bias involved in the data so collected. The present paper suggests simple indirect methods for data collection reducing this bias in respect of inputs and outputs and also to cross-check the reliability

of cultivators' statements while furnishing information. Simple proformae have also been suggested for data collection relating to inputs.

It has also been brought out that simple and precise schedule, shorter interviews with the cultivators interested in the subject and having trust in the investigator who has working knowledge of farm technology, may yield more unbiased and accurate data.

32. Availability and disposal of dung in India

B.B.P.S. Goel, K.B. Singh & K.P. Singh, I.A.R.S., New Delhi-12.

Dung excreted by bovine animals is useful in many ways and reliable statistics of dung production and its disposal are quite important. Utilizing the data collected through sample surveys for estimation of milk production and study of bovine practices conducted by the Institute of Agricultural Research Statistics in a number of States of the country, the estimates of evacuation rates of dung per bovine and its percentage utilisation for compost, for dung cakes and for other purposes have been worked out.

On the basis of certain assumptions, the All India estimate of dung production for the year 1966 has been worked out to be 344·5 million tonnes. For the areas studied, it was found that 69 per cent of the total dung collection was used for manure, 29 per cent for dung cakes and 2 per cent for other purposes. Potentiality for soil nutrients i.e. nitrogen, phosphoric acid and potash from dung has also been worked out.

Following Acharya (1957) a suggestion has been made for better utilisation of dung according to which not only it is possible to increase the production of compost but substantial availability of domestic fuel in the form of fuel gas from dung can also be achieved.

33. A study of latent secular changes by Fisherian Regression Integral Technique

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Due to slow changes in the climate of a place or due to continuous cultivation of a field as per the changing local practice of agriculture, the yield of a crop may undergo secular changes. However this change may not be apparent because of greater year to year variability in weather factors influencing the crop. Fisher has developed a method to evaluate the continuous effect of weather factors on the crop. In this method, a regression integral replaces

the linear regression function. The yearly rainfall is represented by the components of the orthogonal polynomial. The progressive changes from this set of orthogonal constants and the yield are then eliminated by means of the polynomial function.

By removing the trend variance and the variance due to the regression function between the distribution constants and yield *after removal of trend,* the error variance may get considerably refined. If this error variance is used as a measuring rod to test the variance due to trend, the latent secular changes may become apparent. This is illustrated with the cotton and rainfall data for Khandwa in Madhya Pradesh.

34. *Poultry egg production and its per capita availability in India*
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The Institute had undertaken, during Second and Third Plan periods, pilot sample surveys in typical tracts of the country with the objectives of evolving suitable sampling methodology for estimation of annual output of egg production and for study of poultry practices. While the date available from the pilot surveys as also those conducted by the State Animal Husbandry Departments utilising the techniques evolved by the Institute could provide an estimate of egg production only for the tracts covered and for the years during which the surveys were undertaken, a further study on the data has been made to build up an estimate of production for the country as a whole for the year 1966. In building up an all India estimate, it has been assumed that changes in the level of egg production per layer over a period of five years in different tracts were small. Similarly, since the Census data on the number of layers related to one point of time in the Census year, a suitable correction factor has been built up making use of the seasonal variations in the number of layers as estimated from the pilot surveys and this correction factor has been used to build up an estimate of layers during 1966. Estimates of standard errors of estimates of production have also been worked out.

An estimate of per capita availability of eggs for the different tracts as also at all India level has been worked out. In working out this estimate, the proportion of eggs utilised for hatching and those damaged was excluded.

35. *A study on national income and electricity consumption in India*
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In this paper, an attempt has been made to study the relationship between electricity consumption and net domestic product (NDP) at factor cost accruing from various sectors of the Indian economy. With the help of inter-correlation coefficients and by adopting abbreviated Doolittle solution, different values of C' matrix have been calculated, and finally, all the 15 values of partial correlation coefficients obtained and analysed. A few of the revealing inferences are :

(i) Confirmation of the existence of a very close structural relationship between the total NDP and its broad components, (ii) Emergence of inverse relationship between any two broad components of NDP with other factors of variation held constant, and (iii) Existence of poor and inverse relationship between electricity and the total NDP with other factors of variation held constant, and poor but positive relationship between electricity and the NDP accruing from various sectors with exception to other services.

With these eye-opening results it will not be advisable to apply partial regression analysis to the existing data on electricity consumption and NDP of India for prediction purposes.

36. *Studies on reproductive character of deshi cows of Orissa*
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The present investigation was taken as a routine survey in I.C.D. Project, Cuttack, Orissa, in eight Blocks trying in the delta region of Cuttack and Puri district. Studies on certain reproductive characters of the deshi cows of Orissa, *viz.*, age at first, second and third calving including calving intervals and length of dry periods were made.

Data were collected by the Bench-mark and Assessment survey conducted by I.C.D.P., and were utilised to study the age at first calving, inter-calving period and sex ratio. The average age at first calving was found to be 49.1 ± 0.5 months, and the average calving interval was 18.4 ± 0.7 months. The calving interval was not found to be influenced by the month or the season of calving.

37. *Plant population density and crop geometry studies with sunflower in drylands*
     K. Vijyalakshmi, N. K. Sanghi, & Ch. Krishnamoorty, Dry Farming Main Centre, and Dryland Agril. Project, Hyderabad.

Sunflower is a recent introduction and the available information on cultivation practices is largely based on irrigated trials. It has,

therefore, become necessary to investigate into the cultivation of the crop under dryland conditions. It is worthwhile to determine the optimum population which gives reasonably high yield during normal and above normal rainfall year with minimum chance of crop failure in years of subnormal rainfall. After optimum plant population, crop geometry is also an important consideration. The present study was conducted in these directions on sunflower variety EC 68415 with plant population density ranging from 18 to 207 thousands/ha on a sandy loam soil. Results of the investigations are discussed at length in the present paper.

38. Prediction of soil erosion on the basis of some soil properties

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Some of the properties of soil are responsible for causing soil loss along with run-off water. Efforts are made in this paper to find out an index of erodability by measuring some physical property or a group of properties of soil, and then fitting a suitable multiple regression equation involving these quantities. Method of least squares analysis is followed to obtain the best fitted regression equation for predicting the soil loss. Results obtained are discussed in details. For our investigations, soil losses under two per cent slope and under saturated condition of the soil have been taken up.

Soil properties considered are (i) day (X_1), (ii) pH(X_2), (iii) total soluble salts (S_3), (iv) plasticity index (X_4), and (v) structural instability (X_5). All these properties seem to have significant correlation with soil loss. The partial regression coefficients for X_3 and X_5 were significant. In fact, these two variables are found influencing soil losses to a large extent for, they are found to contribute 70·65 per cent variation out of the total variation contributed by X_3, X_4 and X_5.

39. Results of the sample survey conducted for estimation of milk production in Maharashtra state during 1970-71

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The Department of Animal Husbandry, Maharashtra State, had implemented an Integrated Survey Scheme for estimation of annual milk production and study of bovine keeping practices. The stratified random sampling design was adopted for the survey. Several results of interest have been obtained from the analysis of the data collected under the scheme. These, alongwith the technical details of the conducted survey, are discussed at length in the present paper.

To mention a few, we find that the annual estimated production of milk in the State is 327.8 thousand tonnes of cow milk. Also, per capita availability of milk as per human population of the State for the year 1971 (census) is seen to be 18 gm., and 40 gm. of buffalo milk, *i.e.*, total 58 gm. per day.

40. *A comparative study of different estimation procedures in sample survey on multiple characters through Monte Carlo methods*

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In the present paper three estimation procedures *viz.* sample means, ratio and regression have been studied for comparing their performance in estimating the population mean of a realistic field data taken from the surveys on fruits. The study for comparing these methods of estimation has been carried out by drawing independent samples from a population consisting of 415 orchards. The characters under study were number of trees of three varieties of mango and the total number of mango trees planted in the orchards. The auxiliary character for the study was the area reported for each orchard. It has been found that ratio method of estimation is superior to the regression method. Although, this looks contrary to the concept as propounded in the literature on sampling theory, that the precision of estimates provided by regression method is always more than that of the estimate provided by ratio method, the present study has however revealed that this statement is not true specially in the populations which satisfy the model :

$$y_i = ax_i + e_i \text{ with } E(e_i) = O \text{ and } E(e_i^2) = \text{const } x_i^g$$

where g is greater than one. In populations which we come across in agriculture it has been found (Mahajan 1971) that the above model holds good with values of g lying between 1·62 to 2·50. The study has revealed that for all the four characters under study, the precision of ratio estimate is more than that of regression estimate. Also, the percentage number of estimates provided by ratio method of estimation lying in a confidence interval of a given size was found to be consistently higher than those provided by either regression or simple estimator.