ABSTRACT OF PAPERS PRESENTED AT THE 26TH ANNUAL GENERAL MEETING HELD AT KALYANI IN DECEMBER, 1972

1. How Variant are Spot to Spot Rainfall Gradients *by G.M. Panchang, Retired Director, Central Water & Power Commission, Poona.*

Agricultural operations largely depend on rain depths received between critical dates of the season. Tabular presentation of mean daily rain depths data for fifteen successive ten-day unit periods yearly from 14th May to 10th October of the years 1960-71 individual-wise for 22 raingauge stations covering the 33,67,000 hectares (or 13,000 odd sq. miles) area of the lower central region of Bhima sub-basin in Maharashtra State discloses their most unregulated variations. No clearly discernible consistencies are evident between the years to years or stations to stations fluctuations, excepting broadly perhaps the seasonal pattern persisting of more concentrated rain depths falling in Septembers and Julys.

Series of ranks assigned to the 22 stations' data in order of respectively observed rain depth magnitudes do not help disclose tolerable parity of values either from year to year or from one unit period to another. In fact the Chi square values computed show the station to station variations are completely disparate despite a large measure of camouflaging concordant variations. The important finding thus cuts at one stroke the regionally graded variational theory of rain depths data, which has been commonly availed otherwise for weighting observed rain depths either by drawing time to time isohyetal curves or the all time constant Theissen polygons. Corroborative studies of extensive data of other regions have therefore to be undertaken on a priority basis.

2. The Increase in the Efficiency of Corrected Daughter Average Index of a Sire due to the use of an Auxiliary Character *by Prem Narain and K. S. Suchdeva, Institute of Agricultural Research Statistics, New Delhi.*

In a programme for the genetic improvement of dairy cattle, a major problem is to assess the breeding value of a sire. The

average performance of the daughters of a sire gives the most efficient procedure for judging this breeding value, since the correlation between this value and the average performance of sire's daughters tends to one as the number of daughters is increased indefinitely. In order to take into account the unequal production levels of the dams mated to a sire, the daughter's average for a character is usually corrected on the basis of the regression of daughter's performance on those of dams' for this character. Narain and Mishra (1971) showed that the efficiency of selective breeding on the basis of a given character could be increased if the selection is made on the basis of an index expressed as the deviation of the phenotypic value of this character from its expected value predicted with the help of a correlated auxiliary character. This approach has been used in this paper to further correct the corrected daughter average index for the given character with the help of an auxiliary character.

It has been found that the proposed index is more efficient than the corrected daughter average index whenever the phenotypic and genetic correlations between the characters are of opposite signs. When these correlations are of the same signs, the proposed index is more efficient provided C is less than 1 and phenotypic correlation is greater than $2C/(1 + C^2)$ where C equals the genetic correlation times the ratio of the heritabilities of auxiliary and the main characters. This has been further illustrated with the help of the data on four dairy cattle herds.

3. Asymmetrical Rotatable Designs with Blocks *by A.R. Das*, *Coordinated Research Project (Jute), J.T.R.L., Calcutta.*

Much light has not been thrown on the study of asymmetrical response surface (ARS) designs. Since the exploration of rotatable designs by Box and Hunter (1957), several authors have worked on the rotatable designs of symmetric type. But there are certain situations in practice, where it is desirable to include different number of levels for different factors. Keeping this end in view, Ramchander (1963) put effort to develop some ARS designs and obtained two series of such designs. However, Mehta and Das (1968) are the first to present the method of construction of response surface designs which are asymmetrical and, at the same time rotatable too. In this paper, an effort has been made to suggest a method of constructing asymmetrical rotatable designs split into blocks generated through operating orthogonal transformation on suitable symmetrical rotatable designs.

4. A Study of the Experimental Errors in Groups of Agricultural Field Experiments Conducted in Different Years *by R. K. Khosla, P. P. Rao and M. N. Das, Institute of Agricultural Research Statistics, New Delhi.*

Agricultural field experiments are generally conducted by the scientists of the State Agricultural Departments or Universities on different crops at a few selected Centres/Stations. These stations are, in general, selected so as to represent tracts of land having similar soil types and agro-climatic conditions. As such, the results obtained at the agricultural Research Stations can be assumed to be applicable to the entire tracts they represent. However, the results of a single experiment conducted in any particular year cannot be relied upon, as they are subject to the climatic conditions of the particular year which fluctuate from year to year at any place. Hence to make the inferences and draw conclusions which are reliable and applicable to at least a few years to come, it is necessary to repeat the experiment for a number of years with the same set of treatments adopting the same cultural and other agronomic practices. The treatments averaged over the years will give more stable information.

The statistical problems involved in combining the results of similar experiments repeated at different places in a year or during different years at the same place have been discussed at length by Cochran and Cox, Kempthorne etc. with certain basic assumptions, *viz.*

(*i*) The set of years (or places) of experimentation constitute a random-sample of a population of future years (or places).

(*ii*) The design adopted during each year is the same.

(*iii*) There is no missing value of the character under study in any experiment.

(*iv*) Treatments tried are identical in all the years.

(*v*) No. of replications adopted are the same in all the experiments. (However, procedure of combining the results of experiments with varying replications has been suggested).

(*vi*) The interaction components of all the treatments with years, have the same variance (In case they are not the same breaking up of the treatments into the groups whose interactions with the years are homogeneous was suggested).

However, some methods have been developed to combine the results of experiments with some common treatments though the procedures are quite complicated.

In the simple case of the experiments laid out in Randomized Blocks in uniform number of replications, error variances may be homogeneous or heterogeneous. Heterogeneity of error variances makes the pooled analysis difficult. However, presence of 'treatment × year' interaction, which may be verified by weighted analysis, will solve the problem of testing the treatment effects.

It is of common experience that the environmental conditions of different places are altogether different. It may, therefore, be expected that the experimental errors may prove to be heterogeneous. However, in the case of any particular place the environmental conditions do not vary much from year to year and hence we may not expect heterogeneity of error variances.

Efforts have been made in this paper to study the behaviour of experimental errors and presence of 'treatment × year' interactions in the case of groups of experiments conducted at different research stations in the State of Gujarat during different years of the period 1960-65. Homogeneity or otherwise of experimental errors has been studied with reference to different crops, types of experiments (*viz.* manurial, cultural, irrigational etc.) and broad soil types.

5. On a Method of Construction of Rectangular Designs *by C.K. Midha and A. Dey, Institute of Agricultural Research Statistics, New Delhi.*

The Rectangular association scheme was introduced by Vartak (1955 ; Ann. Math. Statist.) as follows :

There are $v = mn$ symbols arranged in an $m \times n$ rectangle. Two symbols are first associates if they belong to the same row of the rectangle, second associates if they belong to the same column and third associates otherwise. The parameters of this scheme are given by Vartak.

A design based on this scheme may be called a Rectangular design. In the present paper we give a method of construction of such designs. It is proved that the existence of two BIB designs with

parameters v', b', r', k', λ' and v'', b'', r'', k'', λ'' implies the existence of a Rectangular design with the following parameters :—

$v = v'v''$, $b = b'b''$, $r = r'r'' + (b'-r')(b''-r'')$,

$k = k'k'' + (v'-k')(v''-k'')$,

$\lambda_1 = r'\lambda'' + (b'-r')(b''-2r''+\lambda'')$,

$\lambda_2 = r''\lambda' + (b''-r'')(b'-2r'+\lambda')$

$\lambda_3 = \lambda'\lambda'' + (b'-2r'+\lambda')(b''-2r''+\lambda'') + 2(r'-\lambda')(r''-\lambda'')$,

$m = v'$, $n = v''$.

6. On a $2 \times 3 \times 4$ Factorial Design in Single Replicate *by R.K. Bohra, Institute of Agricultural Research Statistics, New Delhi.*

To economise in the use of resources as also to ensure flexibility it is desirable to obtain designs involving smallest feasible number of replications providing mutually orthogonal estimates of all the effects. Binet *et. al.* (1955) first obtained asymmetrical factorial designs in single replicate but in their designs the effects were not estimable mutually independently. Bohra and Das (1970) have given a technique of construction of various asymmetrical factorial designs in single replicate giving mutually independent estimates of all the affected interactions.

In the present paper, the use of the method of construction given by Bohra and Das (1970) has been made to construct single replicate confounded designs for $2 \times 3 \times 4$ factorials in different block sizes for the practical use of the experimenters. The mutual independence of affected interactions in different layouts has been tested and their efficiencies have been compared.

7. Growth of Minor Irrigation Projects and their effect on Agriculture in the District of Nainital *by S.C. Rai and M.N. Das, Institute of Agricultural Research Statistics, New Delhi.*

The present study deals with the development and utilisation of minor irrigation works and their effect on agriculture in the district of Nainital of Uttar Pradesh. All the state tube-wells constructed in the district upto March, 1972, were taken and from each tube-well 10 cultivators whose fields were irrigated during 1972 were selected at random for detailed enquiry.

It was observed that more than 80 per cent of private tube-wells and pumping sets were installed 'in the district during the period 1965-65 to 1971-72. This is due to the fact that a number of draughts in the state of Uttar Pradesh had focussed the attention of planners on the role of irrigation during the above period and irrigation and power development had received a significant share in the resource allocation. Regarding the utilisation of state tube-wells, it was found that most of the tube-wells were not uscd to their full capacity is the district. Various reasons for not utilising the tube-wells to full capacity as obtained in the present study are defective and inadequate irrigation channels, lack of electric power when required, uneconomical working and unsuitable location of tube-wells and indifference of illiterate and poor cultivators towards irrigation. A study on the change of cropping pattern and increase in yield rates of important crops after irrigation was also made.

8. On Construction of Partially Balanced *n*-ary Block Design *by A.K. Nigam, S.K. Agarwal and S.K. Mehta, Institute of Agricultural Research Statistics, New Delhi.*

In this paper we have evolved some methods for constructing partially balanced *n*-ary block designs using the incidence matrix of a PBIB design. The order of the associations scheme for the partially balanced *n*-ary block designs remains the some. Dualisation of balanced *n*-ary designs as well as of partially balanced *n*-ary designs in specific cases is seen to be partially balanced *n*-ary designs.

9. Use of Ancillary Information in the Analysis of Agronomic Experiments *by D.K. Agarwal & M.G. Sardana, Institute of Agricultural Research Statistics New Delhi.*

The paper contains the results of investigations dealing with estimation of gain in efficiency of statistical analysis by utilising the ancillary information on plant population in case of agronomic experiment on maize, jowar and bajra and the relative efficiency of some of the commonly used regression models for studying the underlying relationship between grain yield and some of the yield contributing biometrical characters with the help of the agronomic experiments on rice and wheat.

The data of 4 experiments in case of maize and jowar each and 3 experiments in case of bajra conducted during the period 1969-70 to 1971-72 under the All-India Coordinated Agronomic Scheme

(A.I.C.A.S.) were available for the study. It was observed that in 7 out of 11 cases the variation in plant population was not independent of treatment effects and as such these cases were excluded from the study. On the basis of the data of experiment no. 2 conducted in 1971-72 at Model Agronomic Centre (M.A.C.) at Talab Tilloo for maize, 1969-70 and 1970-71 at M.A.C. Indore for jowar and in 1971-72 at M.A.C. Rahuri for bajra, in which the variation in plant population was independent of the treatment effects and also 'F' ratio for testing treatments effects was found to be significant, it was observed that the use of ancillary information on plant population resulted in increase in efficiency of statistical analysis of grain yield data by 10 to 20 per cent.

The data of 9 experiments on rice, namely experiment No. 2 conducted at M.A.C. Bhubaneswar and Kathulia farm, experiment No. 5 at M.A.C. Kalyani and Rai Pur, experiment No. 6 at M.A.C., Raipur, Kathulia farm, Mangalore, Kalyani and experiment No. 12 (a) at M.A.C. Raipur, all conducted in 1969-70 and the data of 3 experiments on wheat, namely experiment No. 6 at M.A.C. Umrala an 1 experiment No. 14 at M.A.C. Jagudan and Umrala, all conducted in 1970-71 were available for the study. It was found that in most of the cases where multiple correlation co-efficient was significant, the percentage of variation in grain yield explained was the highest in case of the model where the independent and dependent variates were in original scales as against three other regression models which involved the independent and dependent variates in the logarithmic, square root and reciprocal scales.

10.   Relationship between Survival and Wool yield in Sheep *by V.K. Bhatia and P. Narain, Institute of Agricultural Research Statistics, New Delhi*

The data collected at the Sheep-breeding farm, Banihal-Reasi (Jammu and Kashmir) during 1952-66 under the I.C.A.R. Scheme for improvement of sheep and wool by crossing the Kashmiri ewes with Rambouillet rams, were processed and analysed in an attempt to study the probability of survival of an ewe upto a given clip and its relationship with initial wool yield. The results pertaining to proportion of ewes surviving upto a particular clip, the average wool yield of the Starter clip and of their survivors, the regression of proportion surviving on the starter clip yield and the relative survival coefficient obtained in respect of indigenous as well as half bred and three-fourths ewes.

It was found that the proportion of ewes surviving to various orders of clip continues to decrease with the increase in the order of clips for both the indigenous and cross-bred ewes. The 50 per cent survival was observed at about 11th clip in case of local type but it was as early as 8th clip in the case of half-breds and 5th clip in the case of three fourths. The average greasy fleece weight of ewes surviving to various order of clips showed an almost increasing trend with the increase in the order of clip in so far as the local type was concerned. No such definite trend was noticed in the case of cross-bred animals. It was further found in the case of local type of ewes that with almost 50 per cent survival the increase in wool yield over the yield of 2nd clip (Starter) was of the order of about 21 per cent.

With the local type of ewes it was found that in the initial four clips starting from 2nd, the ewes were not probably culled on the basis of their wool yield. The regression coefficient of proportion surviving on the 2nd Starter clip yield showed an increasing trend for the order of clips beyond 7th. The relative survival coefficient showed an increasing trend with the increase in the order of clip even in those cases where the regression coefficient somewhat fluctuated. In the case of half bred ewes the behaviour of regression coefficients was not very consistent, indicating thereby that the correlations between the early and late wool yields were not very high. For three fourth ewes, however, the regression showed an increasing trend for the 7th clip onwards which suggested significant correlation between initial and later wool yields.

11. A Unified Method of Construction of Second Order Rotatable Designs *by P.S. Rawat and A. Dey, Institute of Agricultural Research Statistics, New Delhi.*

Second Order Rotatable Designs (SORD) were introduced by Box and Hunter (Ann. Math. Stat. 1957). Various methods of construction of these designs are reported in the literature. All these different approaches of construction of these designs, however, can be looked upon as special cases of a general unified method. This paper makes an attempt in unifying the theory of construction of SORD. It has been shown in this paper that for any given number of levels, a SORD can always be constructed by choosing an appropriate Partially Balanced Array. Conditions which must be satisfied by these arrays in order that they yield SORD have been derived.

12. Economics of Fertilization of Maize under Cultivators' Conditions *by V.N. Iyer and M.G. Sardana, Institute of Agricultural Reasearch Statistics, New Delhi.*

Three types of studies were made on the data of 689 Simple Fertilizer trials on Cultivators' fields with local varieties of maize conducted under All-India Coordinated Agronomic Experiments Scheme, during the period 1967-68 to 1969-70 in 7 districts.

The first study relates to estimation of average response to fertilizer treatments over years. The distribution of profits obtained by farmers due to fertilizer application is studied in the second part. The third part deals with the estimation of optimum combinations of plant nutrients along with its economics.

The results showed that while response to nitrogen at 120 kg N/ha was significant in all the districts, response to phosphorus at 60 kg P_2O_5/ha was significant in four districts and that of potassium at 60 kg K_2O has (over a basal dose of $N_{120}P_{60}$) was significant only in two districts. Generally the response obtained to the different plant nutrients was of a lower order and not very economical under the prevailing price of the produce and the cost of fertilizers. Interaction between the effect of nitrogen and the effect of phosphorus was absent in majority of the districts.

A study of the distribution of profits obtained by the farmers due to application of different plant nutrients showed that farmers who had applied nitrogen and phosphorus together or alongwith potassium obtained more profit in comparison to those who applied nitrogen alone.

The study of optimum dose of nitrogen and phosphorus showed that within the levels of nutrients tried the responses were generally linear in all the districts except Warangal where the optimum combination of nitrogen and phosphorus was found to be 47 and 40 kg/ha respectively. At this optimum combination the expected response was about 395 kg/ha which will give a profit of about 21 paise for every rupee of investment on fertilizer.

13. Influence of Organised Milk Supply Schemes on Production and Allied Aspects of Commercial Milk Producers *by K.C. Raut and Shivtar Singh, Institute of Agricultural Research Statistics, New Delhi.*

A number of dairies have been set up in the country and more milk supply schemes are envisaged during the plan periods. The organised dairies should take all necessary measures to lift as much milk as possible from the milk shed area so as to run the plant to full capacity and thereby attaining maximum efficiency. In order to increase the procurement, the producers should be told about the assured market and guaranteed price of milk being offered by the milk supply schemes throughout the year. In addition, it should provide some incentives to the suppliers. The producers would chan- nelise their produce through the organised dairy only if they are convinced about the advantages and profitability.

A comparative study has been made to show the milk produc- tion and its related characters in the supplying and non-supplying areas in Krishna delta area (Andhra Pradesh). The study particularly throws light about the production and utilization of milk in the com- mercial households which supply milk to the organised dairy and those which sell milk either directly to the consumers or through middle men. A comparative economics of milk production has also been worked out for these categories of producers in the area.

14.   On Comparison of some Fractional Plans for 2^n Factorials, *by A.K. Sarkar and A. Dey, Institute of Agricultural Research Statistics, New Delhi.*

Many fractional factorial plans for 2^n factorials are available in literature. In many situations, the experimenter is interested only in the estimation of main-effects and in such a case, it is possible to reduce the size of the experiment to a great extent. Such factorial plans which permit the estimation of all main-effects only are called main-effect plans.

In the present paper, an attempt has been made to compare the efficiency of various main-effect plans in order to enable an experimenter to make a suitable choice. The comparisons have been made on the basis of trace, generalised variance and largest latent root criteria, considering the dispersion-matrix of the estimated main-effects in each case.

15.   An Application of the Theory of Runs to the problem of Occurrence of Droughts in Relation to Crop Production *by P. N. Bhargava, Prem Narain and Asha Pradhan, Institute of Agricultural Research Statistics, New Delhi.*

The problem of the occurrence of droughts during the period of the growth of crop is very important for adjusting the crop season. Although, studies have been conducted in the past on the occurrence of droughts but these have all been related to hydrology. In the case of agriculture, however, the occurrence of a dry spell during a short interval of one month rather than the whole year is required to be studied. With this end in view, the monthly rainfall data spread over 43 years in respect of Raipur district has been analysed with particular reference to paddy. For each of the months, June, July, August and September which are crucial for paddy, distributions of rainfall have been fitted. All these distributions have been found to be normal. With the help of these distributions, criteria for normal rainfall and scanty rainfall have been fixed for each of the months. Using these criteria probability of a particular month being dry is found. With the help of the probabilities, mean recurrence times of the dry runs of lengths 1, 2 and 3 have been found using the theory of runs. Also, taking the whole period from June to September, distribution of rainfall has been fitted and similiar mean recurrence times have been calculated. The results indicated that the mean recurrence time of run of length one is around 4·2 years, whereas corresponding figures for runs of lengths 2 and 3 are approximately 21 years and 27 years respectively. These results hold good for monthly periods as well as for the period from June to September as a whole.

16. On Sampling from Fleeces for Assessment of Wool Quality *by B. Marutiram, U.G. Nadkarni and T.B. Jain, Institute of Agricultural Research Statistics, New Delhi.*

Indian wools, in general, present considerable variation in quality characters due to different breeds growing varying qualities of fibres and secondly the quality differing within a sheep from region to region. A proper method of sampling from a fleece to assess the quality of wool will provide a basis for all scientific studies on fleece quality. An investigation for evolving a suitable sampling technique for the purpose was carried out by I.A.R.S. and covered Niligiri, Nilgiri × Romney Marsh, Chokla and Polworth × Rampur Bushair crosses of sheep maintained at the farms in Tamil Nadu, Rajasthan and Uttar Pradesh.

The data pertained to various wool characters viz., fibre diameter, fibre length, medullation etc. of samples drawn from different anatomical regions and by three composite sampling procedures. It was found in majority of cases arising from the combinations of

breeds, age groups and characters that (*i*) between sheep variation, (*ii*) region to region variation and (*iii*) sheep×region interaction variation were present.   Also in general, overall means obtained by regional sampling and those by composite sampling did not differ. Though later is the case, regional sampling should be resorted to when regional means for quality characters are to be estimated for grading of wool.

The paper gives, for different flock sizes, the number of sheep required for estimating mean quality characters with 1% and 5% S.E. of mean by regional and composite sampling and also the sub-sampling rate for observed flock size.

17.   Optimum Age at Disposal of Cow Calves *by K.V. Sathe, Institute of Agricultural Research Statistics, New Delhi.*

The study of economics of calf rearing is important from the view of devising ways and means to lower the cost of rearing and thus encourage the people in rural areas to take up this profitable business on scientific lines.   This will indirectly give an impetus for improved milk production.   Up till now no systematic work has been done on scientific lines to study the relation between the cost of rearing and the profits at disposal.

An attempt has been made to study the relation between the cost of rearing and the price fetched at disposal of male cow calves by using the data collected in the scheme "Study of the economics of raising cattle and buffaloes, Hissar, 1963-66" conducted by the Institute of Agricultural Research Statistics, New Delhi.

18.   Single Locations *vs* Group Locations Variations of Unit Period Rainfall Depths *vis a vis* of Agricultural Operations *by G.M. Panchang, Retired Director, Central Water* and *Power Commission, Poona.*

Failure of rains during agriculturally critical times is liable often to adversely affect crop yields.   Such failures occasionally cover small patches alone or may be even spread over large regional zones. Examination of daily and 10 day unit periods rain depths data of the years 1960-1971 for 22 raingauges in Maharashtra State's Bhima sub-basin discloses that apart from seasonal and year to year variations present in rainfall vagaries, raingauge station to station variations are even more pronounced.   It is incumbent, therefore, to restrict applications of the usual declarations of any impending scarcity conditions etc. to relevant individual raingaugewise areas alone.

19. Economic Analysis of Fertilizer Trials on Bajra on Cultivators' Fields *by Pranesh Kumar and M.G. Sardana, Institute of Agricultural Research Statistics, New Delhi.*

In this investigation, three types of studies were undertaken with the help of the data of simple fertilizer trials on cultivators' fields on locally improved varieties of bajra conducted in Ahmedabad, Jamnagar and Hissar districts during the period 1967-68 to 1969-70 under the All-India Coordinated Agronomic Experiments Scheme. The first study related to the estimation of average responses to the various treatments over the period of years. In the second study, the distribution of profits obtained on individual fields by application of various fertilizer treatments, was studied. The last part of investigation related to working out the optimum combination of nitrogen and phosphorus for bajra crop.

The response to nitrogen was found to be significant in Ahmedabad and Hissar districts and the response to phosphorus could attain the level of significance in Hissar and Jamnagar districts. With treatments tried, the response to potassium could be studied only over a basal dose of nitrogen and phosphorus and such a response was found to be significant only in Ahmedabad district when potassium was applied at 15 kg K_2O/ha. When the level of nitrogen was raised from 30 kg N/ha to 60 kg N/ha, the additional response was about 60 per cent of the response obtained with 30 kg N/ha. In case of phosphorus application in Jamnagar district, when the level of phosphorus was raised from 15 kg P_2O_5/ha to 30 kg P_2O_5/ha, the additional response was 1·5 times the response obtained at 15 kg P_2O_5/ha. In Ahmedabad district, with a basal application of 60 kg N/ha and 30 kg P_2O_5/ha when the level of potassium was raised from 15 kg K_2O/ha to 30 kg K_2O/ha, no additional response was observed. There appeared to be no interaction between the effect of nitrogen and the effect of phosphorus.

In second study, it was observed that the farmers applying all the three nutrients namely nitrogen, phosphorus and potassium jointly were likely to get more profit in comparison to those who applied nitrogen alone.

In the study of response surfaces of nitrogen and phosphorus, it was found that there was no interaction between the effect of nitrogen and the effect of phosphorus in any of the districts. Thus the optimum doses of nitrogen and phosphorus were computed from their corresponding response curves. The optimum doses and corresponding responses for phosphorus were found to be 22·4 and 20·2 kg/ha

and 157·3 and 213·8 kg/ha respectively in Ahmedabad and Jamnagar districts. By the application of phosphorus at optimum level, a farmer may expect to get about 21 per cent profit in Ahmedabad as against 17 per cent in Jamnagar. The response curve of phosphorus in Hissar and those of nitrogen in all the three districts were found to be linear in the range of levels tried and hence the optimum doses of nutrients could not be computed.

20.   Estimation of Annual Egg Production and Poultry Keeping Practices in Maharashtra State, during 1971-72 *by A.D. Godbole and S.M. Patel, Department of Animal Husbandry, Maharashtra State, Poona.*

In the survey conducted during March, 1971 to February 1972 a multistage stratified random sampling design was adopted. The State was divided in 4 strata excluding greater Bombay District. The data was collected from 75 randomly selected clusters of 2 villages each; selected in proportion to poultry population in each stratum and afresh for every season.

The important results are as follows :

Amongst the birds observed, 9·28% were deshi birds and 8·12% were of improved breeds in rural areas. In 1966 Livestock Census the percentage of improved breeds in rural areas was 7·95%.

The estimate of annual egg production in the State during 1971-72 was 68·14 crores with per capita availability of 13·5 eggs per year as per 1971 Census.

It was estimated that 48.90% eggs were used at home for table purpose, 26·66% eggs were sold for table purposes, 21·92% eggs were used at home for hatching and 1·13% eggs were sold for hatching and remaining 1·39% was spoilage.

Amongst the households rearing poultry layers 70.25% households reared 1 to 3 layers and contributed 36·38% of eggs in total production of eggs which was a maximum contribution in total production. This shows that the contribution in total egg production by the small poultry keepers having 1 to 3 layers is maximum.

Amongst the total birds observed 6·53% died due to diseases and 1·66% consumed at home.

21.   Agricultural Survey of Madhya Pradesh *by B. L. Deverya, Directorate of Economics & Statistics, Madhya Pradesh, Indore*

Two types of studies have been made on the data of Agricultural Statistics relating to the State of Madhya Pradesh—the first one relating to the period 1959-60 and the second 1961-62 to 1970-71. The comparative efficiency in agriculture in different regions of M. P. in respect of different categories of crops is discussed in this paper. The calculations are made on the assumptions that the farmers from various quarters of this vast province are putting in the maximum inputs under the existing conditions. A special survey on the agricultural activities of M. P. was conducted by the Directorate of Economics & Statistics in 1959-60 on the basis of data received from Agricultural Department, District Statistical units and those supplied by the Directorate of Land Records. The productivity per unit area (hectare) based on the districtwise yield relating to various levels of agricultural output has been worked out at current prices and also at 1952-53 prices, on one hand, and Index numbers of area, production, productivity and form prices, etc. have been calculated by taking 1956-57, as base, on the other. The results obtained have been discussed in this paper. Suggestions have also been made for collection of relevant data on agriculture in the State.

22. Construction and Analysis of Partial Diallel Crosses— Extended Triangular Designs *by Prem Narain and C. Subbarao, Institute of Agricultural Research Statistics, New Delhi.*

In complete diallel crosses, with n inbred lines, there are $n(n-1)/2$ crosses excluding selfs and reciprocal crosses. As n increases, this number increases rapidly. With limited resources, it may not be always possible to raise all the crosses. In such cases, one can only raise a sample of all possible crosses among the inbred lines. Such diallel crosses are known as partial diallel crosses. Fyfe and Gilbert (1963) constructed such crosses with the help of Triangular Designs in which the number of lines is of the form $p(p-1)/2$ where p is an integer. In the present investigation, partial diallel crosses have been constructed and analysed when the number of inbred lines is of the form $p(p-1)(p-2)/6$, where p is an integer greater than 3. Such plans have been termed as Extended Triangular Designs and have been studied for $n=20$ and $n=35$. It has been found that the average variances for comparing two *g.c.a.*'s in these designs are less than that of the corresponding Circulant Designs given by Kempthorne and Curnow (1961) with same values of n and s, thereby proving that the extended Triangular Designs are more efficient.

23. On some replacement patterns in multistage successive sampling *by A.K. Srivastava and Shivtar Singh, I.A.R.S., New Delhi.*

In the present paper two commonly adopted replacement patterns in case of multistage successive sampling are compared under a generalised set up of product model of correlations for estimating the change between two occasions. The two replacement patterns considered are as follows :

(1) The same sample fraction np of p.s.u.'s is retained on all the occasions and each time it is supplemented by a fresh sample fraction nq, selected at random from the units not used upto that time. (2) The p.s.u.'s are not retained for more than two occasions. A sub-sample of np p.s.u.'s out of n p.s.u.'s from the first occasion are retained for second occasion and is supplemented by a fresh sample of nq p.s.u.'s. On third occasion a sub-sample of size np is selected out of nq fresh units of the second occassion. On subsequent occasion same method is followed. In both the patterns selected secondaries are retained along with the p.s.u.'s. It has been shown that both the patterns are equally good from precision point of view for estimating the change between two occasions.

24. 'On Use of Linear Regression Estimators in Ratio and Product Method of Estimation' *by P.C. Gupta, Rajasthan University, Jaipur.*

If there are more than one auxiliary variables highly correlated to character under study, they can be used to improve the efficiency of the estimates of population mean or total. One of the auxiliary variables can be used to build up the linear regression estimates, for the population mean or total of the character under study and the other auxiliary variable. These estimates, then, used to build up the ratio (product) estimates for the population mean or total of the character under study. The proposed estimate is of the following form;

$$\overset{\wedge}{\overline{Y}}_R = \frac{\overline{y}_{1r}}{\overline{z}_{1r}}\overline{z}$$

$$\overset{\wedge}{\overline{Y}}_P = \frac{\overline{y}_{1r}\ \overline{z}_{1r}}{\overline{Z}}$$

where

and

$$\overline{y}_{1r}=\overline{y}_n+b_{yx}(\overline{X}-\overline{x}_n)$$

$$\overline{z}_{1r}=\overline{z}_n+b_{zx}(\overline{X}-\overline{x})$$

The variance of these estimates, to first degree approximation, are always less than conventional ratio (product) estimates. Further these estimates are compared with conventional estimates taking suitable linear cost functions. The results are also extended in case when double sampling is employed.

25. Two Dimensional Varying Probability Sampling Without Replacement *by Sukhdev Sharma and G. Sadasivan, I. A. R. S , New Delhi.*

In the present paper, the results of Brewer (1963) on varying probability sampling has been extended to the case of two dimensional populations. The extended model can be solved for revised probabilities. When these revised probabilities are used for selection the inclusion probabilities work out to be proportional to the size of the unit, under the assumption that $Z_i W_k = X_{ik}$ where Z_i is the value of the first ancillary character along ith row and W_k is the value of the second ancillary character along the kth column, x being the composite character on which the unit is selected. Comparing the variances of Brewer's type estimate in the two dimensional case against the corresponding estimate in the undimensional case, it is observed that the two dimensional approach reduces the variance for the sample size two, under the conditions that the revised probabilities satisfy the relation $R_i \leqslant (P^*_{ik}/P_{\cdot k}) \leqslant 1$ where R_i is the initial probability for selecting ith row, $P_{\cdot k}$ is revised probability for selecting kth column in the two dimensional case, and P^*_{ik} is the revised probability in the undimensional case.

26. Non-response in successive sampling *by R. Singh, I.A.R.S , New Delhi.*

For population which are subject to change from time to time, it is necessary to repeat surveys at some regular interval of time. Jesson (1942) initiated the use of auxiliary information available on previous occasion to improve the estimate for the current occasion. Patterson (1950), Tikkiwal (1955), D. Singh (1968) and others have contributed to the theory of successive sampling.

But the failure to obtain response from every member of the sample on any occasion will invalidate the procedures outlined so far and bias will be introduced in the estimator. In theory it can be eliminated by repeated calls but in practice it is seldom possible.

Bartholomew (1961) has suggested method to obtain unbiased estimate after two calls. In this paper the purpose is to use this technique for the case of successive sampling on two occasions to obtain unbiased estimate in the presence of non-response from some units in the sample.

27. A Study on the Efficiency of Systematic Sampling in estimating the Lactation Yield of a Cow *by Vinod Kumar Gupta and M. Rajagopalan, I. A. R. S., New Delhi.*

Systematic sampling is often practised for convenience in forest inventory surveys. In many livestock farms also, milk yield of cows is stripped once in a week, primarily for lessening the work load. Usefulness of systematic sampling for estimating the lactation yield of a cow has been examined by many authors. It was concluded that in general, systematic sampling is more efficient than the comparable procedures of stratified random sampling and simple random sampling. But no general conclusion could be drawn as the relative efficiency of the different systems depend upon the structure of the population. One way to deal with a problem is to consider a population as a random sample of a super population following a given model. One such model for auto-correlated populations was suggested by Cochran (1946). The object of this dissertation is to study the applicability of this model for the daily milk records of a cow in a lactation on the basis of which a sample could be drawn for estimating the lactation yield of a cow. For this purpose daily milk record of first lactation for ten cows maintained at Institute of Agriculture, Anand, Gujarat, were analysed for comparing the efficiency of systematic sampling with stratified and simple random procedures of sampling using the above model. Even though the conditions of the model are satisfied, it was found that simple random sampling is surprisingly found to be more efficient than stratified sampling. However, systematic sampling is found to be more efficient than the other two procedures in most of the cases. It can, therefore, be concluded that systematic sampling could be used, in general for estimating the lactation yield of a cow.

28. On PPS Systematic Sampling *by S. Mohanty, College of Agriculture, O. U. A. T., Bhubaneswar*

Given a population of N units, it is required to draw a sample of n units in such a way that the probabilyty of the ith unit to be

included in the sample is proportional to its size X_i. From the alternative methods of achieving this, one is so called systematic sampling method developed by Madow (1949). The unit in the population are arranged at random, their X_i accumulated and a systematic selection of n elements is made by selecting a random number less than or equal to k,

$$\left(= \sum_{i=1}^{N} X_i/n \right).$$

In a paper Hartley and Rao (1962) gave an asymptotic estimation theory (for large N) associated with the method as the evaluation of inclusion probability of a pair of units presented formidable difficulties. This estimation procedure can be applied only when $X_i \leqslant k$ (for all i). However, when $X_i \geqslant k$ (for some i), we have here developed a procedure of evaluation of different inclusion probabilities, which makes

it possible to find $V(\hat{Y})$ easily for any N. This method can also be applied easily for the usual systematic pps sampling ($X_i \leqslant k$, for all i).

29. A Study of a Minimum Variance Unbiased Estimator *by I.C. Sethi, I.A.R.S., New Delhi.*

Ancillary information is a part and parcel of Modern Sampling theory. It has been used in different forms to increase the reliability of estimates by making use of inherent correlation between ancillary information and variate under study.

The most common estimators are Ratio and Regression estimators. It has been said that Ratio estimators is more biased compared to regression estimator because intercept is ignored in the former, but we find that

$$\log \bar{y}_R = \log \bar{y}_n + (\log \bar{X}_R - \log \bar{x}_n) \qquad \dots (1)$$

is nothing but ratio estimator which is comparable to a difference estimator of the form

$$\bar{y}_D = \bar{y}_n + (\bar{X}_N - \bar{x}_n)$$

From (1) it can be inferred that ratio estimator (or log difference estimator with $k=1$) is biased because $\log \bar{y}_n$ is not an unbiased

estimate of $\log \bar{y}_N$ and $\log \bar{x}_n$ is not an unbiased estimate of $\log \overline{X}_N$. With these things into view log linear estimators are proposed of the form

$$\log \overset{\wedge}{\bar{y}}_{uR} = \log C + \log \bar{y}_n + (\log \overline{X_N} - \log \bar{x}_n)$$

$$\log \overset{\wedge}{\bar{y}}_{uR*} = \log \bar{y}_n + p (\log \overline{X}_N - \log \bar{x}_n)$$

$$\log \overset{\wedge}{\bar{y}}_{MuR} = \log C + \log \bar{y}_n + p (\log \overline{X}_N - \log \bar{x}_n)$$

where p and c have been chosen in such a way that $\overset{\wedge}{\bar{y}}_{uR}$, $\overset{\wedge}{\bar{y}}_{uR*}$ or $\overset{\wedge}{\bar{y}}_{MuR}$ are unbiased, minimum variance or unbiased and minimum variance estimators as may be demand of the situation.

30.   Further Developments in Snowball Sampling Technique *by S.K. Aggarwal and G. Sadasivan, I.A.R.S., New Delhi.*

In this paper Snowball Sampling procedure has been extended to the case of continuous character for the case $s = k = 1$ where s represents the no. of stages and k the no. of individuals named by any individual at any stage. We have found the different estimates of mean of a continuous character along with the variances and also studied the extent to which these estimates were influenced by the number of mutual relationships in the population. We have studied the variances in two different cases of Snowball Sampling (*i*) when repetitions are included (*ii*) when repetitions are not included. We have also found an expression for lower and upper bounds for the difference between exact and approximate variances when repetitions are not included.

31.   Cluster Sampling in Conjunction with Multivariate Extension of the Ratio Method of Estimation *by G.K. Mishoo, Bureau of Economics & Statistics, Bhubaneswar.*

Olkin (1958) while discussing the use of two auxiliary variables to increase the precision of Ratio Estimate, has suggested an estimate of the type

$$\bar{y}_w = w_1 \bar{y}_{r1} + w_2 \bar{y}_{r2}$$

where $\bar{y}_{r1} = (\bar{y}_n / \bar{x}_{1n}) \bar{x}_{1N}$, $\bar{y}_{r2} = (\bar{y}_n / \bar{x}_{2n}) \bar{x}_2$

and (y_i, x_{1i}, x_{2i}) $i=1,2,\ldots,n$ is a simple random sample y being the variable under study and x_1 and x_2 the auxiliary variables. He has shown that this estimate will be more efficient than the estimate based on the simple arithmatic mean if

$$\frac{\rho_{xy}}{1+\rho_{x_1x_2}} \times \frac{C_y}{C_x} > 1/4$$

where ρ_{xy}, $\rho_{x_1x_2}$, C_x and C_y have their usual meaning.

In this paper it has been shown that use of cluster sampling in conjunction with Multivariate Extension of the Ratio Method of Estimation will provide a more efficient than that suggested by Olkin. The case when the sample is selected with varying probability of selection has also been discussed.

32. Quadratic Regression Estimator in Successive Sampling *by Padam Singh, I.A.R.S., New Delhi.*

It is desirable to repeat surveys at some regular interval of time for population which are subject to change from time to time. The use of auxiliary information available on previous occasion to improve the estimate for the current occasion was initiated by Jesson (1942). Further work in this direction has been done by Patterson (1950), Tikkiwal (1955), D. Singh (1968) and others.

In the present paper, the use of quadratic regression estimate in place of linear regression has been examined and it is found that the new estimate is always more efficient than the usual regression estimate for symmetric populations.

33. Bias in the Estimation of Proportion in a Single Question Model in Mail Survey *by G. Sadasivan and B.C. Barah, I.A.R.S., New Delhi.*

For small scale enquiry mail surveys are very convenient and economic but the main problem in the cases are non-response and response bias. Non-response in the surveys are due to : (1) non-availability of respondents; (2) refusal to give information; (3) non-coopera tive attitude of informants; (4) misunderstanding of questions. In the present article we are presenting simple models for estimation of proportion of non-response, its variance and optimum sample size.

Further, Double Sampling procedure is used for solving the same problem for the case of variable characters. The bias for estimation of mean due to non-response is estimated along with its error under this model. The optimum sample size using a suitable cost function is also discussed. Some alternative procedures for estimating non-response for double sampling when first sample is selected independently of the second is also discussed. We have also used successive sampling technique for estimating non-response and response-variation with time. From the study we find that the estimate of time variation using the composite sample is more precise than the estimate from the corresponding matched portion. In a single question model of mail survey we have found the bounds for bias 'b' in the estimate of proportion of individuals who respond. We have also discussed double sampling procedure for single question model. The number of first sample, second sample and number of common units to be used under this design is also derived. Under this situation we have also discussed the model for optimum sample size because the normality assumption for the distribution of bias may not be valid. The optimum sample size under this with appropriate cost function, is also developed.

An iterative solution for optimum sample size without using cost function has been attempted on the computor and the results tabulated. The table can be used for deciding optimum sample size in certain ranges.

34. Choice of Strata for Estimating Sheep Population *by R.P.S. Malik, I.A.R.S., New Delhi.*

Before a sample survey is launched, the first consideration is to specify the number and suitable strata into which the population units could be grouped, stratification could be done on the basis of geographical contiguity of the units, or on the basis of their sizes or both. The problem of demarcating suitable strata for estimating sheep population is dealt within this paper. For this purpose the sheep population in the tehsils of Rajasthan as enumerated in the Livestock census, 1956 was considered. The different methods for demarcation of stratification points were examined and the efficiencies for estimating total sheep population for the state when these methods are adopted, are worked out. The comparative performance when the natural divisions of the state are taken as strata is also studied. The results indicate that $\sqrt[3]{f}$ method, in general, fares better than the other procedures.

This method was adopted, for construction of strata and the estimate of total sheep population as in 1961 census year was obtained, using different methods of estimation namely, simple estimate, ratio and regression estimates. It is shown that $\sqrt[3]{f}$ rule of construction of strata using regression method of estimation provides an estimate of total sheep population with smallest standard error.

35. On the Non-existence of Second Order Necessary Best Estimation in T_4, T_5 and T_6 Classes *by A.K. Yogi and P.C. Gupta, Rajasthan University, Jaipur.*

The criterion of necessary best estimators in linear classes of unbiased estimators was introduced by Prabhu Ajgaonkar (J.A.S.A., 1965). Later he (Sankhya, 1969) defined the necessary best estimators of various orders and pointed out that the minimum variance linear unbiased estimator (MVLUE) is a necessary best estimator of order N, the size of the finite population. In the same paper he showed that the necessary best estimator of order two exists in the most general class of unbiased linear estimators. Rao (J.I.S.A.S., 1971) remarked that Prabhu Ajgaonkar's (1969) result that Y_{ht} is also the necessary best estimator of second order is incorrect. Hedge (J.A.S.A., 1967) proved the Horvitz-Thompson's (J.A.S.A., 1962) estimator is the necessary best estimator of order one in all the classes of linear unbiased estimators. Prabhu Ajgaonkar (Metrika, 1970) has established the existence of MVLUE in T_4 class under certain specified probability systems and not otherwise. But Tikkiwal (unpublished paper 1971) in general proved the non-existence of MVLUE independent of population values in T_4 class.

In the present paper, we have examined the non-existence of second order necessary best estimators, independent of population values in T_4, T_5 and T_6 classes of unbiased linear estimators. Further it has been shown that in all these classes the necessary best estimator of order one exists and it is the same as given by Horvitz and Thompson (1952).

36. Stratification in Surveys on Fruit Crops *by Miss R. Sethumadhavi, I.A.R.S., New Delhi.*

An investigation of stratification is reported for a universe with high positive skewness. The choice of stratification variable, the method of constructing strata, the sample allocation, the number of

strata and the optimum sample size are considered. Comparisons are made among four types of allocation in combination with the corresponding optimum stratifications. Gains from stratification are examined for the two estimation variables. Illustrations utilised data collected in the sample survey conducted on temperate fruit crops in Mahasu district of Himachal Pradesh during the year 1965-66. However, the findings apply to the stratification of other populations having similar distribution function.

37. A Note on Collapsing of Strata *by I.C. Sethi, I.A.R.S., New Delhi.*

There are many instances when we have to collapse strata in order to estimate sampling variance. In case of deep stratification we sometimes select one unit or *psu* from each stratum as a result of which sampling variance cannot be estimated as such. For such a situation Cochran (1963) suggested a technique called the method of "Collapsed Strata" for estimating $V(\bar{y}_{st})$ which consists in grouping the strata in pairs such that two strata in pairs should have equal mean and size. As these assumptions are too restrictive, Seth (1966) suggested a modification to Cochran's procedure. Mohanty, S. & Singh, P. (1969) used ancillary information for collapsing of strata.

The procedures used by the above mentioned workers over-estimate's sampling variance particularly in the situation where we have selected more than one unit from each stratum but are compelled to collapse the strata for immediate estimation of sampling variance. In the present investigation an attempt had been made to estimate sampling variance when stratification is of a specified pattern or when we have knowledge of an ancillary information.

38. A Procedure for Designing Controlled Random Sampling-I *by M.S. Avadhani I.A.R.S., New Delhi & B.V. Sukhatme, Iowa State University, Ames.*

The problem of controlled sampling is presented in a form suitable for mathematical tractability. The well known systematic sampling with unequal probabilities has been utilised together with linear programming technique to develop an optimum controlled sampling design. A simple procedure of controlled sampling, which ensures elimination of the non-preferred samples altogether, is then proposed. An illustrative example is worked out to demonstrate the technique. Working out estimate of the population total, together with its precision, is also discussed.

39. On Rao, Hartley and Cochran's Method of Sampling *by Ravindra Singh and Lalit Kishore, Punjab Agricultural University, Ludhiana.*

Rao, Hartley and Cochran (1962) have given a simple procedure of selecting a sample with probability proportional to size (*pps*) and without replacement. It is claimed that the unbiased estimator of population total corresponding to this scheme of sampling is always more efficient than the usual unbiased estimator of the total in *pps* with replacement sampling. In this paper, we prove the inadmissibility of this claim when the cost aspect of the problem is also taken into account.

40. Use of Transformation in PPS Sampling with Replacement *by V.K. Sharma and M.N. Das, I.A.R.S., New Delhi.*

Auxiliary variates are used to improve the precision of the estimates in sample surveys through ratio and regression methods of estimation and also through the PPS sampling. The success of these techniques depends mainly on the degree of association between the variate under study and the auxiliary variates. While selecting the auxiliary variate, importance is given only to the magnitude of the correlation between the variates but it may so happen that given two auxiliary variates each having the same correlation with the variate under study, still the precision of the estimates might differ when the two auxiliary variates are utilized separately. Mohanty and Das (1971) have shown that the bias and mean square error of the estimate can be reduced by suitably transforming the auxiliary variate in the case of ratio method of estimation. In the present investigation an attempt has been made to study the effect of such a transformation in case of PPS sampling with replacement. It has been observed that when suitably transformed auxiliary variate is used as a size measure, both at the selection and estimation stages, the estimate is found to be more efficient.

41. A Comparative study of different Approaches of Stability Analysis *by B.K. Makin,@ R.B. Mehra@ and I.C. Sethi**

Genotype × environment interaction is an important component of the phenotypic variability observed in plant populations and as

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such of great importance to the breeder in developing improved varieties. With the realisation of the importance of such interaction various approaches have been developed for measuring this component. One such statistical approach is the phenotypic stability analysis developed by Yates & Cochran (1938) and used by Finely & Wilkinson (1963) and modified by Eberhart & Russel (1966), Perkins & Jinks (1968) and Freeman & Perkins (1971) to study the stability in performance of varieties over several environments, A comparative study of the last three approaches for estimating the stability of different varieties of Bengal gram in relation to varieties × environment has been made.