IARS ·

STATISTICAL NEWSLETTER

Volume III	January-March, 1977	Number 1

ICAR

Compiled and prepared
by

R. K. KHOSLA

D. P. SINGH   R. S. KHATRI
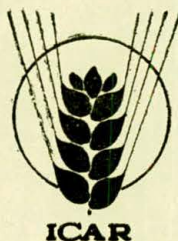
S. D. BAL   and   D. S. ANEJA

PREFACE

This is the ninth issue of *IARS Statistical Newsletter* and covers the activities and allied information in respect of this Institute during the quarter Januray to March, 1977.

I hope this Newsletter has been proving useful for the Agricultural Research Statisticians and other users. I would welcome and appreciate any comments and suggestions for its improvement in the subsequent issues.

I am thankful to all the officers and other members of the staff of the Institute who supplied the requisite material for this issue of the *IARS Statistical Newsletter*. I am also thankful to my colleague, Dr. Prem Narain, Senior Professor for going through the material.

<div align="right">

D. SINGH
DIRECTOR
INSTITUTE OF AGRICULTURAL
RESEARCH STATISTICS
NEW DELHI-110012

</div>

CONTENTS

1. TECHNIQUES OF PREHARVEST FORECASTING OF CROP YIELDS BASED ON BIOMETRICAL CHARACTERS

A reliable estimate of crop production, if available in advance of harvest, will be of considerable help in taking policy decisions, among other things, on import-export, prices, storage and marketing of agricultural commodities. Under the present system of crop forecasting, preharvest estimates of yield rates are obtained on the basis of visual observations and impressions of agricultural and land revenue officials. In making early forecasts, normal yield and condition factors are taken into account. The determination of normal yield involves an element of subjectivity. Therefore, there is a great need to develop an objective method of obtaining preharvest estimates of crop yield. To develop a suitable method of forecasting crop yields it is necessary to discover specific plant characters which are useful predictors of yield. Once these plant characters are identified a suitable prediction model could be used to relate yield with biometrical characters. In the prediction model using biometrical characters, the advantage is that these characteristics are already integrated effects of weather and other factors upto the time of observation.

The Institute of Agricultural Research Statistics at the instance of the Ministry of Agriculture & Irrigation, Govt. of India initiated a series of pilot studies in recent years to obtain preharvest estimates of crop yield based on observations on biometrical characters recorded during the growth of the crop. The primary objective of the survey to develop a reliable yield prediction model based on biometrical characters recorded at periodical intervals during the crop growth. Once the prediction model connecting yield and biometrical characters is standardized, yield rate in any year can be worked out by substituting the values of biometrical characters estimated on the basis of sampling, in the regression equations.

The Institute during the IV Five Year Plan period initiated pilot studies on rice, wheat, cotton and jute on farmers' fields in typical crop growing areas in the

1

country. The studies were further extended to sugarcane, tobacco and jowar during the V Plan period.

Crops and Areas Covered

The crops along with locations and period of surveys are given in the following table :—

Crop	Location	Period
Wheat	Ludhiana	1971-72 to 1974-75
	Aligarh	1970-71 to 1973-74
Paddy	Sambalpur and	
	West Godavari	1971-72 to 1974-75
	Ludhiana	1971-72 to 1974-75
Cotton	Baroda and Jalgaon	1970-71 to 1973-74
	Aligarh	1971-72 to 1974-75
Jute	24-Parganas	1970-71 to 1973-74
	Purnea	1970-71 to 1973-74
Jowar	Sangli	1975-76-Continuing
Tobacco	Prakasam	1975-76-Continuing
Sugarcane	Meerut	1975-76-Continuing
	Kolhapur	1977-78

Sampling Design

For the collection of data a stratified multistage random sampling design was adopted. In each selected district, a sample of four Community Development Blocks having sizeable area under the crop' was selected. The totality of these blocks constituted the population. In the selected blocks the survey was carried

out in all the Village Level Workers' Circles which constituted the strata. In each stratum, two villages and in each village two or three fields were chosen at random. In all about 250 fields were selected in each district. In each selected field, two plots of 1 sq.m. for paddy and wheat, 2 square metre for jute and 3 rows of 3 metres length for cotton were located at random. For jowar, sugarcane and tobacco plots of size 5 rows × 5 metres length are being taken.

Observations on biometrical characters selected for each crop were made at monthly intervals commencing generally from one month after planting/sowing. At the time of harvest, yield data were recorded for the sub-plots in addition to biometrical characters. In case of cotton, in addition to biometrical characters, data on yield were recorded at different pickings. The sampling units and plants were kept fixed for all the successive sampling occasions.

Salient Results

The results obtained from the pilot studies on different crops are briefly described here under.

Comparing the efficiency of the four models studied, it was observed that model IV was generally inferior to other models, there being no marked differences among the remaining three models. It may, therefore, be advantageous to use the simple linear multiple regression model with all the variables in original scale because of its simplicity and easy computation. The above results were true for all the crops investigated.

Wheat : The yield of wheat showed significant correlation with plant population and number of tillers per plot. Other biometrical characters viz. plant height, basal diameter, number of green leaves and length of earhead did not show significant and consistent correlation with yield.

The amount of variation explained by the six biometrical characters varied from 50 to 60 per cent in Ludhiana district. In Aligarh, this percentage was much smaller and varied widely. The regression analysis also indicated that among the six biometrical characters studied viz. plant population and the number of tillers per plot are the two characters which mainly account for the variation in yield. The results of the studies showed that a good prediction of yield based on biometrical characters is possible two to three months after sowing of crop.

Paddy : Six biometrical characters viz. plant population, plant height, number of tillers, basal diameter, number of green leaves and lengths of earheads were considered for the study. The yield of paddy showed significant correlation with plant population and number of tillers per plant.

The regression analysis showed that plant population and number of tillers per plant contribute about 50-60 per cent of the total variation in yield in Ludhiana district. In West Godavari and Sambalpur their contribution was comparatively low. Preharvest forecasting of paddy yield based on biometrical characters seems to be possible when the crop is two to three months old.

Cotton : Of the six biometrical characters viz. plant population, plant height, basal diameter, spread of plant, number of branches per plant and number of bolls per plant, *kapas* yield showed positive and significant correlation only with plant population. Only in a few cases, correlation between yield and number of bolls per plant was found to be significant. Other biometrical characters did not show significant and consitent correlation with yield. Low correlation of number of bolls per plant with yield was due to the fact that actual number of bolls maturing on a plant could not be recorded as the bolls burst at different points of time whereas the enumerator took observations only at fixed points of time. A high correlation between first picking yield and total yield was observed in all the districts and in all years. The amount of variation in yield accounted for by the six variables ranged from 30 to 40 per cent. However, inclusion of the first picking yield as an additional independent variable considerably improved the contribution (40 to 80 per cent). A satisfactory prediction of cotton yield based on plant population and first picking yield appears to be possible four months after sowing for short duration crops and five months after sowing for long duration crops.

Jute : The studies were confined to three biometrical characters viz. plant population, plant height and basal diameter. Of these, plant population and plant height were found to be significantly correlated with fibre yield in all years and in both the districts. The correlation between yield and basal diameter was rarely found significant.

The multiple correlation coefficients were significant in all periods and for all years. The amount of variation in yield explained by the regression equations ranged from 30 to 50 per cent. The partial regression coefficients of fibre yield on plant population and height of plant were generally significant. The regression of yield on basal diameter was, however, mostly not significant. Of the total variation due to regression, plant population alone accounted for nearly 80-90 per cent. The inclusion of plant height further increased the contribution to 90-95 per cent. The most suitable time for preharvest forecasting of jute yield appears to be about 2-3 months after sowing.

Future Programme of Research Work

1. The results of pilot investigations on wheat, paddy, jute and cotton indi-

cate that biometrical characters included in the prediction models could explain only a part of the variation in yield. Crop yield is affected significantly by other factors like variety, irrigation, date of sowing and rate of fertilizer application which vary widely on farmers' fields. Accordingly, it will be useful if these factors are also considered in the prediction equations, in addition to biometrical characters.

2. It is well recognised that weather experts pronounced influence on agricultural production, more so in a country like India which depends heavily on monsoon for timely agricultural operations and for proper growth of crop. In view of the pronounced effect of weather on crop yield, it is desirable to develop prediction models considering biometrical characters in conjunction with meteorological variables.

3. It is likely that with the changing agricultural technology, coefficients in prediction models may also undergo change. It would, therefore, be of interest to examine the change in the technical coefficients in various situations to modify them suitably to obtain reliable estimates of crop yield.

4. In forecasting crop yield based on plant count and measurement, more intensive studies are required on the choice of biometrical characters, prediction models and sampling designs to be adopted for collection of such data. It may also be necessary to examine the stability of regression coefficients of the prediction equations over years. Use of principal component and other techniques for constructing a suitable weather index with a view to reducing the number of independent variables and the value of such an index in crop forecasting techniques need investigations.

2. TRAINING ACTIVITIES

(a) During the period under report, at the Annual Convocation of I.A.R.I. held on 29th January, 1977, 15 students of this Institute were awarded M.Sc. degree and 6 were awarded Ph.D. degree in Agricultural Statistics. The second trimester was started on 10th January, 1977.

(b) Training for the ARS Probationers continued during the quarter. The batch of 8 probationers visited various I.C.A.R. Institutes to acquire a first hand

knowledge of research work done at these Institutes from 28th Dec., 1976 to 12th Jan., 1977. Shri Randhir Singh, Asstt. Prof. of Statistics accompanied them. Five probationers who had been undergoing training at Hyderabad returned back on 22nd March, 1977. Training programme in computer programming, research methodology and village level field training was in progress.

(c) The final examination of the Junior Certificate Course was held during the quarter under report. Eleven students appeared in the examination. The Half Yearly Examinations of Professional Statisticians' Certificate and Senior Certificate Courses were also held during March, 1977. The students of Junior Certificate Course worked in various research projects and submitted the Project Reports in partial fulfilment of their study.

(d) A meeting of the Advisory Board on Training Courses of I.A.R.S. was held on 31st March, 1977.

(e) Special training programmes were also arranged for the benefit of trainees deputed from other organisations. The details of such programmes were as given below :

	Deputing Organisation	Category of Trainees	No of Trainees	Period of Training
1.	I.A.R.I., New Delhi-12	A.R.S. Probationers	50	5th Feb., 1977
2.	Deptt. of Agri., Ministry of Agriculture and Irrigation, New Delhi-1	One Divisional Chief of Statistics and one Asstt. Agri. Statistician, Deptt. of Agriculture, Nepal Govt.	2	21st Feb., 1977 to 28th Feb., 1977

3. BASIC RESEARCH

Some statistical designs for varietal selection were developed with and without balance among new varieties with some reduction in number of replications for

checks. Fractional factorial plans for several types of asymmetrical factorial experiments were developed. Both orthogonal and non-orthogonal types of plans were obtained and procedures for blocking these designs were also developed. Some corrections to blocking conditions for mixture experiments were proposed to avoid singular designs. Some work was done on using incomplete multi-auxiliary information in sample surveys. A new method of analysis of variance was developed by ranking the observations. A test for testing the suitability of the model was also evolved.

---

4. ADVISORY SERVICE

During the quarter under review, technical advice and guidance was rendered to research workers and students of Research Institutes, Agricultural Universities and other research organisations in planning of their experimental investigations and statistical analysis/computerisation of their research data as also in regard to research projects referred to the Institute by the I.C.A.R. and other organisations. Some details of the technical advice and guidance given by the Institute during the quarter under review, are given below in brief :—

(a) Crop Sciences.

1. Shri S.N. Sinha, Assistant Statistician, Rajendra Agricultural University, Sabour (Bihar) was rendered technical advice on experimental design and survey techniques in the field experiments.

2. Shri Dinesh Kumar from I.V.R.I., Izatnagar (U.P.) was advised in regard to the analysis of data of a research project on pigs.

(b) Animal Sciences :

1. The Joint Director (Statistics), Department of Animal Husbandry, Lucknow (U.P.) was given technical advice on "Analysis of data accumulated at various livestock farms and under A.I. (Artificial Insemination) programme as well as maintenance of records of bulls operating in the state."

2. Technical comments were offered on the project "Economic role of livestock in small scale farming and rural life" submitted by Dr. D.S. Chauhan, Institute of Social Sciences, Agra University, Agra (U.P.).

3. A Ph D. student, I.V.R.I , Izatnagar (U.P.) was given technical guidance regarding procedure of statistical analysis of data on animal nutrition.

4. B.R. College Bichpuri, Agra (U.P.) was given advice regarding procedure of statistical analysis of data of the project "Semen studies in bovines."

5. Technical advice on statistical aspects was rendered to the ICAR in regard to various research projects sponsored by the Council.

(c) Sample Survey Investigations :

1. The Project Co-ordinator, N.R.L., I.A.R.I., New Delhi was given technical advice on the project "Effect of boron-urea spray on wheat under dry-farming conditions."

2. Technical advice was given to (i) Sh. R L. Shreshtha, Chief of Statistics Division, Department of Food, Agriculture and Marketing Services, and (ii) Sh. Raghu Shreshtha, Assistant Agricultural Statistician, Nepal, in the planning and organisation of sample surveys for estimation of livestock numbers and products in Nepal.

3. ICAR was given technical advice on "Evaluation of Operational Research Projects."

4. Sh. Brahma Prakash, a Ph.D. student from N.C.E.R.T. was given technical advice in regard to statistical analysis of the data collected by him for his Ph.D. thesis in Social Sciences.

(d) Computer Sciences and Numerical Analysis :

Shri Narain Das Rana, Assistant Oil Seeds Botanist, Himachal Pradesh Agricultural University, Palampur was rendered technical advice in preparation of tabulation plan, code structure, card design for his research project.

(e) Training and Basic Research :

Prof. N. Y. Palimkar from Marathwada Agricultural University, Parbhani (Maharashtra State) was provided technical guidance on "Rank Analysis."

5. FIELD WORK

(a) Field Training

During the quarter under review, field training was imparted in connection with the projects mentioned below at the places shown against them :—

(i) Sample surveys for methodological investigations into high yielding varieties programme-Chandigarh.

(ii) Index of cost of production of milk in I.C.D. area—Bikaner (Rajasthan).

(iii) Preharvest forecasting of yield of sugarcane-Kolhapur (Maharashtra).

Practical field training was also imparted at Delhi to A.R.S. Probationers in the conduct of the Pilot sample survey to evolve sampling methodology for estimation of losses taking place in the marketing of vegetables in transit and its price spread at various stages.

(b) Field Work Inspection/Supervision

During the quarter under review, inspection/supervision of the field work of the following projects was carried out in the areas/places shown against them :—

(i) All India Co-ordinated Agronomic Research Project (M.A.E.)—Sabour (Bihar).

(ii) Pilot sample survey to evolve sampling methodology for estimation of losses taking place in the marketing of vegetables in transit and its price spread at various stages-Delhi.

(iii) Sample surveys for methodological investigations into high yielding varieties programme-Patiala distt. (Punjab).

(iv) Preharvest forecasting of yield of Sugarcane-Meerut distt. (U.P.)

(v) Preharvest forecasting of yield of Tobacco-Prakasam distt. (A.P.).

(vi) Pilot study for estimation of birth and death rates in Bovines-Panchmahal and Kaira distts. (Gujarat).

(vii) Social benefit, cost analysis of tubewell irrigation in Union Territory-Delhi.

(c) During the quarter under review, the officers of the Institute visited and discussed to study the constraints responsible for the proper implementation of following Operational Research Projects of ICAR at the places shown against them :

(i) Rice pest control/Rice cultivation-Cuttack and Bhubaneswar (Orissa).

(*ii*) Improvement of livestock and fodder in Bareilly district-I.V.R.I., Izatnagar (U.P.).

(*iii*) Sheep and Wool development-Avikanagar (Rajasthan).

(*iv*) Improvement of lac production-I.L.R.I., *Ranchi* (Bihar).

(*v*) Stepping of oilseeds, cereals and animal husbandry production-Udaipur and Chittorgarh (Rajasthan).

(*vi*) Composite fish culture-C.I.F.R.I., Barrackpore (W.B.).

---

6. ABSTRACTS OF PAPERS PUBLISHED

1. MATHUR, S. N. and SATHE, K. V. Computer in Agricultural Research ; *Annual Convention-CSI-77, Vol. III.*

In our country, a large number of research institutions and universities are engaged in research activities in the field of agriculture for evolving new varieties and determining the factors influencing yield of crops to get higher production rates with minimum investment. Some of the research organisations are conducting research experiments in animal sciences for selection of animals for higher milk/meat production. This involves conducting of scientifically laid experiments and collection of data in a manner suitable for analysis by using modern statistical techniques. In the first part of the paper, the techniques employed for sophisticated analysis of the data collected in crop sciences research from various important investigations undertaken by research scientists including a number of schemes and projects of the Institute of Agricultural Research Statistics, have been described with a view of the contribution made by the electronic computer in providing timely and accurate results.

In the second part of the paper, the complexity of the data collected in animal sciences research and use of computer in analysing the data by applying highly sophisticated modern techniques which would have not been possible otherwise have been presented. Mention has also been made of the future expansion of the computer centre by installing another modern third generation computer system.

2.   NARAIN, P. A plan for evolving a dairy breed, utilizing cross-bred cattle available in Military Farms : *Military Farms Journal, Vol. 9, No. 1, March, 1977, pp. 41-47.*

Several attempts have been made in the past for improving the productivity of the indigenous cattle in the country by crossing them with more productive foreign breeds. By far the most significant attempt in this manner has been with the cattle in Military Farms in the country where the grading upto European breeds was introduced somewhere in the beginning of this century. However, the breeding policy of the Military Farms has been undergoing changes from time to time. These farms which are now about 26 in number run essentially on commercial lines. The breeding policy prior to 1952 was that of criss-cross breeding wherein European (Friesian and Ayrshires) and Zebu (Sahiwal) sires were used alternatively on cross-bred cows with a view to balance milk yield of exotic breeds and hardiness and suitability to local conditions of indigenous breeds. Subsequent to 1952 a breeding policy of back-crossing with Sahiwal bulls was introduced to cull criss-cross-bred stock gradually. Subsequent changes in the breeding policy, which of course did not deviate from the crossing of Friesians to Sahiwals, have resulted in animals with varying proportions of Sahiwal and Friesian blood in most of the Military Farms. A fixed type of animal has therefore not been evolved by adoption of backward and forward crossing. In spite of the non-emergence of a new breed at Military Farms, it has been felt that these farms are singularly having adequate experience, knowledge and perhaps the maximum number of animals which are maintained under good managerial practices. It is, therefore, visualised that with this genetic material, it may be possible to evolve a new breed provided further breeding programme of the Military Farms is planned on different lines. However, since these farms run on commercial basis, it is felt that any research aspects for the evolution of the new breed with this genetic material should be taken with the help of the Indian Council of Agricultural Research. With this end in view, a plan for evolving a dairy breed utilising the cross-breds available at the various Military Farms has been proposed. This article spells out such a plan in detail.

3.   NARAIN, P. A review of the book entitled "Genetic diversity among Australian aborigines" : *Human Genetics Bulletin, Vol.-II, No. 2, Dec., 1976, pp. 3-4.*

Advances in agriculture and industry and the consequent social changes have unleashed new evolutionary forces in human societies. However, there are still certain societies which did not have the full impact of these forces. Australian aborigines form one such group. The book under review is an attempt at formulating a thesis to explain the genetic diversity found in this population.

4. NIGAM, A. K. Corrections to blocking conditions for mixture experiments : *Annals of Statistics* (1977).

In this note, it has been demonstrated that the blocking conditions derived earlier by the Author (1970, Annals of Statistics) lead to singular designs. As such new conditions have been proposed.

5. SINGH, B.N. and PANDEY, R. K. Supply situation in wheat and rice : *Eastern Economist, Feb., 1977.*

The analysis of this study is devoted to compare the growth rate of population with production and found that before 1963-64 the growth of population was more rapid than the production while in the later stages it was production which led the race. A comparison had also been made among production, import and net availability of wheat and rice to total foodgrains and it was found that the percentage production and net availability of wheat and rice is increasing consistantly. However, import of wheat and rice had declined after 1963-64 and in 1971-72 India reached such a position that it started exporting wheat and rice. However, the performance has been irregular in the recent years.

The regression analysis approach has also been utilised. This study had three dependent variables, i.e., production, net import and availability of rice and wheat. The independent variables included are time variable and dummy variable to see the impact of new technology. A projection of net availability indicates similarity with the actual observed values.

---

7. PAPERS ACCEPTED FOR PUBLICATION

1. BATHLA, H.V.L., JAISWAL, S.P. and KANWAR, R.S. Sampling techniques of Sugarcane for juice analysis. *Cane Grower's Bulletin.*

2. GOEL, B.B.P.S. and SINGH, D. On the formation of clusters. *Indian Society of Agricultural Statistics.*

3. JAIN, J.P., ANEJA, K.G. and NIRMAN, K.P.S. Role of Delhi Milk Scheme in generating employment and income in its milk-shed area. *Indian Journal of Dairy Sciences.*

4. KRISHNAN, K.S., BHARGAVA, P.N., BATHLA, H.V.L. and SWARUP, OMKAR. A study on the effect of weedicides on Wheat and Paddy : *Food Farming and Agriculture.*

5. NARAIN, P. Average time until fixation of a mutant at a triallelic locus in a finite population. *Indian Journal of Genetic and Plant Breeding, Vol. 38., No. 1.*

6. NARAIN, P. The conditional Markov-Chain in a genetic context; *Journal of Genetics.*

7. NARAIN, P., GARG, L.K. and JAIN, J.P. The effect of including individual's egg weight in a selection index for rate of lay in Chickens. *Indian Poultry Review.*

8. NIGAM, A.K., MEHTA, S.K. and AGARWAL, S.K. Balanced and nearly balanced designs with varying block sizes and replications. *Jour. Ind. Soc. Agri. Stat.*

9. PURI, P.D. and NIGAM, A.K. Balanced Block Designs. *Communication in Statistics.*

10. SINGH, PADAM. A procedure of sampling with inclusion probability exactly proportional to size. *Biometrika.*

11. SINGH, RANDHIR. A note on the use of Incomplete Multi-Auxiliary information in Sample Survey. *Australian Journal of Statistics.*

---

8. I.A.R S. PUBLICATIONS

1. BHARGAVA, P.N., NARAIN, P., SINGH, D. and SAKSENA, ASHA. Monograph on statistical studies on the behaviour of rainfall in a region in relation to a crop.

To develop statistical methodology for studying the behaviour and pattern of occurrence of rainfall in a region in relation to a crop, the data on rainfall and paddy crop for Raipur distt. (M P.) and data on rainfall, evaporation and jowar yield for Jalgaon distt (Maharashtra), were utilised.

Distribution of rainfall, during the 20 days interval, one month interval and the entire rainy season (June to September), was studied. Data was normalised with the help of logarithmic or squareroot transformation, confidence limits and probabilities of occurrence of various amounts of rainfall, were obtained in respect of data on Raipur. Pattern of occurrence of dry and wet days, expected lengths of dry runs and wet runs and expected number of wet days in a period were obtained by fitting a Markov-Chain model. Assuming that the occurrence of deficient rain forms a series of Bernoulli trials, mean recurrence period of deficient rain was obtained.

Using the concept of water balance, each day of the rainy season was classified as dry, moist or humid on the basis of the rainfall being less than PET/2 (potential evapo-transpiration) or greater than PET respectively. Effect of length of humid and moist periods on crop production was then studied using data of Jalgaon.

2. KHOSLA, R.K., MEHTA, B.N. and SINGH, D.P. Annual Report of I.A.R.S. for the year, 1975.

3. SINGH, D., MANWANI, A.H. and SRIVASTAVA, A.K. Survey on fresh fruits in Tamil Nadu.

4. NARAIN, P., DEY, A. and RAO, P.P. Functions and Activities of I.A.R.S. (1970-75).

---

9. ABSTRACTS OF DISSERTATIONS APPROVED

Ph.D. Degree

1. MENON, T.C.M. On some statistical designs for varietal selection.

The whole dissertation has been divided into a gamut of eight chapters. The first chapter presents review of literature and sets out the problems for investigation. The second chapter gives an account of the matrix notations and Lemmas used in the course of this work. In chapter III, the class of designs

are formally postulated and the method of analysis has been outlined. A discussion of the combinatorial possibility of equireplicates designs of this category has also been made here. Chapter IV mainly deals with the case of designs involving only one check variety ensuring balance between new varieties. Here a new series of designs ensuring balance between new varieties and at the same time, number of replications for the check being lesser than the number of blocks, have been introduced and their methods of construction and analysis have been described in detail. In chapter V, another series of designs without complete balance among new varieties, again the number of replications for the check needed being lesser than the number of blocks have been introduced. The method of construction and analysis of these designs have been discussed in this chapter. In chapter VI, a very useful series of designs which require only 2 replicationts for the new varieties and a conveniently small number of replications for the check have been described and their analysis have been derived. In chapters VII and VIII, the extension to the case of more than one check variety has been considered with a view to effect further reduction in the number of replications for the checks, both in the case of designs with balance among new varieties and without it. Some convenient designs of the equireplicate type have also been obtained. The analysis of different series of designs thus obtained has been dealt with in detail in the respective chapters.

(Guide : Dr. A.K. Nigam)

2. PILLAI, S.S. On efficiency of cluster sampling techniques.

One of the major components in the cost of a survey in which the villages are sampling units is the cost of travelling between villages in the sample. A method to reduce the cost of the survey, when the clusters of villages form the units of sampling is to form the clusters before sampling in such a manner, that the distance between villages in the clusters is minimum. The method used in solving the Travelling Salesman problem which deals with the question of finding the smallest closed loop that connects a number of points in a plane has been used in the formation of minimum-distance-clusters.

An alternative method in which varying probability sampling of clusters with minimum expected distance-between elements within clusters has been described. Linear programming technique has been used in calculating the probabilities associated with each cluster of given size.

A method to group the elements of the population into clusters of any given size in such a manner that the variance of the elements within cluster is maximised by using the transportation technique, has been evolved. The methods developed have been applied to a population of villages of Nokha Tehsil of Bikaner District in Rajasthan.

(Guide : Dr. Daroga Singh)

3. RAMAKRISHNA, G.V.S. Contributions to the design and analysis of fractional factorials.

This thesis deals with the design and analysis of fractional factorial experiments. The emphasis has been made more on the asymmetrical factorial experiments, that is, where the different factors have different number of levels. In fractional factorial, it is desirable to have designs which permit the estimation of effects with zero correlation Such plans are called orthogonal plans. This thesis presents several classes of orthogonal plans of resolution III for asymmetrical factorial experiments. These designs permit the estimation of the mean and all main-effects in the absence of all interactions. Procedures for blocking these designs have also been dealt within the thesis and a catalogue of useful designs has been appended.

The assumption of zero interactions required in resolution III plans is not always realististic. In such situations where all interactions cannot be assumed to be zero, one has to choose designs of higher resolution. In the present thesis, some useful designs of resolution IV for asymmetrical factorials have been developed which can be analysed with ease. These designs are also orthogonal and can be split into blocks of small sizes. Finally, some series of non-orthogonal fractional plans have been constructed and their analysis discussed.

(Guide : Dr. Aloke Dey)

M.Sc. Degree

1. GOEL, J.P. Estimation of average yield of wheat at the block level of Patna district of Bihar State by double-sampling technique.

In the present study, the use of double sampling technique in multi-stage design has been examined with the help of data on wheat crop collected for

Patna district of Bihar State during the years 1962-63 to 1968-69 under the scheme "Sample surveys for block level estimates of agricultural production". The results indicated the feasibility of obtaining estimates of crop yield at the Community Development Block level with reasonable degree of precision and with reduced cost by the use of double sampling.

(Guide : Sh. A.K. Banerjee)

2. KAPOOR, J.K. Some contributions to incomplete block designs.

In this thesis, an attempt has been made to provide some designs which require less material and can accomodate larger number of treatments. These designs are based on orthogonal partitioning of the latin square. The concept of orthogonal partitioning of latin square was given by Finney (1945). He defined the orthogonal partitioning of latin square in most general form as the partitioning of s^2 cells of a s $\times$ s latin square into K sets of sn_1, sn_2,...... sn_k cells where $n_1 + n_2 + ...$ ...... n_k in such a way that the i th set has n_i cells in each row, n_i cells in each column and n_i cells of each letter. Each such set is an orthogonal portion of latin square. In the present thesis, the analysis of $(s^2 - s)$ orthogonal portion of a s $\times$ s latin square partitioned into two orthogonal portions $(s^2 - s, s)$ has been given. Utilising $(s^2 - s)$ orthogonal portion of a latin square and taking row or columns as blocks it has been shown that they form BIB. If the s cells are filled with any other treatment then the design so obtained by taking row or columns as blocks provides a supplemented balanced design. The other design which can be formed from $(s^2 - s)$ orthogonal portion is a row column design which is of the form T : TT. If the s cells are filled with some other treatment then the three way design is of the type O : SS. The analysis of these designs have been given through the method broadly given by Calinski (1971) and Pearce (1975).

(Guide : Sh. P.N. Bhargava)

3. SAPRA, R.L. An analysis of linked paired comparison designs.

Wilkinsson's analysis (1957 Biometrika) of linked paired comparision designs does not isolate the judge $\times$ treatment interaction. This is a feature of the model used in his analysis. In this thesis we have used a variant of the Thurstone —Mosteller Model for isolating the judge $\times$ treatment interaction. First a single

judge analysis with an exact overall test is developed. A pooled analysis over all judge is also developed. The results are generalised to unequal numbers of repetitions on the pairs compared by any judge. The methods developed are illustrated with the help of a numerical example.

(Guide : Sh. G. Sadasivan)

4. SCARIAH, K.S. Non-response in sample surveys.

Hansen and Hurwitz (1946) developed a model for mail survey consisting of an initial sample and a random sub-sample of non-response stratum. The model has been extended by EL-Badry (1956) to m states. In the present thesis, a variant of EL-Badry's model is developed alongwith two different estimates with their variances. These variances have been compared for their efficiency. Further, a generalisation of EL-Badry's model using succesive sampling scheme is made. A double sampling model has been developed. Three different estimates have been developed from this methodology with their variances. The efficiency of the estimates 1 and 2 have been compared. An expression for response bias is also obtained from the scheme. A regression estimate for a continuous character has been obtained along with its error and bias from the same scheme. The scheme has been extended to three stages. The results of the double sampling model have been illustrated with numerical data. In addition to above, how non-response effects the randomness of the actual sample realised, has also been investigated.

(Guide : Sh. G. Sadasivan)

5. SUMAN, C.L. Comparative returns from high yielding and local varieties of Paddy under cultivator's conditions.

The investigation involves (i) study of average profit per hectare district-wise and pooled over the districts in a State, (ii) the extent of additional yield of high yielding varieties over the local varieties of rice, (iii) distribution of net profits obtained in growing high yielding varieties over local varieties and (iv) fitting approriate regression model to explain the yield variation due to fertilizer use. The result showed that in Andhra Pradesh the profit due to cultivation of high yielding variety in different districts varied between Rs. 68/- to Rs. 733/- during 1972-73 and between Rs. 25/- to Rs. 937/- during

1973-74. The distribution of the net profit followed Pearsonian type IV in most of the districts while type I was observed in four districts. Pooled over the districts, the net profit followed type VI and IV distribution in 1972-73 and 1973-74 respectively. The additional yield of high yielding varieties over local was significantly higher in all the districts. However, the multiple correlation coefficient between yield and N, P, K was generally poor in various districts.

(Guide : Sh. S.K. Rahaja)

10. PAPERS PRESENTED AT INTER-ORGANISATIONAL SEMINARS, WORKSHOPS, ETC.

During the quarter under review, papers by the officers, members of the staff and students of the Institute were presented at Inter-Organisational seminars, workshops, etc. The titles and author-ship of papers presented and the particulars of the seminars, workshops, etc., at which these were presented are given below :

1. *Symposium on "Conservation of Resources" held on 4th January, 1977 on the occasion of 64th session of the Indian Science Congress Association held at Bhubaneswar from 4th to 10th January, 1977.*

   SINGH D. and BHARGAVA, P.N., Conservation of water and its utilisation.

2. *Annual Convention of "Computer Society of India" held at Poona from 9th to 12th January, 1977.*

   MATHUR, S.N. and SATHE, K.V. Computers in Agricultural Research.

3. *International Workshop on "Inventory of Livestock Resources in Asia" held at Manila (Phillipines) from 25th to 27th January, 1977.*

   NARAIN, P. Livestock data collection techniques in India.

4. *I.C.A.R.—P.A.U. Seminar on "Agricultural Librarianship and Documentation" held at Ludhiana from 2nd to 5th February, 1977.*

   SRIVASTAVA, S S. Co-operation in Agricultural Libraries with special reference to I.C.A.R. Institutions.

has capability of processing jobs in a multi-programmed environment. The central processing unit has a Processor storage of 150 K Bytes. The systems peripherals are two card readers, one train printer, four magnetic tape units and four disk drives and a visual display console.

The IBM 1620 system was also shifted to the new building in an adjoining room to the Burroughs system.

(b) Training Activity

During the quarter under report, Tata Consultancy Services organised the four training courses (i) COBOL programming language; (ii) System software operation; (iii) Burroughs programming language and (iv) Disk Forte/2 at IARS.

Course on COBOL was taken by Shri R.V. Rao of TCS. It was attended by 20 participants from the Institute including 11 members of Computer Centre. The remaing three courses were taken by Dr. G. Dorman, Consultant to Burroughs Corporations, U.S.A. during the period from 27th Jan. to 7th April, 1977. These courses were attended by the staff of the computer centre and eight trainees from Agricultural Research Service. He also gave practical training in the actual operation of the new system and guided in conversion of the programmes written in FORTRAN II to run on the new system.

(c) Programming Facilities, etc.

During the month of March, a number of jobs were tested and completed on the new system. The system was made available to the centre for use in the morning from 21st of March. The old system (IMB 1620) worked round the clock upto the end of February. After its shifting in the new building the night shifts were dropped so that the operating staff was available to participate in the practical training for operation of the new system during office hours.

The centre has also started a queue system for processing user's jobs on both the systems (IBM 1620 and B 4700). The jobs are accepted in the Input-Output room alongwith instructions of processing. These are processed in the queue and the computer results are collected by the users from the Input-Output room.

(d) **Mechanical Tabulation Unit**

During the quarter under review, the work relating to punching of cards, listing and tabulation, etc., of various schemes of IARS, a large number of projects and schemes of the scientists of IARI, other Central Institutes of ICAR, Agricultural Universities and other research organisations, were undertaken. Technical guidance to a large number of students and research workers was also provided in data preparation and code structure. About 4.5 lakh of cards were punched 425 listings and 187 tabulations were prepared and 118 sorting jobs were carried out.

(e) **Other Information**

A Souvenir was published by the IARS on the occasion of the inauguration of New Computer Centre. Articles on "The Functions and Activities of IARS" by Dr. D. Singh, "Electronic Processing of Research Data" by Dr. S.S. Pillai, "Agricultural Field Experiments Information System" by Shri K.S. Krishnan and "The Burroughs B-4700 Computer System at IARS" by Shri A.R. Cooper, were published in this Souvenir.

---

14. MISCELLANEOUS

(a) **Appointments**

Dr. R.K. Pandey was appointed to the post of Sr. Scientist (Econometrics) w.e.f. 29th Jan., 1977 and Shri S.S. Srivastava was appointed to the post of Librarian w.e.f. 18th Feb., 1977.

(b) **Exhibition Room**

During the quarter under report, nearly 50 new charts were prepared. These new charts were displayed on the ground floor of new building of the Institute at the time of the inauguration of Computer Centre on 11th March, 1977. Acting President Shri B.D. Jatti was taken round the exhibition room and was informed

PERIODICAL PUBLICATIONS

ANNUAL REPORT

The Annual Reports issued by the Institute cover all the aspects of its functions and activities and provide useful information to research workers in the field of agricultural statistics.

NATIONAL INDEX OF AGRICULTURAL FIELD EXPERIMENTS

The results of statistical analysis of the data pertaining to agricultural field experiments (other than varietal trials) conducted at the various research stations all over the country are published in the form of compendia series. Two such series in respect of the various States pertaining to the periods 1948-53 and 1954-59 have already been completed and the third for the period 1960-65 is nearing completion. The experimental data for the period 1966-71 have been collected and are under process.

The prices of the different volumes are given below :-

State/Region	Series I (1948-53)	Series II (1954-59)	Series II (1960-65)
Andhra Pradesh	Rs. 12.00	Rs. 12.80	
Assam	Rs. 4.00	Rs. 6.80	
Bihar	Rs. 9.75	Rs. 21.85	
Gujarat	Rs. 6.75	Rs. 9.25	
Kerala	Rs. 7.25	Rs. 8.05	
Madhya Pradesh	Rs. 11.25	Rs. 13.70	
Tamil Nadu	Rs. 13.25	Rs. 11.70	
Maharashtra	Rs. 25.00	Rs. 24.25	
Karnataka	Rs. 14.00	Rs. 20.45	*
Orissa	Rs. 3.50	Rs. 6.30	
Punjab, Haryana, H.P. and J. & K.	Rs. 19.50	Rs. 19.20	
Rajasthan	Rs. 4.00	Rs. 6.20	
Uttar Pradesh	Rs. 35.75	Rs. 42.10	
West Bengal	Rs. 7.75	Rs. 8.15	
Central Institutes.	Rs. 11.00	Rs. 16.50	
Total for the set	Rs. 184.75	Rs. 227.30	

* Prices not yet fixed.

OTHER PUBLICATIONS