

ANNUAL REPORT
1972



INSTITUTE OF AGRICULTURAL RESEARCH STATISTICS
(I. C. A. R.)
NEW DELHI-110012.

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INSTITUTE OF AGRICULTURAL RESEARCH STATISTICS
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INTRODUCTION

The Institute of Agricultural Research Statistics is the premier institute for research and training in agricultural statistics in the country. It deals with research methodology for improvement of techniques in agricultural and animal experimentation and sampling investigations. It also carries out research projects to demonstrate the feasibility of the techniques evolved and to develop the methodology for evaluating the progress and the impact of important development programmes. It provides advisory service and training in agricultural statistics to research workers and professional statisticians.

The Institute has achieved international recognition for the high quality of its research work and training. Several research workers from the Institute have served as consultants and advisers in Asian, African and Latin American countries. A number of statisticians and trainees of the Institute are now occupying high positions in the universities and other research institutions of the U.S.A., Canada, and several other countries.

The Institute made a modest beginning in 1930 as a statistical section of the Indian Council of Agricultural Research in pursuance of the recommendations of the Royal Commission of Agriculture. It was then manned by only one Statistician and a limited staff. The principal function of the Statistician was to assist the agricultural officers

in the various provinces of the country in planning experiments, analysing the data and interpreting the results. He was also responsible for scrutiny of the technical programmes and progress reports of the research schemes of the Council.

The activities of the statistical section entered a new phase towards the end of 1943 when, at the instance of the Government of India, research was initiated to develop objective and reliable methods for collecting yield statistics of principal food crops. This led to the development of the crop - cutting survey technique which was, in the course of a few years, extended to almost the entire country for estimating agricultural produce. In the course of this work, the statistical section had to undertake research in sampling theory and train a large number of statisticians and field staff. With its increasing activities, the 'Statistical Wing', as it now came to be called, was re-organised into two units dealing with statistical applications to research in agriculture and in animal husbandry and was now headed by the Statistical Adviser to the Council.

In 1945, the Council instituted regular post - graduate training courses for professional statisticians wishing to specialize in agricultural statistics and for research workers in the field of agriculture and animal husbandry who were desirous of acquiring knowledge of simple statistical methods required most often for use in their work. Although research and teaching was integrated, a small training unit consisting of whole-time professors, assistant

professors and demonstrators was constituted for organising the various courses of study. The 'Statistical Wing' soon acquired international recognition as a training and research institution in the field of agricultural statistics and was made responsible for training foreign students and organising seminars for the Food and Agricultural Organisation of the United Nations.

Valuable contributions were made by the 'Statistical Wing' to the problem of improvement of crop acreage and production statistics. Sampling techniques were developed for securing objective and reliable estimates of marine fish catch and of livestock numbers. By the end of 1952, the crop-cutting surveys for the estimation of production of the principal food crops were extended to almost the whole of the country. In January, 1953, according to the decision of the Government of India, the work of the large scale sample surveys on food crops and a few other surveys was transferred from the I.C.A.R. to the Directorate of National Sample Surveys in the Ministry of Finance.

In 1952, the services of two F.A.O. experts, Dr. Frank Yates, Chief Statistician, Rothamstead Experimental Station and Dr. D.J. Finney of Oxford University, were assigned to the Government of India to advise and assist the I.C.A.R. in reviewing its research and training activities. As a result of their recommendations, the activities of the 'Statistical Wing' were expanded in many directions. In August, 1955, it moved to its present campus at Pusa in the neighbourhood of the Indian Agricultural Research Institute for closer collaboration with that

Institute. The campus provided adequate space not only for office accommodation for the technical and the ministerial staff but also for facilities of a library, class rooms for the training classes, an auditorium and a hostel with the usual amenities including a play - ground for the students admitted to the various courses of study. Also, in view of its important role as a training and research institution, the 'Statistical Wing' was designated as the 'Institute of Agricultural Research Statistics' in 1959. A mechanical data processing unit was also now added to the Institute.

On the completion of construction of a new four - storey building in the campus of the Institute in 1964, the mechanical data processing unit was shifted to its ground floor and was expanded with the installation of an I.B.M. 1620 Model II electronic computer and other related equipments. The first and the second floors of the new building provided additional suitable office space for the expanding technical and ministerial staff of the Institute and a better accommodation for the co-operative canteen of the Institute that had been established in 1959. Also, there was now another more spacious auditorium in the third floor, which also served as a suitable venue for the cultural and other activities of the Recreation and Welfare Club of the Institute. All these facilities enabled the Institute to discharge its functions more efficiently.

The Institute was declared a full - fledged institute under the administrative control of the I.C.A.R. with effect from 1st April, 1970 and was now headed by a

Organisational structure of the Institute.

As mentioned earlier, the Institute was declared a full-fledged institute under the I.C.A.R. with effect from 1st April, 1970 and was still in the process of re-organisation. Action was being taken to re-organise the research and technical work of the Institute in five broad divisions as indicated below:-

1. Statistical Research in Agricultural Sciences,
2. Statistical Research in Animal Sciences,
3. Sample Survey Investigations,
4. Basic Research and Training, and
5. Mechanical and Electronic Data Processing.

The number of class I officers in position as on 31st December, 1972 was 45. A list of these officers is given as Appendix I. The number of posts (including out-station posts) sanctioned as on 31st December, 1972 was 560, comprising 69 Class I, 51 Class II, 382 Class III and 58 Class IV posts. A list of these posts is given as Appendix II.

On the research and training side, the Director was assisted by 3 Senior Statisticians, 16 Statisticians-cum-Associate Professors, 1 Agricultural Economist, 17 Junior Statisticians, 1 Assistant Professor, 1 Mechanical Tabulation Officer and 2 Field Officers and on the administrative side, by a Chief Administrative Officer, an Administrative Officer, an Assistant Administrative Officer and an Accounts

Officer.

1.2 Staff Research Council

In accordance with the recommendations made at a meeting of the Directors of the Research Institutes under the administrative control of the Indian Council of Agricultural Research held at the Indian Agricultural Research Institute, New Delhi-12 in May, 1966, a Staff Research Council was constituted at the Institute early in the year 1970. The objectives of the Research Council are to carefully choose the research programmes of the Institute, to decide on priorities, and to watch the progress of the various schemes. It discusses the progress of research problems in Statistics involving inter-disciplinary collaborations. It also considers the results of the statistical research which are worthy of being passed on to the research workers in the field of agricultural and animal sciences.

The Staff Research Council continued to function during the year under report. Dr. A.K. Nigam took over as the Member Secretary of the Staff Research Council from Shri B.B.P.S. Goel in November, 1972. Meetings of the research council were held on April 20, 21 and 25, 1972, May, 3, 4, and 8, 1972 and September, 21, 22 and 23, 1972. The progress of all the 47 research projects which were in operation or were proposed to be taken up during the year was discussed in these meetings.

1.3 Hostel

The Institute has a well - furnished and well organised Hostel within its campus. Boarding and lodging in the hostel is compulsory for all the students admitted to the various courses of study conducted by the Institute. There is a well equipped and well furnished mess run by the students on a co-operative basis. Crockery, utencils, etc. for the mess and all furniture and fittings for the hostel are provided by the Institute. Students are provided free medical aid, including free supply of essential medicines.

There are adequate arrangements for indoor and out-door games. Besides, recreational facilities are also provided for the students. There is a well furnished Common Room where important newspapers and periodicals are available. Students are encouraged to take part in games and other extra curricular activities. They organise sports and tournaments as well as a cultural programme on the occasion of the Annual Day of the Hostel.

During the year under report, the Dinning Hall of the hostel was provided with better furniture, a gas cooking range was installed in the kitchen to ensure cleanliness and better service and a television set was provided in the Common Room. The students celebrated the Hostel Annual Day on 31st March, 1972. Dr. B.K. Soni, Deputy Director General, I.C.A.R. was the Chief Guest.

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1.4 Library

During the year under report, 290 new books and 700 other publications were added to the Library. As usual, there was a constantly increasing number of queries about references and location of literature, which were duly attended to. About 13,000 persons visited the Library for consultation, references, borrowing or reading purposes. About 18,500 books and other publications were issued on loan to the students and the members of the staff of the Institute. The practice of imposing fine for late return of books and other publications by borrowers, which has been introduced in February, 1971 was continued during the year. As usual, inter - library loan facilities were exchanged with other libraries in the country in general and those in Delhi in particular.

As in the past, reprints of the articles by the scientists of the Institute were sent to scientists in the country and abroad. The service hours of the Library were extended; the Library now remained open for 11 hours between 9.00 A.M. and 8.00 P.M. to enable the students and members of staff of the Institute to make a better use of the facilities provided.

The Library was looked after by a Senior Librarian Assistant (Grade II) under the guidance of Dr. Prem Narain as Chairman of the Library Committee.

1.5 Exhibition Room

There is an Exhibition Room in the premises of the Institute, where results of all the important projects undertaken by the Institute are presented in the form of graphs and charts. Besides, important publications by the officers and members of staff of the Institute are also displayed there. The Exhibition Room enables a visitor to the Institute to

at one place a comprehensive picture of the important research activities of the Institute.

During the year under report, several distinguished visitors to the Institute were taken round the Exhibition Room.

1.6 Fellowships.

The courses of study for which fellowships are awarded by the Institute, the values of the fellowships, and the periods for which the same are tenable are given below:-

	<u>Course</u>	<u>Value</u>	<u>Period</u>
i)	Ph.D.	Rs.300/-p.m.	Two years (The period may be extended in special cases)
ii)	Diploma	Rs.250/-p.m.	One year
iii)	M.Sc. I year	Rs.200/-p.m.	One year
	II year	Rs.200/-p.m.	One year
iv)	P.S.C.	Rs.200/-p.m.	One year

During the year under report, 36 fellowships were awarded as detailed below:

i)	Ph.D. I year	2	iii) M.Sc. I year	10
	II year	1	II year	5
	III year	1		
ii)	Diploma	9	iv) P.S.C.	8

1.7 Research collaboration with other research institutes, universities and other research organisations at national level.

During the year under report, the Institute continued the research collaboration with the Agronomy and the Soil

Science and Agricultural Chemistry Divisions of the Indian Agricultural Research Institute, New Delhi in statistical analysis, summarisation of data, and reporting of results under the All India Co-ordinated Agronomic Experiments Scheme of the I.C.A.R. and with the Soil Science and Agricultural Chemistry Division of that Institute in the planning and designing of experiments under the Soil Test Crop Response Scheme.

The Institute also continued the research collaboration with the Indian Grassland and Fodder Research Institute, in the analysis of grass samples for their chemical composition in connection with the pilot survey for estimation of available grazing land and its utilization. Shri S.R. Sreenath, Scientist of that Institute was one of the project associates.

The scheme for estimating the cost of production of apples and studying their marketing practices in the Hilly Region of Uttar Pradesh (vide Section 4.8) was undertaken by the Institute in active collaboration with the Director of Marketing and Inspection, Government of India, the Department of Agriculture, Uttar Pradesh and the Director of Fruit Utilization, Uttar Pradesh. The scheme was financed by the Planning Commission and was a part of the over-all scheme for development of hilly areas of Uttar Pradesh on a multi-level planning basis.

The Institute also collaborated with the Directorate of Economics & Statistics, Ministry of Agriculture, in respect of analysis and interpretation of data collected through assessment sample surveys for the evaluation of the Intensive Agricultural District Programme spread over 18 districts in the country. Based on the analysis undertaken at the Institute, Volume I of the Fourth Evaluation Report of the Expert Committee of the Project for the period upto the year 1970-71 was prepared. In addition, two research monographs, one on the spread and performance of high yielding varieties in IADP districts and the other on current expenditure and capital investment in marginal, small, medium and large holdings of farmers in IADP districts, were finalised and published.

1.8 Advanced training

Shri A.C. Kaistha, Mechanical Tabulation Officer, was deputed to attend the Unit Record Supervision Course conducted by the I.B.M. in May, 1972.

1.9 Visitors

During the year under report, three eminent statisticians, Dr. C.R. Rao, Director of the Indian Statistical Institute, Dr. Raghava Rao, Professor of Statistics, Punjab Agricultural University, Ludhiana and Dr. J.S. Rustagi, Professor of Statistics, Ohio State University, U.S.A. visited the Institute and delivered lectures on topics of current research. Two F.A.O. experts, Shri D.M. Lele and Shri M.P. Jha, visited the Institute for discussions in connection with the planning and conducting

of sample surveys on fruits and vegetables to be undertaken in Ethiopia and South Korea respectively. An officer of the N.S.S. also visited the Institute a number of times to discuss the sampling design and other technical details for organising an All India survey on fresh fruit crops in the following year.

Besides, groups of trainees/officers of the Central Statistical Organisation, Pre-Investment Survey of Forest Resources (Ministry of Agriculture), Central and State Government Poultry Farms and other organisations visited the Institute at different times during the year under report to attend the lectures and practicals specially arranged for them.

1.10 Participation in Committees, Panels, etc.

(a) During the year under report, several officers of the Institute represented the Institute at the meetings of the various ICAR Scientific Panels/Committees as indicated below:-

- | | |
|------------------|--|
| Dr. P. Narain | 1. Scientific Panel for Plant Breeding. |
| | 2. Scientific Panel for Fisheries Research. |
| Sh. M.G. Sardana | 1. Scientific Panel for Entomology. |
| | 2. Scientific Panel for Plant Pathology. |
| Sh. S.K. Raheja | Scientific Panel for Agricultural Economics, Statistics and Marketing. |
| Sh. B. Marutiram | 1. Scientific Panel for Plant Breeding. |
| | 2. Scientific Panel for Plant Diseases. |
| | 3. Scientific Panel for Agricultural Products Technology. |

Dr. K.C. Raut

1. Scientific Panel for Dairy Science.
2. Scientific Panel for Agricultural Economics, Statistics & Marketing.

Dr. T. Jacob

Scientific Panel for Animal Nutrition and Physiology.

Dr. B.P. Singh

1. Scientific Panel for Soil Science and Agronomy.
2. Scientific Panel for Plant Physiology and Bio-chemistry.

Dr. A.R. Marwani

1. Scientific Panel of Horticulture.
2. Scientific Panel for Agricultural Economics, Statistics and Marketing.

Dr. P.N. Bhargava

1. Scientific Panel for Soil Science and Agronomy.
2. Scientific Panel for Horticulture.
3. Scientific Panel for Plant Physiology and Bio-chemistry.
4. Scientific Panel for Agricultural Engineering.

Dr. M.S. Avadhani

1. Scientific Panel for Agricultural Economics, Statistics, and Marketing.
2. Standing Committee for Agricultural Economic, Statistical and Marketing Research.

Dr. A.M. Nigam

Scientific Panel for Medicinal Plants and Minor Crops.

Dr. H.K. Khosla

Scientific Panel on Soil Science and Agronomy.

(b) During the year under report, the officers mentioned below were members of the Committees, Sub - Committees etc. mentioned against their names.

Dr. M.N. Das

1. International Biometric Society, U.S.A.
2. Indian Society of Agricultural Statistics, New Delhi (Secretary)
3. Indian Association of Statistics, Bombay.
4. Calcutta Statistical Association, Calcutta.
5. Indian Science Congress Association, Calcutta.
6. Post - Graduate Faculty of the P.G. School, I.A.R.I., New Delhi.
7. The Computer Society of India.

Dr. Prem Narain

1. The Indian Science Congress Association, Calcutta.
2. The Indian Society of Agricultural Statistics (Also Editor of its Journal).
3. The Indian Society of Plant Breeding and Genetics.
4. The International Biometric Society, U.S.A.
5. The Society of Advancement of Breeding Research in Asia and Oceania, Japan.
6. The Genetic Association of India (Also elected as its counsellor).

7. The Indian Association for Animal Production. (Also, a member of the Editorial Board of its Journal).
8. The General Council of the University of Edinburgh, U.K.
9. Post - Graduate Faculty of the P.G. School, I.A.R.I., New Delhi.
10. The Academic Council of the P.G. School, I.A.R.I., New Delhi.

Dr. S.M. Raheja

1. Indian Society of Agricultural Statistics.
2. Post Graduate Faculty of the P.G. School, I.A.R.I., New Delhi.
3. Sub - Committee on Fertilizer Demand Projections (Ministry of Agriculture).
4. Expert Committee on Manures and Fertilizers (Ministry of Agriculture).
5. Standing Committee on Manures and Fertilizers (Ministry of Agriculture)

(Special Invitee)

Dr. K.S. Krishnan

Sampling and Analysis Sectional Committee of the Indian Standards Institution.

Dr. S.S. Pillai

The Computer Society of India.

Dr. K.C. Raut

1. Milk Pricing Committee constituted by the Ministry of Agriculture.
2. Censory Evaluation Test Sub - Committee constituted by the Indian Standards Institution.

Dr. A.E. Marwani

1. Study Team on Fruits and Vegetables Statistics constituted by the National Commission on Agriculture (Convenor).

Sh. B.B.P.S. Goel

Dr. A. Dey

Dr. M.S. Avadhani

Dr. R.K. Nigam

Kum. C.R. Leelavathi

Sh. J.N. Garg

Sh. J.S. Maini

Sh. V.S. Rustogi

Sh. S.N. Mathur

Sh. R.K. Khosla

Sh. K.V. Sathe

Sh. Padam Singh

Sh. A.C. Kaistha

2. Expert Committee for the Development of the Hilly of Uttar Pradesh constituted by the Planning Commission

1. Indian Society of Agricultural Statistics.

2. Study Team on "Livestock Statistics" constituted by National Commission on Agriculture, New Delhi.

1. Indian Science Congress Association, Calcutta.

2. Indian Society of Agricultural Statistics.

Indian Society of Agricultural Statistics, (Life Member & Hon. Jt. Secretary).

Indian Society of Agricultural Statistics.

Sub-Committee of the All India Coordinated Agronomic Experiment Scheme of the I.C.A.R.

1. Indian Society of Agricultural Statistics.

2. Post - Graduate Faculty of P.G. School, I.A.R.I., New Delhi

Indian Society of Agricultural Statistics.

The Association of Scientific Workers of India, New Delhi

The Computer Society of India

1. Indian Society of Agricultural Statistics.

2. The Association of Scientific Workers of India, New Delhi

3. The Association of Rice Research Workers, Orissa.

The Computer Society of India

The Indian Society of Agricultural Statistics.

Indian Society of Agricultural Statistics.

(c) Dr. M.N. Das, Director of the Institute, was ex officio member of the following Committees, Panels, Working Groups, etc. during the year under report.

1. Direction Committee (Computer Sciences), I.A.R.S.
2. Advisory Board on Training Courses, I.A.R.S. (Chairman)
3. Academic Council, I.A.R.I.
4. Governing Body, I.C.A.R.
5. Standing Finance Committee, I.C.A.R.
6. Scientific Panel on Agricultural Economics, Statistics and Marketing, I.C.A.R.
7. Standing Committee for Agricultural Economic, Statistical and Marketing Research, I.C.A.R.
8. Working Group on Agricultural Statistics, National Commission on Agriculture.
9. Working Group on classification of the country into suitable agro-climatic regions and their production potential, National Commission on Agriculture.
10. Technical Committee for studies on evaluation of special employment programmes, Department of Agriculture.
11. Committee on sample surveys in hilly districts of Uttar Pradesh, Planning Commission.
12. Working Group on crop weather relationship, Meteorological Department.
13. Technical Committee on Farm Mechanisation, Department of Agriculture.
14. Expert Committee on the I.A.D.P., Department of Agriculture.
15. Committee on Improvement of Agricultural Statistics, National Sample Survey.
16. Expert Committee on Crop Surveys, West Bengal.
17. Expert Team for assessment of fertilizer requirements for achieving the agricultural production targets, Department of Agriculture.
18. Sub-Working Group on Agricultural Planning, Department of Economics and Statistics.

19. Standing Committee on Export of Manures and Fertilizers, Department of Agriculture.
20. Sub-Working Group on Agricultural Statistics, Department of Economics and Statistics.
21. Working Group on Crop Weather Relationship Studies of the National Commission on Agriculture, New Delhi.
22. Technical Advisory Committee for Agro - climatic Studies of Drought of the Indian Meteorological Department, Poona.
23. Study Group on Rainfall Reliability Analysis of the I.C.A.R., New Delhi.

1.11 Appointments, Promotions, Transfers, etc.

The various appointments, promotions, and transfers of officers in the Institute that were made during the year under report are mentioned below.

Shri S.K. Raheja, Statistician-cum-Associate Professor was appointed as Senior Statistician with effect from 25.2.1972, Sh. J.P. Jain, Junior Statistician, was appointed Statistician -cum- Associate Professor with effect from 10.5.1972, and S/Shri A.K. Srivastava, Padam Singh, and K.V. Sathe, Statistical Investigators, were promoted as Junior Statisticians with effect from 31.1.1972, 8.9.1972 and 18.1.1972 respectively.

Dr. A.C. Kulshrestha, Dr. A.K. Nigam and Dr. R.K. Panigrahy joined the Institute as Junior Statistician, Statistician - Associate Professor and Agricultural Economist respectively with effect from 4.7.1972, 24.8.1972 and 10.11.1972.

Dr. G.M. Saha, Assistant Professor of Statistics, Dr. A.C. Kulshrestha, Junior Statistician, and Sh. M.G. Sarma Senior Statistician left the Institute on 30.9.72, 12.11.72 and 30.11.72 respectively.

Miscellaneous

(a) Dr. M.N. Das delivered a lecture at the Summer School of the Meerut University, Meerut in May, 1972. In June, 1972, he paid a visit to Ranchi as desired by the Director, Lac Development, Govt. of Bihar in connection with the planning of an exploratory survey for estimating production of lac. In July, 1972, he attended a meeting in the Directorate of Cotton Development, Bombay for reconciliation of the official and the trade estimates of cotton production. He also attended the meetings of the Expert Committee on Crop Survey, Govt. of West Bengal held in January, February, May and December, 1972 to review the existing methodology of crop surveys followed by the Bureau of Applied Economics and Statistics, West Bengal.

(b) Dr. P. Narain delivered at the Institute a series of lectures on "Statistical Methods" for the benefit of the officers of the Pre-Investment Survey of Forest Resources (Ministry of Agriculture) and on "Statistical Genetics" for the benefit of Assistant Statisticians of the Central Poultry Farms and officials of the State Govt. Poultry Farms. He also delivered lectures at the Indian Veterinary Research Institute, Izatnagar (U.P.) in June, 1972 on "Methods of analysing diallel crosses in poultry" and "Construction of selection index - its use in poultry breeding".

(c) Shri S.K. Raheja organised a symposium on "Measurement of Impact of Green Revolution" under the Chairmanship of

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Dr. B.S. Minhas, Member, Planning Commission on the occasion of the Annual Silver Jubilee Conference of the Indian Society of Agricultural Statistics held at New Delhi in March, 1972. He also acted as the rapporteur of the Symposium.

(d) Sh. S.D. Bokil delivered a course of lectures on "Statistical Methods" to the trainees of the Directorate of Marketing and Inspection at Nagpur.

(e) Sh. V.V.R. Murty put up a note entitled "Future requirements of bovine milk and its availability in India" for discussion at a meeting held at the Central Statistical Organisation under the chairmanship of Sh. T.P. Abraham, Joint Director, C.S.O. to discuss the present status and future targets of milk production in India.

(f) Sh. A.H. Manwani attended a number of high level meetings under the chairmanship of Dr. B.S. Minhas, Member, Planning Commission held in connection with the scheme for development of the hilly areas of Uttar Pradesh. Also, as convenor of the Study Team of Fruits and Vegetables Statistics constituted by the National Commission on Agriculture, he prepared a background paper giving the present position regarding the availability of fruits and vegetables and the gaps to be filled up. Sh. Manwani also discussed with Sh. T.P. Abraham, Joint Director, C.S.O. the programme of work to be initiated for filling up the lacunae in the availability of statistics of the area and the yield of different vegetable crops.

Details of the sample surveys to be initiated on different vegetable crops during the Fifth Plan were discussed and the budget estimates for taking up the surveys were studied.

(a) Sh. B.B.P.S. Goel delivered lectures on "Agricultural Statistics" to the post - graduate students of the Delhi University, Delhi.

(b) In collaboration with Dr. P.N. Saxena of I.A.R.I., New Delhi, Dr. A. Dey organised a symposium on "Design for Agricultural Experimentation and Computerization of their Analysis" under the chairmanship of Prof. M.C. Chakravarti, Professor and Head of the Department of Statistics, Bombay University on the occasion of the Annual Silver Jubilee Conference of the Indian Society of Agricultural Statistics held in New Delhi in March, 1972.

(c) Sh. R.K. Khosla attended a meeting held in the Directorate of Plant Protection, Quarantine and Storage, New Delhi in November, 1972 to discuss the present reporting system in plant protection.

(d) As mentioned in the report for the year 1971, an Achievement Audit Committee under the chairmanship of Dr. K. Ramiah, M.P. and with Dr. M.S. Swaminathan, Director, I.A.R.I., New Delhi, Dr. P.V. Sukhatme, Director, Statistical Division, F.A.O., Rome, Dr. C.R. Rao, Director, I.S.I., New Delhi and Prof. V.M. Dandekar of the University of Poona, Poona as members was set up by the I.C.A.R. in May, 1971 to examine the working of the Institute. The report of the Committee was still awaited.

2.

STATISTICAL RESEARCH IN AGRICULTURAL SCIENCES

The programme of statistical research in agricultural sciences was continued during the year under report. The progress of work in respect of the various items of research included in the programme is briefly described in the following paragraphs. The names of the principal investigator and his associate or associates are given at the end of the description.

2.1 National index of agricultural field experiments

The objectives of the project were (a) to maintain at a central place the results of all the agricultural field experiments conducted at research stations all over the country, (b) to summarise the results of such experiments over years and publish their results in the form of compendia, and (c) to prepare critical summaries on important topics of agriculture research.

Data of about 5335 experiments had been reported by the regional staff posted in different states. Analysis of about 2500 experiments as per the design adopted in the different experiments as also of about 200 groups of experiments was made during the year under report. An index of the experiments received upto December, 1971 and conducted during the period 1966-71 was under print. Similar index for 1972 was under preparation. Compendium of results of the agricultural field experiments pertaining to the 1960-65 period of Gujarat State was also under print.

(R.K. KHOSLA, M.G. SARDANA, P.P. RAO, B.L. CHOUDHRY & M.P. SAKSENA

2.2 Study on size and shape of plots in experiments on apple crop.

The investigation was carried out with the objective to obtain the optimum size and shape of plots and blocks in experiments on apple crop. The data for the study was collected from Summer Ford Garden, Ramgarh, Nainital during 1965 and 1969. The trees in the orchard were of ages ranging from 15 to 20 years. The average spacing between 2 trees was about 5 meters. The orchard was divided into different terraces, each terrace having trees between 12 and 36 in number. In this study, adjoining terraces were combined so as to form blocks of 48 trees each. The number of blocks so formed was 4 in 1965 and 5 in 1969.

The optimum size and shape of block is one for which the coefficient of variation is minimum for a given size of experimental area. Since trees were experimental units in this study and the total number of trees available were not large, the investigation was based on plots having 1, 2, 3, 4, 6, and 8 trees arranged in plots of regular shapes.

The results of study have indicated that the coefficient of variation for plots of different sizes mentioned above decreases with an increase in plot size both with blocking as well as without blocking. Further, the estimate of 'b' (coefficient of heterogeneity) which was fairly close to 1 indicated that the plots could be taken to behave as randomly picked up groups of experimental units. Further, under such a situation, the positional variation is not that much important as the genetic variation. The study of the relative information per tree for plots of different sizes arranged in blocks of various sizes as well as without any blocking arrangement

indicated that the percentage of the information obtained from single tree plots was relatively higher in each case. Hence, a single tree plot was considered to be the most suitable for experiments on apple.

(P.N. BHARGAVA and M.G. SARDANA)

2.3 Critical analysis of crop rotational experiments.

The objective of the study was to examine the data on some of the long term crop rotational experiments conducted in India with a view to developing simple and straight forward methods of statistical analysis of such experiments. For the purpose of the investigation, data on rotational experiments for a period of 8 years was collected from the Agricultural Research Station, Amreli and similar data for about 20 years was collected from the State Department of Agriculture, Maharashtra.

(a) Crop rotational experiment at Amreli:

The experiment was laid out in two randomised block design of 16 plots corresponding to 16 phases of the 10 crop rotations, namely, (i) jowar every year, (ii) jowar - bajra, (iii) jowar - groundnut, (iv) jowar-cotton, (v) bajra every year, (vi) bajra-groundnut, (vii) bajra-cotton, (viii) groundnut every year, (ix) groundnut-cotton and (x) cotton every year.

The analysis of the data indicated that jowar-groundnut and bajra-groundnut were the best rotations for the production of jowar and bajra, that the fertility of soil also appreciated over years with these rotations and that the economic return per unit area per unit of

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time was also appreciably good for these two rotations.

(b) Crop rotational experiment at Jalgaon (Maharashtra)

This experiment was laid out at Jalgaon in the year 1950. The data upto the period 1970-71 were made available to the Department of Agriculture, Maharashtra State for analysis. The objective of the experiment was to compare the different rotations with two and three crops in a rotation, to study the behaviour of these crops in rotation over years and to examine the economics of different rotations tried.

The experiment was laid out in randomized block design with 22 plots with 6 replications. In the plots where groundnut was grown, the area was divided into two halves one of which was having the application of phosphatic fertilizer while the other had no phosphatic fertilizer applied to it. It was done with the purpose to examine the effect of fertilizer on groundnut and its residual effect on the subsequent crops. The following eleven rotations were adopted: (i) cotton (manured) every year, (ii) sorghum (manured) every year, (iii) cotton (manured) in alternate years (iv) sorghum, (manured) in alternate years (v) cotton (manured) - sorghum (vi) sorghum (manured) - groundnut, (vii) cotton (manured) - groundnut, (viii) cotton - groundnut, (ix) sorghum - groundnut, (x) cotton (manured) - sorghum - groundnut and (xi) Cotton (manured) - groundnut - sorghum.

The results of the investigation indicated that the average yield of cotton crop obtained from the three

crop rotation 'cotton (manured) - sorghum - groundnut' and the two crop rotation 'cotton (manured) - groundnut' were higher. In respect of bajra, the rotation 'sorghum (manured) - groundnut' gave the higher yield. The other two rotations, namely, sorghum (manured) and cotton (manured) - groundnut - sorghum, were also found to be equally superior as compared to the remaining rotations. In respect of groundnut, the average yield of the crop in the rotations was found to be of the same order.

Owing to continuous growing of crop on the same field in a specific sequence over a long time, some changes in the soil fertility take place. In order to study this aspect, regression analysis technique was adopted. The results of the study for cotton suggested that the rotation 'cotton (manured) - sorghum' was found to improve the soil fertility while the other rotations deteriorated the fertility of the soil. In case of jowar and groundnut, continuous cropping had not been found to be beneficial for the soil fertility. It was further observed that the inclusion of groundnut in any rotation gave a higher income per hectare as compared to the rotations without groundnut.

(P.N. BHARGAVA and M.G. SARDANA)

3.4 Evaluation of yardsticks of additional production from the use of various developmental measures.

The objective of the study was to evaluate the response to various improvement measures and thereby work out the yardsticks of additional production. Data of nearly 10000 experiments conducted on cultivators' fields during the years 1967-1970 were collected and analysed. The district-wise responses to

N, P₂O₅ and K₂O were pooled over the years and the errors free from year-to-year variation were calculated. The doses at which the yardsticks of additional production were formulated were 60 and 120 kg. N/ha, 30 and 60 kg. P₂O₅/ha and 60 kg. K₂O/ha. The responses to potassium were measured over a basal application of 120 kg. N/ha and 60 Kg. P₂O₅/ha.

The yardsticks of additional production from the use of nitrogenous, phosphatic and potassic fertilizers on high yielding as well as locally improved tall varieties of cereals were evaluated from the data of 9252 experiments conducted from 1967 - 68 to 1970-71 on cultivators' fields. Project report was prepared. It was seen that the most widely used high yielding varieties were IR-8 of rice and S-227 of wheat. The data available on jowar, maize and bajra were, however, limited.

The average yardstick of additional production was 10.3 tonnes/tonne of nitrogen for IR-8 while that for the locally improved tall varieties was 9.7 tonnes/tonne of nitrogen at 120 Kg.N/ha in Kharif season with irrigation. In rabi season the yardsticks of additional production were 12.6 tonnes/tonne of nitrogen for IR-8 and 8.6 tonnes/tonne of nitrogen for locally improved tall varieties under irrigated conditions. In Mysore and Madhya Pradesh where the soils were generally low in available phosphorous in the districts covered, additional production of about 14-16 tonnes/tonne of P₂O₅ were obtained with IR-8 and locally improved tall varieties at 60 Kg. P₂O₅/ha in Kharif with irrigation. IR-8 yielded about 7 units more than Adt.27 in Tamil Nadu. On an average, in rabi season the yardsticks

Additional production for IR-8 were nearly double for locally improved tall varieties under irrigation. On an average, additional production of 5 tonnes/tonne of K_2O were obtained under irrigated conditions in Kharif season for both IR-8 and locally improved tall varieties. Higher yardsticks were indicated by about 3 tonnes/tonne of K_2O for IR-8 in rabi season.

The yardsticks of additional production were 5.3 tonnes/tonne of nitrogen for S-227 at 120 Kg. N/ha, while that for locally improved tall varieties was 6.6 tonnes/tonne of nitrogen. At 60 Kg. P_2O_5 /ha the yardsticks of additional production for S-227 was 7.5 tonnes/tonne of P_2O_5 , 0.8 tonnes/tonne of P_2O_5 more than that for locally improved tall varieties. The estimates of yardsticks of additional production from the use of potassium were higher for S-227 by about 1.4 units than those for locally improved varieties (2.7 units).

The data available on jowar, maize and bajra were too meagre to see the trend.

(C.R. LEELAVATHI, S.R. BAPAT, and M.N. DAS)

1.5 Pilot studies on pre - harvest forecasting of yield of crops.

The objective of the studies was to investigate whether pre-harvest estimates of crop yield can be obtained objectively on the basis of bio-metrical observations such as plant density, plant height and basal diameter recorded at various stages of crop growth. Investigations on 4 crops, viz; wheat, cotton, paddy, and jute were in progress under the project. For each crop, two districts in two different States, namely, Aligarh and

Ludhiana for wheat, Jalgaon and Baroda for cotton, Sambalpur and West Godavari for paddy and 24-Parganas and Purnea for jute were selected. In each district, about 250 fields were selected by adopting the stratified multiple stage random sampling technique and the bio-metrical data were collected at intervals of four weeks starting one month after the date of sowing. Statistical analysis was carried out for the data collected in the previous year for wheat, paddy, jute and cotton crops at different centres.

Average estimates alongwith their variabilities were found out for different characteristics of the plant. Multiple regression analysis was adopted for the association studies for developing the suitable relationship between yield and different bio-metrical observations at different intervals of time. The analysis was carried out under 4 different models: viz, (i) Simple (ii) Logarithmic, (iii) Square-root, and (iv) In-verse. Suitability of models was judged on the basis of the amount of variation in the yield explained due to multiple regression equation and the significance of partial and multiple co-relation co-efficients. For wheat and paddy crops, the partial regression co-efficients were found to be significant in most of the cases. On the basis of the amount of variation in yield explained by the regression equation it was concluded that in forecasting of yield of wheat and paddy we can use the simple regression of yield on the number of tillers only instead of multiple regression taking other variables like number

plants, diameter and height of the plant, etc. In case of late crop, the logarithmic model was found superior on the basis of variation in the yield explained by the regression equations. The partial regression co-efficients, on the number of plants and the height of the plants were found significant in all the cases. The investigations, thus, pointed to the possibilities of forecasting objectively with reliabilities the yield rates of different crops by using bio-metrical observations taken from randomly selected plants at different intervals of time.

(H.P. SINGH and N.K. OHRI)

Statistical analysis and summarization of data collected under the All India Co-ordinated Agronomic Experiments Scheme.

(a) Simple fertilizer trials (SFT) on cultivators' fields.

Simple fertiliser trials numbering about 9000 were conducted with high yielding varieties on cultivators' fields in 37 selected districts and a similar programme but with emphasis on dry farming technique was carried out in 20 districts during the year under report. The main objectives were to study (i) the response of important cereals to nitrogen, phosphorus and potassium with a view to formulating fertilizer recommendations for different agroclimatic regions in the country, (ii) the response of cereals, legumes and oilseed crops to nitrogen, phosphorus and potassium under dry farming conditions, and (iii) the relationship between crop response and soil test values.

High Yielding Varieties Programme:

Application of nitrogen upto a level of 160 Kg N/ha

gave high responses of rice during kharif season in Thanjavour, Pondicherry, Patna, Bilaspur, West Tripura, Cuttack and Alleppy, while in rabi season high responses were observed in Sambalpur, Thanjavur, Cuttack and Pondicherry. The responses ranged between 2900 and 4900 kg/ha. In case of wheat crops, high responses ranging between 1800 and 2900 kg/ha were observed to 160 KgN/ha in 16 out of 21 districts. Responses of jowar, maize and bajra varied between 800 and 2000 kg/ha.

Phosphorus application from 90 kg P_2O_5 /ha to 180 kg P_2O_5 /ha to kharif rice showed responses ranging between 500 and 1900 kg/ha while in rabi the range of responses was 900 to 2000 kg/ha. In case of wheat, phosphorus application at varying levels showed responses between 700 and 1500 kg/ha. The crops like jowar, maize and bajra showed moderate responses to application of phosphorus.

Application of potassium to rice and wheat showed responses ranging between 400 and 1100 kg/ha in a few selected districts.

Application of zinc to rice, wheat, jowar, maize and bajra showed significant and moderate responses varying between 200 and 700 kg/ha in some of the districts where these crops were under study.

Dry Farming Programme

Results of trials conducted under dry land conditions on rice, wheat, jowar, maize, bajra, groundnut, castor, mustard, gram and horsegram showed that fertilizer application is as important as moisture for crop production.

It was also observed that NP fertilization is necessary even under dry land conditions, contrary to the belief that only nitrogen need be applied.

(M.G. SARDANA, S.R. BAPAT and V.N. IYER)

Complex experiments at model agronomic centres

The objectives of the experiments were to study the response of important cereals to nitrogen, phosphorus, and potassium and to micro-nutrients, the best method and time of fertilizer application, the relative efficacy of complex fertilizers, the most efficient method of weed control and their residual effect on succeeding crops. During the year under report, data of about 275 complex experiments conducted at 43 Model Agronomic Centres were analysed. The experiments were conducted as per the technical programme decided at the annual workshop of the scheme and the progress was reviewed in the sub-committee meetings of the scheme.

Significant responses to soil application of zinc and manganese were obtained at Kathulia farm (IR-8), Nandyal (Raya) and Indore (Swarna). Experiments conducted during the previous two years showed no adverse effect of biuret in urea upto 0.9% for use as foliar spray. Placement of super-phosphate at 7.5 cm. below seed was found to increase the up-take and utilization of applied fertilizer in case of jowar crop in red loam soils. Similar results were obtained in case of wheat crop in the previous year on alluvial sandy loam soils. At most of the locations, nitro-phosphate containing 30% of its phosphate in water soluble form was found to be inferior to combination of straight

fertilizers such as ammonium sulphate or urea and superphosphate and other NP complex fertilizers such as diammonium phosphate and ammonium phosphate sulphate.

(M.G. SARDANA, C.R. LEELAVATHI, and SHANTI SARKAR)

2.7 Study of influence of meteorological factors on crop production.

The objective of the project was to study the effect of rainfall on crop production during crop season, namely June to September in Raipur district of Madhya Pradesh. Daily rainfall data for 24 years viz; from 1944 to 1967 and the yield rates for paddy for the corresponding period were utilised. Rainfall data were collected from the Meteorological Department, Poona and the yield data from the Directorate of Agriculture, Madhya Pradesh. To describe the distribution of rainfall of the individual months and overall season (June to September), by a suitable probability distribution function the usual method of moments was adopted. Yield and rainfall of individual months were plotted on the graph to find the correlation between the two. With the help of the graphs, periods when rainfall had significant effect on crop production were found. Graphs also helped in fixing the minimum amount of rainfall required for getting the normal yield. Rainfall falling below this minimum limit was called deficient rain. Probability of the occurrence of deficient rain was calculated from the distribution fitted to the rainfall. From these probabilities recurrence times of deficient rain during each month and season were obtained.

The distribution of rainfall for the months June, July

August and September and the whole season June to September was found to be normal. It was observed that rainfall during June and August did not have a significant effect on crop production, but in the months of July and September it had a profound effect. Rainfall 26% below normal in July and 31% below normal in September was found to be deficient for paddy crop. The probability of this deficiency of rainfall in July was found to be .2843 whereas in September, it was .2206. The deficient rain in July was expected to reccur after every three years and in September, after every four years.

The studies relating to rainfall reliability were in progress.

(P.N. BHARGAVA, P. NARAIN and ASHA PRADHAN)

3.

STATISTICAL RESEARCH IN ANIMAL SCIENCES

The programme of statistical research in animal sciences was continued during the year under report. The progress of work in respect of the various items of research included in the programme is briefly described in the following paragraphs. The names of the principal investigator and his associate or associates are given in brackets at the end of the description.

3.1 A genetic simulation study of response to selection in finite populations.

The objective of the study was to simulate genetic systems on computer for investigating the interaction of population size and directional selection. The simulated genetic populations were to provide an estimate of rate of advance and selection limits under varying conditions. Since the study was of a theoretical nature, no data were required. Instead, hypothetical populations were to be constructed under various genetic models. For studying the nature of random genetic dispersion for varying population sizes, computer programmes for simulating simple genetic models of 30 loci with two alleles per locus, with variation in the recombination between loci and without selection were developed.

(P. NARAIN, J.P. JAIN and K.V. SATE

Measurement of genetic improvement due to cross-breeding in sheep.

The object of the investigation was to develop statistical techniques for estimating genetic improvement due to cross-breeding in sheep. The sheep breeding data on local Kashmiri, pure Rambouillet as well as half-breeds and three-fourths derived from them, collected at Sheep Breeding Farm, Banihal - Reasi (Kashmir) and spread over a period of 14 years (1952-66), were taken up for study. The data were analysed with respect to four characters, viz., greasy fleece weight, fibre diameter, fibre length and fleece density. The techniques of discriminant function and D^2 -statistic were used to compare different grades and to measure the contribution of different characters in comparing the grades.

It was found that significant differences existed between different pairs of grades. Local versus pure breed showed maximum divergence whereas half-bred versus three-fourths showed the least divergence. The contributions of fibre diameter and greasy fleece weight to D^2 values were about 65 to 75 percent in different comparisons.

(P. NARAIN and L.K. GARG)

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3.3 Statistical methodology for developing efficient selection procedures in poultry breeding.

The objectives of the project were to investigate alternative selection procedures based on combining information from relatives as well as on combination of characters and to give concrete help in the operation of Coordinated Poultry Breeding Programme of Madhya Pradesh Government located at Bhopal, particularly with regard to selection of birds and their matings. These were to be based on a rapid and critical examination of the data flowing continually from that programme.

The data obtained from the Regional Poultry Farm at Bhopal were processed and analysed. On an average, the data pertained to 7,500 birds each season. The characters observed were age at maturity, egg production upto 240 days of age, egg weight and incidence of mortality. The estimates of heritabilities and genetic correlations were obtained by the methods of half-sib analysis. Studies on the type of distribution of egg weight and of selection scores based on combining individual performance with that of full-sibs and half-sibs showed that the former followed Pearsonian Type II and the latter, Type IV. Studies on

abilities and genetic as well as phenotypic correlations between egg weight and selection score remained in contrast. A theoretical study of combined selection for populations undergoing inbreeding was also completed. The most important result in this study was that with a mixed population the efficiency of combined selection was increased.

(P. NARAIN and J.P. JAIN)

Statistical studies on data from the scheme on improvement of poultry through family selection.

The objectives of the project were to study the efficiency of selection on the basis of part-time production and to estimate genetic parameters on some important characters such as annual egg production, age at maturity, weight at maturity, etc. The data collected on White Leg-horn breed under the scheme for improvement of poultry through family selection at the centre at Malappara - Kunnu (Kerala) were processed and analysed. Data in respect of age at maturity, weight at maturity, and egg production in first 100 days of lay were available for each of about 600 birds purchased and those raised as foundation stock and first generation birds. In addition, data

on egg production in first year of lay for each of about 200 birds selected from the purchased and foundation stocks were also available. The data could be arranged according to about 20 paternal half-sib families.

Heritabilities and genetic correlations were estimated by the method of intra-sire regression of progeny on dam as well as by the method of half - sib analysis. Relationship between part-time production and total production was studied by the regression technique. It was observed that only about half the number of heritabilities estimated were in the admissible range. Even the admissible estimates were not statistically different from zero. Negative estimates of heritability resulted in estimates of genetic correlation being imaginary. Among the non-imaginary estimates, some were either less than -1 or greater than +1. The correlation between part-time production and total production was estimated to be of the order of 0.5.

(R. GOPALAN and B. MARUTIRAM)

3.5 Study of cost of poultry and egg production.

The objectives of the study were to evolve a suitable methodology for estimation of cost of poultry and egg production under commercial management conditions, to secure

information on factors helpful in lowering the cost, secure information on prices of eggs and birds at various stages of marketing from producer to consumer so as to reduce the price spread, and to investigate into the methodology of building an index of cost of poultry and egg production.

In the first instance, a complete enumeration of existing poultry farms in the selected areas of Dasuya and Tada in Punjab and in Delhi and the surrounding areas, was undertaken to obtain the sampling frame as well as the maintenance and rearing practices followed. On the basis of this frame, about 130 commercial farms taking into consideration the flock size in terms of layers, mixed and unsexed birds and operational feasibility, were selected for recording detailed information on different categories of birds, feeds fed to them, labour (including unpaid family labour) and other investments on assets and equipment etc., at weekly intervals through personal visits for a period of two years. In order to study the relative changes in the cost of production of poultry and eggs under commercial management conditions from year to

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year, information on prices of feeds, wage rates, etc. from the same set of poultry farms, besides commercial establishments dealing with the sale of poultry feeds, was also taken up in the selected areas of Dasuya and Tanda in Punjab and in Delhi and the surrounding areas.

Keeping in view the objectives of the survey, cost accounting approach was followed. Estimates of different components of cost, viz., feeds fed, labour put in, management practices, investments, depreciation on assets and equipment, depreciation on adult birds and miscellaneous expenditure could be obtained separately for different categories of birds in rural and urban areas. These components of cost could be added up to get the gross cost of production of poultry and eggs. From these estimates, the cost of production of table and hatching type eggs, cost of hatching day old chicks and cost of rearing day old chicks to the adult stage could be estimated. Data on income from items other than sale of birds and eggs could be utilised to obtain estimates of the net cost of production. Price relatives of feed and other components of cost could be calculated to find the indices of cost of production of eggs and poultry birds.

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The data on various items of cost for each farm were processed to get each component of cost, viz; feed, depreciation on assets and equipments, depreciation on assets and miscellaneous expenditure. Further analysis of the data was in progress.

(B. MARUTIRAM, U.G. NADKARNI and
L.B.S. SOMAYAZULU)

Resource productivity in poultry under commercial management conditions.

The objectives of the investigation were to investigate into the relationship between egg production and inputs like feed, labour etc. and to estimate productivity indices of egg production with respect to these inputs.

Information on production and feed cost was compiled from the data collected during the winter season in Punjab under the survey for 'estimation of cost of production of poultry and egg'. The data were stratified according to the size of the farm. Within each size category, frequency distributions were formed according to the cost of production. Production functions were fitted relating egg production to feed cost. The linear function explained

more than 75 percent of the variation. The study was to be continued by adding other inputs in the relationship as soon as the work of compilation of the relevant data was completed.

(T. JACOB)

3.7 Estimation of availability and cost of production of milk and its index.

The objectives of the investigation were (i) to estimate the availability of milk and its disposal in different seasons of the year in the areas of operation; (ii) to estimate the cost of production of milk; (iii) to estimate the components of cost of production both in monetary terms and in terms of physical quantities; (iv) to secure information on factors helping to lower the cost of production of milk; ^{and} (v) to build up an appropriate index of cost of production of milk.

The field work was to be carried out at two centres, viz., (i) Krishna delta area in Andhra Pradesh and (ii) Dhulia region of Maharashtra State. The field work in Krishna delta area was taken up during 1967-68 and completed in July, 1969. The field work in Dhulia region was initiated in December, 1969. After the completion

Detailed enquiry in February, 1972, the collection of data for building up an appropriate index of cost of production of milk was initiated in the area in March, 1972. At each centre, 48 villages selected for cost study remained fixed throughout the period of enquiry, while 48 villages selected for the study of availability of milk were selected fresh during each season. In all 192 commercial producer households (four in each selected village) were selected for cost study and 22 producer households per village for availability study in each season. The items of information collected were particulars regarding individual animals in the stall, production and utilisation of milk, quantity and composition of feeds given to animals, procurement of cattle feeds, etc. The data on milk yield of animals and quantities of feeds fed to them on the day of visit were recorded by actual weighing and other information such as details of paid and family labour, capital investment, recurring expenditure, etc. through careful observation and enquiry from each stall. After completion of the detailed enquiry in February, 1972, data on prices of feeds and fodders, labour wage rates, etc. were collected from these villages to build up an appropriate index of cost of production of milk.

The sampling design adopted was stratified, multi-stage random sampling for selection of sampling units. Estimates of total milk production in the milk shed area in each season were obtained. Various components of cost per milch animal as well as per kilogram of milk were obtained to estimate the cost of production.

The final report on the project pertaining to Krishna delta area was prepared and considered by the Scientific Panels of ICAR in December, 1972. It was observed that the overall daily production of buffalo milk in the area was 406 tonnes, of which 54.4 percent was in Krishna area and the remaining 45.6 percent in Guntur area. The production of cow milk in the area was estimated to be about 36 tonnes per day. The average daily milk yield of a buffalo in milk was about 1.9 kg. both in Krishna and Guntur areas. The average milk yield of a cow in milk in Krishna area was estimated to be 1.2 kg. per day. The cost per kilogram of buffalo milk was Rs.1.12 in the first year and Rs.1.04 in the second year when family labour was included and 91 paise and 85 paise in the two years respectively when family labour was excluded. The cost of production of cow milk could not be worked out as in most of the stalls selected for cost study, the cost

were not milked at all and the entire milk was fed to the calves. The estimates of cost per kilogram of milk were obtained with a reasonable degree of precision, the sampling error being 3.6 to 5.0 per cent. Feed cost accounted for 76 per cent of the gross cost whereas family labour contributed to the extent of 17 per cent. Family labour accounted for 3 to 4 per cent of the gross cost.

In about 40 per cent of the commercial producer households, the cost of production of buffalo milk was less than 90 paise per kilogram when the family labour was included. The cost was less than 90 paise per kilogram in 58 per cent of households when family labour was ignored. Considering 80 per cent of commercial producer households as efficient, the average cost of production worked out to be of the order of 91 paise per kilogram including family labour and 74 paise per kilogram when family labour was excluded. The overall market rate of milk in the area was 90 paise per kilogram. The average butter fat and solids-not-fat (S.N.F.) contents in buffalo milk were 6.4 per cent and 9.7 per cent respectively. About 16 per cent of commercial producers in Krishna area sold milk directly to the organised dairy. There was hardly any collection of milk in Guntur area by any organised dairy. On an average, 56 per cent of

buffaloes and 49 per cent of cows were in milk in the area. The proportion of death among milch buffaloes in the area was about 3.0 per cent.

(K.C. RAUT and SHIVTAR SINGH

3.8 Index of Cost of production of milk:

The object of the project was to build up an appropriate index of cost of production of milk in selected areas through collection of relevant data on prices of feeds and fodders, labour wage rates, etc. which would indicate relative increase or decrease in the cost of production of milk in areas of operation as compared to the estimates obtained in large scale enquiries.

For the purpose of estimating the cost of production of milk, 24 villages were selected in each of the sub-urban and the rural areas of Tamil Nadu and West Bengal. All these selected villages were visited by the supervisors (one each in the sub-urban and the rural areas) once in each season for collection of relevant data. Out of the remaining villages in each of the sub-urban and the rural areas, 16 additional villages were selected at random in each season for collection of data. In each of the villages selected

For detailed enquiry, household information was collected from all the four households which had been selected earlier and from four more households (commercial households) in each village. All the relevant information pertaining to the villages and the market rates was collected from the additional villages. In case of urban area households, information was collected by the supervisors in each season from all the 54 selected stalls and from 160 freshly selected commercial stalls.

The items of information collected were prices of feeds and fodders, local wage rates of permanent and casual labour, prices of animals sold and purchased, market rates of milk and milk products, composition of milch stock in the selected households and the relevant information on the extent of fodder cultivation, etc. Similar data were also collected in 60 clusters of three villages each in the milk collection areas of D.M.S. where large scale enquiry to study the impact of milk supply schemes on rural economy was carried out.

Utilizing the quantities of different constituents of feeds and fodders fed to the animals, the average milk yield as estimated from detailed enquiry

and the prevailing market rates of these feeds and fodders, the feed cost per kilogram of milk was calculated. Similarly, the quantum of labour put in for maintenance of milch animals, the milk yield for milch animals at the time of detailed enquiry and the prevailing wage rates were utilised to work out the labour cost per kilogram of milk. Assuming that the ratio of feed cost, labour cost, etc. to the gross cost remained the same, the cost of production per kilogram of milk was calculated. Laspeyres method was used for preparation of the index of cost.

During the period under report the final report was prepared incorporating the results obtained in Tamil Nadu, West Bengal and the milk collection areas of D.M.S. The salient results were as follows:

.....50/-

Tamil Nadu:

The cost of production including family labour per kilogram of cow milk at the time of detailed enquiry (1957-59) was 48 paise in the rural area, 67 paise in the sub-urban area of Madras and 59 paise in Madras city and these costs were 28 paise, 49 paise and 55 paise in the three areas respectively when family labour was excluded. The production costs per kilogram of buffalo milk in these three areas were 52 paise, 44 paise and 38 paise when family labour was included and 33 paise, 31 paise and 57 paise when family labour was ignored. During 1960-71 the production costs both for cow milk and buffalo milk increased by 75 to 120 per cent in these areas as compared to the costs obtained during the detailed enquiry. The prevailing market rate, too, increased, the rate of increase being higher in the rural area as compared to the other two areas. The producers of both cow milk and buffalo milk in the rural area, and of cow milk in the sub-urban area could not meet their production cost when family labour was included but the producers in Madras city realised profit both for cow milk and buffalo milk.

West Bengal:

The production cost during 1960-62 per kilogram of cow milk was 66 paise in the rural area, 65 paise in the sub-urban area and 81 paise in Calcutta city when family labour was included and the corresponding costs excluding family labour were 44 paise, 34 paise and 80 paise in these areas respectively. In case of buffalo milk, the cost of production was 92 paise per kilogram in Calcutta

when family labour was included and 89 paise, when family labour was ignored. During 1969-71 the production cost increased by 70 to 100 percent in the rural area, 95 to 130 percent in the sub-urban area and 90 to 108 percent in the urban area, as compared to the costs obtained during the detailed enquiry carried out in 1960-62. The prevailing market rate also increased by 80 to 105 percent in the three areas, being more in the rural area. The producers of cow milk in the sub-urban and the rural areas as also in the Calcutta city could not meet their production cost when family labour was included, although the producers of buffalo milk in Calcutta city realised profit.

D.M.S. milk collection areas:

The cost of production of cow milk including family labour during 1966-67 was about Rs.1.20 in the supplying areas and 93 paise in the non-supplying areas. These costs were 97 paise and 73 paise in the two areas respectively when family labour was excluded. In the case of buffalo milk, the production cost was 78 paise and 68 paise in the supplying and the non-supplying areas respectively when family labour was included and 63 paise and 55 paise in these two areas respectively when family labour was ignored. During 1969 - 71 the production cost increased by 3 to 13 percent in these areas as compared to the cost obtained in 1966-67. Although the prevailing market rate increased by 8 to 24 percent, the producers of cow milk could not meet the production cost even when family labour was excluded. However, the producers of buffalo milk both in the supplying and the non-supplying areas realised some net return even when family labour was included in the production cost.

(K.C. RAUT and H.B. CHAUDHARY)

3.9. Pilot survey for estimating area of grazing land and its utilization.

The objective of the survey was to evolve a suitable sampling technique for estimating, with reasonable degree of precision, (i) the area of grazing land, (ii) the average yield of grass per unit of grazing area in different seasons and (iii) botanical and chemical composition of grasses and to obtain information on grazing practices in the area.

Data on a few samples for chemical analysis were obtained during the year under report. The data obtained earlier from a detailed survey on area of grazing land and yield of grass carried out in Jhansi District of Uttar Pradesh were also analysed. The estimates of the mean grazing area and the mean yield of grass per cut were obtained for each month of the rainy and the winter season separately for the four strata formed according to geographical contiguity. Overall estimates of mean area of grazing and of yield per cut were obtained by first pooling the data over months, weighting each month's mean inversely with the variances. These were then pooled over strata without weighting as the selection probabilities were calculated for each stratum separately. The final report on the project was prepared and presented to the scientific panels of the I.C.A.R.

The average grazing area per village in the rainy season was 121.42 hectares and that in the winter season 83.47 hectares which constituted about 15 per cent and 9 per cent respectively of the geographical area in a village. No grazing was available in the summer season. The average

of herbage per hectare was estimated to be 6.24 quintals in the rainy season and 1.78 quintals in the winter season, when cuts were taken before grazing. The corresponding figures based on cuts taken after grazing were 5.44 quintals and 1.52 quintals respectively. On an average, 19 kg. of grass was consumed per cattle per day. In both the seasons, one-third of the weight of the grass sample was nitrogen free extract, and one-fourth crude fibres. Ash, crude protein and ether extracts in the sample formed about 13%, 8% and 1.7% respectively in the rainy season and 11%, 6% and 11.5% respectively in the winter season.

(U.G. NADKARNI, K.C. RAUT, B.C. SAXENA and P.R. SREENATH of the I.G.F.R.I., Jhansi).

Study of the impact of milk supply schemes on rural economy in milk collection areas.

The object of the scheme was to develop a suitable sampling technique for the purpose of assessing changes likely to accrue as a result of assured market and guaranteed price of milk in respect of i) milk production in the area and its cost, (ii) employment due to milk production, its handling and fodder production, and (iii) economics of production of selected fodder and other crops.

The data of bench-mark survey in the milk shed areas of Dadhsagar Dairy, Mehsana (Gujarat) which was carried out during 1967-68 were processed for statistical analysis during the year under report. These pertained to milk production and its utilization, the quality, quantity and

composition of feed given to animals, changes in number of milch animals, breed and age composition of animals, major and subsidiary occupations of householders, cropping pattern, cost of production of fodder and other crops, return from various crops, income from dairying, fodder production, etc. The design adopted for this survey was one of stratified two-stage sampling. Three groups of contiguous talukas in Mehsana district were formed according to the flow of milk from the various talukas to constitute the three strata. Clusters of villages within each stratum formed the primary sampling units and households within a cluster formed the second stage units. The villages in each stratum were divided into two groups: those supplying milk to organised milk schemes and those which did not supply milk to any organised milk scheme. In all, 60 clusters of three villages each within a radius of 5 km. from one another, 30 each from the supplying and non-supplying areas, were selected at random. With the help of the sampling frame obtained through enumeration of the households in the selected villages, a sample of 10 to 18 households representing various categories of commercial milk producers were selected in each cluster. For detailed enquiry these households were kept fixed for observations through-out the year. For enquiry and data were collected from them through fortnightly visits by a trained investigator located in one of the villages. It was found that in commercial milk producing households, the average daily milk yield of a cow in the supplying areas was 2.5 kg. in the supplying areas and 2.1 kg. in the non-supplying areas. The corresponding averages per buffalo

the milk were 4.6 kg. and 4.1 kg. respectively. On an average, 216 tonnes of milk was produced per day in the district, of which 40 per cent was from the supplying villages. The bulk of the milk produced (92%) was from buffaloes. The commercial and private milk producers contributed equally to the total milk production. Sixty-six per cent of the buffaloes in the supplying area were in milk whereas the percentage of cows in milk was as low as 42. In the non-supplying areas the corresponding figures were 56 and 42 respectively. The final report of the benchmark survey which was carried out in the milk-shed areas of Delhi Milk Scheme during 1966 - 67 was prepared and placed before the Scientific Panel of the I.C.A.R. The salient results of this survey had been reported in the annual report for 1971.

(J.P. JAIN, P. NARAIN, B.C. SAXENA and K.P.S. NIRMAN).

3.11 Repeat sample survey to study the impact of milk supply schemes in milk collection areas of Delhi Milk Scheme and Dudhsagar Dairy, Mehsana.

The objective of the survey was to develop a suitable sampling technique for assessing the changes that are likely to accrue as a result of assured market and guaranteed price of milk offered by urban milk supply schemes in respect of (i) milk production and its cost, (ii) economics of production of selected fodder and other crops, and (iii) overall income of both milk producers and non-producers.

Data were collected from a sample of randomly selected households from a sample of 180 villages spread over the districts of Meerut, Bulandshahr and Gurgaon. Various items such as quantity of milk produced, quantity and composition of feed given to the animal, various components of cost of production of milk, feed and other crops, main and subsidiary occupations of producers, size of agricultural and livestock holdings, changes in cropping pattern, return from milk production and receptivity of producers to improved animal husbandry practices. The data on milk yield of the selected animals and feed supplied to them were obtained through actual weighing and data on other items were obtained through careful enquiry. Estimates of yield of fodder and other crops were obtained through crop cutting experiments conducted in the fields of the selected cultivators. Sorting and coding of the data was in progress during the year report.

(B.B.P.S. GOEL, P. NARAIN, and K.P.S. NIRMAN)

3.12 Standardisation of the procedure of sampling of fleeces for study of wool quality.

The objective of the project was to standardise the procedure of sampling for assessing wool quality of a fleece as well as that of fleeces from a group of sheep as to provide a basis for all scientific studies on wool quality. Data on quality characters, viz; fibre diameter, crimps per cm, fibre length, staple length, medullation percentage and fleece density of regional and composite

samples of ewes of Nilgiri, Nilgiri x Romney Marsh farm flocks and Nilgiri sheep of village flocks collected from Sheep Breeding Farm, Kamarajagar, Ootacamund (Tamil Nadu) and ewes of Chokla and Polworth x Rampur Bushair crosses collected from C.S.W.R.I., Avikanagar (Rajasthan) were utilised for the study. Having obtained the estimates of averages and their standard errors for all quality characters as mentioned earlier, the data were utilised to estimate the number of sheep to be selected from groups of sheep of sizes ranging from 20 sheep to 500 sheep to estimate the mean with standard error of 1%, 2% and 5% of mean. This was done separately for regional sampling with 20 cuts per sheep and for composite sampling procedure with 3 sub-samples per sheep. Out of the three composite sampling methods one which had the least coefficient of variation was used for estimating sample sizes.

Generally, in all the cases, it was observed that the sample of sheep to be selected remained almost constant with increase of flock size above 100 for 5% level; it gradually attained a constant value for 2% level as flock size increased upto 450 whereas it showed a linearly increasing trend for 1% level. The number of sheep to be selected differed widely over the three levels of standard errors of mean, over the age groups and also over the different characters. Also, the observed flock sizes ranged from 20 sheep at C.S.W.R.I., Avikanagar to 60 sheep at Sheep Breeding Farm, Kamarajagar in farm flocks and were of the order of 75 in village flocks.

The sub-sampling rate was calculated for 1,2,3 and 4 per region per sheep in the case of regional sampling for 2 and 4 sub-samples per composite sample of least coefficient of variation. The number of sheep to be selected did not sufficiently decrease with increase the number of cuts or sub-samples so as to make the procedure less costly. On the whole, it was observed that composite sampling may be adopted when the regional and variation are not to be estimated for grading of

(B. MARUTIRAM, U.G. NADKARNI, and T.B. JAIN).

3.13 National index of animal experiments:

The objective of the project was preparation of compendia of the results of the experiments on animals carried out in the country.

The data pertaining to experiments collected from research stations were first scrutinised and those which are amenable to statistical analysis were processed and analysed by applying the analysis of variance and covariance techniques. Regression analyses were also made for growth and requirement studies. The results obtained were categorised and put in appropriate format for inclusion in the compendium.

During the year under report, data pertaining to 50 experiments on Animal Nutrition were collected from U.P. College of Veterinary Science and Animal Husbandry, Mathura. Data pertaining to 60 experiments on Animal Nutrition carried out at I.V.R.I., Izatnagar during the period 1965-70 were statistically analysed and put in

The desired format. The preparation of the Compendium of Nutritional Experiments carried out at I.V.R.I. during the period 1945 to 1970 was completed.

(A. DEY, T. JACOB, and S.N. BAJAJ)

Pilot studies for estimation of birth and death rates in bovines for preparation of life tables.

The objective of the scheme was to estimate age-specific fertility and mortality rates among cattle and buffaloes with a view to constructing life tables for bovines. During the year under report, the work of collection of census data on bovines through complete enumeration of selected villages at the first centre, namely, Vijayawada area of Andhra Pradesh, was completed. Data pertaining to 60 out of the 132 selected villages were received and were being processed. 30 households from each selected village were to be visited successively for detailed information on mortality, fertility etc. of bovines. The first visit was completed by the field staff and the second visit was initiated.

(T. JACOB, B. MARUTIRAM and S.N. ARYA.)

3.15 Statistical studies of data on artificial
insemination in sheep.

The object of the investigation was to compare differences among breeds and among rams within breeds in respect of semen quality as also the results obtained with different diluents in relation to lambing. Data on volume of semen ejaculated, p^H value, number of sperms per ml of volume, percent live spermatozoa, M.B.R. time and initial motility were available for 24 rams belonging to different breeds, Data on keeping quality of semen were also available for semen diluted at the rate of 1:3 or 1:4 and stored in E.Y.E. at a temperature between 0-1°C and 4°C.

in E.Y.E. at
temperatures
between 0-1°C
and

Comparison of differences among breeds and among rams within breeds in respect of semen quality was made. The comparison of keeping quality with different diluents was made after adjusting differences among breeds. Differences were significant only in respect of volume of semen ejaculated and p^H value and not significant in respect of other characters. Rams within breeds were not significantly different in respect of abnormal sperms and M.B.R. time, but they differed in respect of other characters. A comparison of keeping quality of semen diluted at the rates of 1:3 or 1:4 showed that different diluents and temperatures showed different keeping quality of semen.

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4.
SAMPLE SURVEY INVESTIGATIONS

Sample survey investigations undertaken by the Institute aim at evolving suitable sample survey techniques and demonstrating their feasibility in collecting information relating to a wide variety of fields in agriculture and animal husbandry. The investigations which were in progress during the year under report are briefly described in the following paragraphs. The names of the principal investigator and his associate or associates are given at the end of the description.

Pilot sample surveys for developing an integrated technique for estimation of principal livestock products and study of attendant animal husbandry practices.

The objectives of the surveys were to develop an integrated technique for estimation of annual output of principal livestock products, viz., milk, wool, egg and meat and to study attendant animal husbandry practices.

Two pilot sample surveys were proposed under the project, i.e. one in the northern region comprising Punjab,aryana and Himachal Pradesh and the other in Andhra Pradesh of the southern region. The field work in the first centre was successfully completed and data of third round covering wool and meat as main products were collected during the year. In southern region, data on milk as principal product were collected during the year under report. Statistical studies on the data collected in the northern region were in progress.

The sampling design adopted in the pilot investigation was such that the primary units consisted of matched and un-matched units. Critical study of the data on milk yield collected during 1969 - 70 and 1970 and 1970 - 71 in northern region was continued during the year. The studies pertained to estimation of changes in milk yield from season to season and year to year and coefficient of correlation between levels of production in different years etc. during the year.

The results of the analysis were being finalized by (J.N. Garg, V.V.R. Murty, J.S. Maini and K.B. Singh).

4.2 Preparation of monograph on methodology of estimation of poultry egg production and poultry practices.

The objectives of the project were (i) to compile the results of pilot sample surveys for estimation of egg production and study of poultry practices conducted in various States of the country and (ii) to give an account of the technique evolved for improvement of statistics on egg production and poultry practices in the country.

Detailed data on poultry egg production and poultry practices had been collected in the past through pilot sample surveys conducted in various tracts of the country. The data on egg production were utilized to build up estimates of level of production per layer per year and also total egg production in different States also for the entire country. The per capita per year availability of eggs was also estimated from such data.

A further study was taken up to build up estimates of per capita availability of poultry meat during the year in different States of the country. Such studies were completed in respect of five States.

In working out per capita availability of eggs in 1966, an estimate of total egg production available for consumption was worked out for each State. For this purpose, the data collected on utilization of egg production in selected households were utilized. Similarly, for estimating per capita availability of poultry meat, the data on utilisation of poultry birds in selected households for different purposes were used. An estimate of number of birds consumed during the year in a tract was obtained and this estimate together with the estimate of human population projected for the year 1966, and estimate of dressing percentage of poultry meat were utilized to work out an estimate of per capita availability of poultry meat in a year.

An estimate of total egg production in the country during 1966 was obtained as 46978 lakh eggs. The per capita availability of eggs during 1966 was estimated as 8.

(V.V.R. MURTHY, D.V.S. RAO and J.S. MAINI)

4.3 Availability of feeds to cattle and buffaloes in India.

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The objective of the investigation was to estimate per animal availability of feed together with T.D.C.P. values to cattle and buffaloes in different tracts of India.

Detailed information on supply of feed to cattle and buffaloes was collected earlier through pilot surveys for estimation of milk production and for study of husbandry practices conducted in various tracts of the country. The data were used to build up estimates of feed supply to cattle and buffaloes in the various areas. During the year, action was taken to consolidate such results in various tracts covered under the surveys. The results included average supply of feed per animal per day and per head per day availability. In respect of States where such surveys were carried out and for which the results were available, necessary steps were taken to press the State Statisticians to complete the necessary statistical analysis.

Under the study two types of estimates of feed were built up for each area. The first estimate gave average consumption of feed per day per animal and for purpose only those animals which were given the particular feed on the day of visit were suitably included in working out the average. The second estimate indicating per day availability included all animals irrespective of the fact whether they were given the particular feed or not on the particular day of visit.

The study was in progress.

(S.S. RAO, V.V.R. MURTY, and J.S. MAINI)

Estimation of annual meat production and its per capita availability in India.

The objective of the investigation was to prepare a bulletin giving estimates of annual meat production and its per capita availability in different states and also for the country as a whole. Pilot sample surveys for developing suitable sampling methodology for estimation of annual meat production in the states of Tamil Nadu and Haryana was conducted by the Institute. Further, information on the number of animals slaughtered privately, i.e., outside registered slaughter houses, was collected through the pilot sample surveys for estimation of milk production and study of bovine keeping practices conducted by the Institute in various states during the third and fourth five year plans. In addition to this, data on meat production were also collected in the scheme "Pilot investigations for developing an integrated technique for estimation of major livestock products and study of attendant animal husbandry practices in the Northern Region, that is, Punjab, Haryana and Himachal Pradesh".

Meat production was estimated as a product of the number of animals slaughtered and the average meat production per animal. The estimate of the number of animals slaughtered consisted of two components, i.e., number of animals slaughtered in the registered slaughter houses for which a complete count was available, and the

number slaughtered privately. The second component estimated by using the data collected under the same surveys. Similarly, the estimates of average meat production per animal as available from the surveys was used to estimate the total meat production. During the year under report, the analysis was completed for most of the areas. The final results were to be worked out after receiving the necessary data from States like Uttar Pradesh, Madhya Pradesh and Rajasthan where similar surveys have been conducted.

(K.B. SINGH, J.S. MAINI and V.V.R. MURTHY)

4.5 Preparation of a monograph on methodology of estimation of meat production.

The objectives of the project were (i) to compare the results of pilot sample surveys for estimating meat production conducted in Tamil Nadu and Haryana States (ii) to give the exposition of the technique evolved for estimation of meat production in the country.

Detailed information on the number of animals slaughtered, yield of meat production per animal and practices of disposal of meat produced was collected under pilot surveys. Such information had been utilized to estimate the total number of animals slaughtered privately, average meat production per animal and total meat production, besides providing useful data on the prices, utilization of meat, etc. During the year under report a further critical study leading to the estimation of size of sample required for estimating the annual meat production was carried out.

The information on number of animals slaughtered in the registered slaughter houses had been obtained from the State Directorates of Animal Husbandry. Similarly in regard to the private slaughter, the data from the pilot surveys had been utilized to build up estimates of number of animals slaughtered privately. Such estimates together with the estimate of average meat production per animal as worked out from the data collected from registered slaughter houses had been utilized to build up estimates of annual meat production. The results on size of sample required at different stages under the survey were being finalised.

(J.S. MAINI, V.V.R. MURTHY and K.B. SINGH)

4.6 A study on the mortality of bovines.

During 1966-67, cattle mortality surveys were conducted in selected pockets of Andhra Pradesh and Nadu to provide a basis for implementing a pilot scheme for cattle insurance. The areas chosen were 61 contiguous villages in Krishna district of Andhra Pradesh and 61 contiguous villages in Chingleput district of Tamil Nadu. From each of the villages covered by the survey 40 households having cattle or buffaloes were randomly selected with equal probability without replacement. These households were visited every month for recording changes in cattle population and for collecting necessary data for estimating mortality rates.

In the 61 villages selected in Andhra Pradesh there were 81,640 bovines of which 70% were buffaloes and the remaining 30% were cattle. Among cattle, 44.3% were bullocks, 23.3% milch cattle, 31.6% young stock below 3 years of age and the rest belonged to other categories. The corresponding figures for buffaloes were 33.3%, 33.3% and 42.7% respectively while the rest belonged to other categories. The annual mortality rate for young stock of cattle was estimated at 2.1% for males and 1.7% for females. The annual mortality rates for working bullocks, cows in milk and dry cows in the age group 3 to 10 years were 1.6%, 3.1% and 2.3% respectively. The corresponding figures for those above 10 years of age were 4.1%, 10.7% and 10.7% respectively.

The annual mortality rate for buffalo calves below 3 years of age was 19.3% for males and 8.3% for females. The rates for buffaloes in the age group 3 to 10 years was 5.8% for working bullocks and 1.1% for both buffaloes in milk and dry buffaloes. No deaths of working buffalo bullocks above the age of 10 years were reported. The annual mortality rate for the buffaloes in milk above 10 years of age was 2.6% and for dry buffaloes, 5.7%.

In the 60 villages selected in Tamil Nadu there were 30,903 bovines, of which 73.5% were cattle and the remaining 26.5% were buffaloes. Among cattle about 37% were working bullocks, 32% were milch cattle, 28.5% were young stock below 3 years of age and the remaining 2.5% belonged to other categories. Among buffaloes 10% were working bullocks, about 57% were milch buffaloes, 29% were young stock and the remaining 4% belonged to other categories. The annual mortality rate for male young stock and female young stock of cattle were 9.9% and 7.7% respectively. In the age group of 3 to 10 years working bullocks had an annual mortality rate of 2.1%, cows in milk, 1.4% and dry cows, 5.3%. In the age group above 10 years the rates for these three categories were 3.7%, 5.7% and 21.6% respectively.

As in Andhra Pradesh, the mortality rates of young buffalo calves was very high. They were 29.5% for male calves and 21.6% for female calves. In the age group of

3 to 10 years the working bullocks had an annual rate of 3.5%, buffaloes in milk, 0.9% and dry bullocks 2.3%. The corresponding figures for the buffaloes above 10 years of age were 13.0%, 1.3% and 14.5% respectively. In both cattle and buffaloes, the mortality rate was higher in the age group above 10 years as compared to the age group between 3 to 10 years.

(M. RAJAGOPALAN AND S.S. GUPTA)

4.7 Methodology for estimation of inter - censal live-stock numbers through livestock products surveys.

The main objective of the scheme was to evolve suitable models for estimating livestock numbers pertaining to different periods in between censuses with the help of the data collected through pilot sample surveys carried out by the Institute in typical animal husbandry tracts of the country for developing an integrated technique for estimation of principal live-stock products and also to study the attendant animal husbandry practices.

During the year under report some of the data collected from the centres located in the northern part of the country were processed and further work was in progress.

(M.S. AVADHANI and J.S. MAINI)

4.8 Estimation of the cost of production of apples and study of their marketing practices in the Himalayan Region of Uttar Pradesh.

The objectives of the investigation were (i) to determine realistic cost of different components and possible to work out an index which could be used for determining the cost of cultivation from year to year taking into account the fluctuations in the cost of various inputs, and (ii) to study existing marketing practices of apples in the region.

Data on inputs, material labour and overhead costs were being collected by whole time field-man cost accounting method from 20 clusters of 3 villages. These clusters were spread over important apple growing region of Uttar Pradesh, viz; the districts of Almorah, Nainital, and Uttar Kashi, and the Chamba-Mussorie belt. It was intended to collect reliable information on production, marketing of apples and study factors influencing demand of apples of different varieties and grades. For this purpose, 13 marketing centres were selected.

The field work of the survey was initiated in October, 1972.

(A.H. MANWANI, BHAGAT SINGH, B.L. KAUL,
K.L. KAUL and S.K. MAHAJAN).

4.9 Pilot sample survey for developing sampling technique for estimation of production of vegetables

The objectives of the survey were to examine the feasibility of estimating the extent of cultivation, yield rate and total production of important vegetable crops through sample survey techniques and to collect reliable data on cultivation practices and marketing of vegetables in vegetable growing areas around important cities.

During the year under report, the data of the first round of the survey completed in September, 1972 were scrutinized and preliminary tabulation was completed. The technical programme and the sampling design for undertaking the second round of the survey were finalized and the field work was initiated.

The sampling technique adopted for conducting this survey was one of multi-stage stratified random sampling with talukas or groups of talukas in the district forming strata. For collecting data on the extent of cultivation, the design was uni-stage stratified with clusters of villages forming sampling units for estimating the production of different vegetable crops. The entire year was divided into four periods starting from October. Within each village two fields which were expected to be harvested during the period were selected for each of the eight major vegetable crops under yield study. Within each field, a crop cutting plot of size 5 X 5 sq. meters was selected and data on yield recorded as and when the harvesting took place in the selected field. The data on cultivation practices and marketing of vegetables were collected by enquiry from the cultivators of the fields selected for obtaining data on yield. Apart from this, the data on prices prevailing during different seasons were collected from important vegetable markets in the district. The data of the first round were received and were being analysed.

(A.H. MANWANI, A.K.* SRIVASTAVA and SATYA PAL)

4.10 Pilot sample survey for the study of yield and cultivation practices of fresh fruits

A state-wide integrated sample survey was carried out in Andhra Pradesh during the years 1954-55 and 1955-56. The object of estimating the extent of cultivation of different fruit crops, average yield rate and total production of important fruit crops like mango, banana, citrus and reliable information on the cultivation practices of mango, banana and citrus fruit crops by orchardists all over Andhra Pradesh. During the period under report, the final report on the survey was published.

The sampling design adopted for the survey was a two phase stratified multistage random sampling. For the purpose of conducting the survey, a sample of 32 talukas (accounting for 61% of the area under fresh fruit crops in the state) out of 188 talukas in the state was selected in the first stage by a suitable probability scheme and from each of the selected talukas a sample of 15 to 20 villages was selected. Each of the selected villages was completely enumerated so as to record the number of trees according to important varieties of different fruit crops as well as according to bearing and young categories. For estimating the average yield per tree of mango, banana and citrus crops, a sample of 12 trees was selected from the number of bearing trees of each of the main varieties of the fruit crop grown in the village. The total area under all fruits crops in the state was estimated by

2,54,000 ha. of which about 64% was under mango, 15.7% under citrus and 15.3% under banana. The total number of orchards was estimated at 3.5 lakhs of which 88% were bearing. Among the bearing orchards 53% were of mangoes, 42% of banana and 15% of citrus. About 14% of the orchards were mixed orchards having trees of two or more fruits planted together. The total number of fresh fruit trees in regular orchards during 1955-57 was estimated at 60 million with a standard error of 11.90 per cent. Out of these, 11 million trees were of mango, 7.7 million of citrus and 41.0 million of banana. The trees of other minor fruit crops accounted for 0.5 million only. The distribution of trees according to bearing and young categories indicated that among mangoes only 6% were young trees as compared to 48% in the case of citrus. The pattern of fruit cultivation over the three regions, viz., coastal Andhra Pradesh, Rayalseema and Telengana indicated that 75% of fresh fruit cultivation was concentrated in coastal region, 22% was concentrated in Rayalseema and 3% in Telengana. The coastal region accounted for 69% of the cultivation of mangoes and 85% of the cultivation of banana. Rayalseema was most important for citrus (62%) cultivation. The average size of an orchard was estimated at 1.01 ha. in case of mangoes, 0.69 ha. for citrus and 0.31 ha. for banana.

The study of yield of fresh fruit crops indicated that on an average a bearing tree of mango yielded 231 fruits weighing 48.35 kg; while a bearing tree of citrus

yielded 532 fruits weighing 81.51 kg. and that of
yielded 136 fingers weighing 11.45 kg. per plant.
study of yield according to major varieties indicate
that Bangampalli variety of mango gave a maximum
of 51 kg. while Swarnrekha yielded a minimum of 3
per tree. Similarly, amongst citrus fruits, the
group including Sathgudi, Bataria and Chinni had
yielding capacity of 605 fruits weighing 130 kg.
the average yield of lime was estimated at 975 fr
weighing only 36 kg. per tree. Amongst banana all
major varieties excepting Tellichakrakelli were f
to have more or less the same yielding capacity of
135 fingers per stalk, the Tellichakrakelli variety
yielding the minimum of 66 fingers per stalk. The
ing capacity of mango tree was found to increase
age upto 40 years.

So far as the cultivation practices of mango
banana and citrus crops were concerned, the results
the survey indicated that the average distance bet
plants was of the order of 12.12 metres in the case
mango, 8.08 metres in the case of citrus and 3.08
in the case of banana. In majority of the cases
type of mango orchards was sandy loam, while it was
for banana orchards. Citrus orchards were found
on all types of soils. Both citrus and banana orch
were commonly irrigated while only 30% of the mango
received irrigation. The main source of irrigation

well, followed by canal or tank. It was reported that citrus and banana orchards were irrigated uniformly through-out the season receiving at the most 32 and 56 irrigations respectively while mango orchards were irrigated irregularly receiving at the most 15 irrigations in a year. The use of chemical fertilizers was found to be quite common on banana while only 12% of the mango and 32% of the citrus orchards were reported to have received chemical fertilizer. The most common fertilizer was reported to be Ammonium Sulphate. Urea and Super Phosphate were also applied in some cases. The average rate of application of Ammonium Sulphate was reported to be 2.67 kg. per tree of citrus and 0.44 kg. per banana plant, and that of urea was only 0.5 kg. per citrus tree and 0.12 kg. per banana plant. Digging and pruning was a rare practice in mango orchards but pruning was reported in about 30% of the citrus orchards. About 60% of the marketable fruit was carried by bullock-carts. All the fruits were sold in term of numbers packed in baskets.

(A.H. MANWANI)

4.11 Pilot sample survey for developing sampling techniques for estimation of production of fresh fruit crops in Tamil Nadu.

The objectives of the survey were (i) to study the technical and organizational problems associated with the conduct of large scale integrated surveys on fresh fruit crops, (ii) to obtain reliable estimates of the

extent of cultivation under major fruit crops, (ii) to obtain reliable estimates of yield rates and total production of major fruit crops grown in the region, (iii) to study the variation in respect of yield over different varieties of a given fruit crop and (iv) to collect data concerning cultivation practices, incidence of pests and diseases and marketing of fresh fruit crops in the region.

The data collected in the survey might, therefore, be classified into three categories, i.e., (i) extent of cultivation of fruits as indicated by their acreage, number of orchards, number of fruit trees according to bearing and young categories as well as according to different varieties, (ii) yield of selected fruits according to important varieties of a given fruit crop both in terms of weight and counts of fruits, and (iii) cultivation and marketing practices of major fruit crops like mango, banana, citrus and grapes.

The field work of the survey carried out in the state of Tamil Nadu was contemplated to be completed by November, 1972, but due to some administrative difficulties resulting in a delay in commencement of the field work according to schedule, the survey had to be extended for a period of nine months i.e., up to July, 1973. All districts in Tamil Nadu were covered under this survey. The data were collected from 600 villages for estimating the extent of cultivation of fresh fruit crops and 100 villages for studying yield and cultivation practices of important fresh fruit crops like mango, banana, citrus and grape.

The sampling design adopted for the survey was stratified two phase multi-stage random sampling design. All the districts in the state were grouped to form four major fruit growing belts and within each such major stratum tehsils were grouped to form sub-strata on the basis of the extent of cultivation of different fruit crops. Within each stratum/sub-stratum, villages formed the primary units of sampling, orchards as secondary units of selection and clusters of trees as ultimate units of sampling.

During the year under report, the field work of the survey was in progress. However, some data were received and these were being processed.

(A.H. MANWANI, A.K. SRIVASTAVA, and K.R. RAJGOPALACHAR)

4.12 Sample surveys for the assessment of high yielding varieties programme.

The objectives of the surveys were to collect through assessment surveys based on random sampling techniques, objective and reliable data on (i) the spread of high yielding varieties of rice, wheat, maize, jowar and bajra, (ii) the yield rates of high yielding varieties of the above crops and comparative estimates of yield rates of the local indigenous varieties and (iii) the extent of adoption of the associated improved practices such as fertilizer application, plant protection measures, etc. recommended to the cultivators.

Data pertaining to crop cutting experiments A.A.E. enquiry for 1971-72 were partly received from the States. Detailed report embodying the results of crop cutting experiments, giving yield rates of high yielding varieties and local varieties with correct rates of application of fertilizers, conducted during kharif and rabi 1970 - 71 in various States was submitted during the year under report. The data of A.A.E. enquiry for kharif 1970 - 71 giving the area under programmed high yielding variety crops and adoption of package of practices were also analysed during the period.

The data on yield rates were collected by conducting crop cutting experiments in selected States while those on doses of NPK, area under high yielding varieties and extent of adoption of improved agricultural practices were obtained by enquiry from selected farmers. The data were coded at the State level, checked at the Institute. The information in the schedules was then transferred to punch cards and processed on the electronic computer. The analysis of data was done by appropriate statistical procedures available for stratified multi-stage sampling design.

During rabi 1970-71 all the five programmes were covered. The crop-wise coverage in the different States was as follows:

- i) Rice: Andhra Pradesh, Tamil Nadu, Mysore and Orissa.

- ii) Wheat: Assam, Bihar, Gujarat, Haryana, Madhya Pradesh, Maharashtra, Mysore, Punjab, Rajasthan and Uttar Pradesh.
- iii) Maize: Andhra Pradesh and Mysore.
- iv) Jowar: Maharashtra and Mysore.
- v) Bajra: Tamil Nadu,

The salient results were as given below crop-wise:

- i) Rice: In the four States where this crop was covered under the programme, IR-8 variety of paddy was grown by a majority of the selected farmers. The other high yielding varieties of paddy tried were CO-29, TN-1, IR-5, Jaya, Padma and ADT-27. The highest average yield of 48.8 Q/ha (in terms of milled rice) was recorded for IR-8 variety of paddy in Mysore district of Mysore State. Pooled over all the high yielding varieties and the selected districts in a State, the highest average yield of 40.5 Q/ha was recorded in Mysore State while the lowest average yield of 24.6 Q/ha was recorded in Orissa State. The rates of application of N, P and K (kg/ha) were, however, highest in case of Tamil Nadu.

- ii) Wheat: In almost all the States covered under the programme, the most common high yielding varieties of wheat grown were Sonalika and Kalyan Sona. The other varieties tried were Sonora-64, Lerma Rojo Safed Lerma, NP-824, NI-917, NI-747-19, Choti Lerma

PV - 18, Lal Bhadur, Sharbati Sonora and HDM-1593. A record average yield of 54.7 Q/ha was observed for the variety Kalyan Sona in Mandasaur district of Madhya Pradesh followed by 42.4 Q/ha for HDM-1593 variety in Bulandshahar district of Uttar Pradesh. Pooling the high yielding varieties as well as the selected districts in a State, the highest average yield of 47.7 Q/ha was reported in the State of Madhya Pradesh while the lowest average yield rate of 12.3 Q/ha was recorded for the State of Mysore. The rates of application of chemical fertilizers in terms of (nutrient content) N, P, K (kg/ha) were also the highest in Madhya Pradesh. It was also seen that these rates were the lowest in Mysore State.

iii)

Maize: The most common variety of hybrid maize grown by the cultivators in both the States, viz., Andhra Pradesh and Mysore was Deccan hybrid. The other hybrids of maize tried were Ganga-3 and Ganga-5. The highest average yield of 47.6 Q/ha was observed for Deccan hybrid in Mysore district of Mysore State. The yield rate of hybrid maize was high in Mysore State as compared to Andhra Pradesh although the rates of application of N, P, K were almost of the same order in both the States.

Jowar: CSH-1 variety of hybrid jowar was the only variety grown by all the farmers in both the States of Maharashtra and Mysore. The highest average yield was observed in Mysore State where the corresponding rates of application of chemical fertilizer were also higher.

Bajra: Bajra was covered only in the State of Tamil Nadu. The hybrid variety HB-4 of bajra gave the highest average yield of 24.3 Q/ha in Coimbatore district of the State. However, the rates of application of N, P, K (kg/ha) were much lower than the recommended rates in the State.

(S.K. RAHEJA, B.B.P.S. GOEL, A.K. BANERJEE,
P.C. MEHROTRA and V.S. RASTOGI)

Growth of minor irrigation projects and their effects on agriculture.

The main objectives of the investigation were

- (1) comparative study on the growth of minor irrigation projects, (2) estimation of additional area brought under cultivation as a result of minor irrigation projects, (3) comparative study on area irrigated by minor irrigation works, and (4) study of the behaviour and nature of changes in cropping pattern due to minor irrigation works.

In order to study the benefits of irrigation from minor irrigation works (State Tube-wells), a sample survey was conducted in the district of Nainital of Uttar Pradesh during July, 1972. The students of Professional Statistician Certificate and Senior Certificate Courses conducted the field work under the technical direction and supervision

of the officers of the Training Unit of the Institute, was observed that on an average a tube-well could irrigate only about 112 acres during 1971 - 72 and about 123 acres during 1970-71. Enquiries made with the selected cultivators as also the tube-well authorities present at the time of field work indicated that some of the tube-wells were not functioning to their full capacity largely due to defects and inadequate irrigation channels. The poor performance of tube - wells could also be attributed to lack of electricity power when required. Uneconomical working and the unsuitable location of tube-wells from operational angle were also considered as some of the causes for the unsatisfactory working of the tube-wells and to these could also be added the indifference of illiterate and poor cultivators in regard to availing of irrigation facilities created by tube - wells.

(S.C. RAI, M.N. DAS, and R.K. BOHRA)

4.14 Sample surveys to study the impact of the recent war on the agricultural and animal husbandry activities in the border areas.

The objective of the surveys was to study the impact of recent war on the agricultural and animal husbandry activities in the border areas with a view to provide information on the loss of crop production, output of

livestock products and changes in the availability of feed, fodder, fertilizer, seed, labour, irrigation and other agricultural inputs on account of hostilities.

Information on the impact of war on the various agricultural and animal husbandry activities such as sowing, harvesting, supply of various inputs such as seed, fertilizers, labour, irrigation and pesticides, wages of agricultural labour, marketing of the agricultural produce, extent of evacuation of livestock, any unusual sale or mortality of animals; supply of feed and fodder to the livestock and disposal and marketing of livestock products, etc., was collected by enquiry from Patwaries/W.L.s of randomly selected villages in the nine border tehsils of Punjab State. The impact of hostilities on the various agricultural and animal husbandry activities was estimated in terms of percentages or proportions of the total value or in terms of extent of loss or damage as nil, slight, moderate, heavy and very heavy.

It was observed that there was a considerable impact of the hostilities on the agricultural and animal husbandry activities in the border areas in terms of loss of crop production and livestock, adverse affect on the supply of agricultural inputs, fall in wages of agricultural labourers in some areas and rise in others. In many areas certain commodities were cheaper while others were costlier. In certain other areas, the effect on prices of these commodities was in the opposite direction.

4.15 Pilot study for evolving sample survey techniques for estimation of production of cultivated fodders.

The object of the study was to evolve a method of estimating production of cultivated fodder which could be used in regular annual surveys. Data on yield of kharif fodders were collected during the season in about 300 crop cutting experiments conducted in the district of Meerut in Uttar Pradesh during the year under report. Fodder samples were also collected for analysis in about half of the plots where these experiments were carried out. As the scheme was taken up late in the year under report, the data collected could not be taken up for analysis till the end of the year.

(S.D. BOKIL and ANAND PRAKASH)

4.16 Pilot study for evolving sample survey techniques for estimation of crop losses in storage.

The object of the study was to develop a method for estimating crop losses in storage. It was proposed to conduct the survey in the district of Meerut in Uttar Pradesh. During the year under report, preliminary work such as planning of the survey and setting up of various proformas was completed; no data were collected during the year.

(S.D. BOKIL and ANAND PRAKASH)

5.
BASIC RESEARCH IN STATISTICS

During the year under report, significant contributions were made in the application of statistical techniques to problems in Sampling, Genetic Statistics and Design of Experiments. Some of these contributions are as given below;

(a) Sampling

When sample size is sufficiently large, it was shown that the variance of the ratio estimate under Midzuno-Sen sampling is exactly the same as the mean square error of the classical ratio estimator, the mean square error being evaluated to the first order of approximation.

Application of Midzuno-Sen strategy to successive sampling was also studied. Further, it was shown that the Midzuno-Sen ratio strategy defined with reference to suitably transferred ancillary variate is asymptotically the best in the class of all T_3 - type unbiased pps strategy.

A new approach for utilizing ancillary information for providing better estimates was also initiated. A simple size stratification on the basis of ancillary data depending on whether the ancillary data is discrete or continuous, was suggested and a new estimator was proposed. It was shown that the estimator is superior in the sense of smaller variance than many a pps sampling strategy in several situations.

(b) Genetic Statistics

Partial diallel crosses based on extended triangular designs were constructed. The analysis of full and partial diallel crosses with several characters was studied with the help of data on wheat and triticale.

(c) Design of Experiments

Some methods of combining two P.B.I.B. designs with m and n associate classes to yield a new P.B.I.B. design of only $(m+n)$ associate classes were suggested. The saying in the number of associate classes is $m+n$ in general. As a special case of these methods of construction, two P.B.I.B. designs could be combined to obtain a G.D. design. New P.B.I.B. designs were constructed through association schemes. An extended family of association schemes was introduced. Corresponding to an association scheme with m classes a new association scheme with $(m+1)$ classes was defined and it was shown that (a) the m class G.D. association scheme is the extended association scheme of $(m-1)$ class G.D. association, and (b) the generalised right angular associate scheme is the extended association scheme of rectangular association scheme. A new association scheme with $(m+n+mn)$ associate classes was obtained by defining a cartesian product between two association schemes with m and n classes respectively. New methods of construction of this class G.D. design through association schemes were suggested.

6. TRAINING ACTIVITIES

The Institute conducts training in agricultural and animal husbandry statistics mainly for three groups of students. Two courses called the Junior Certificate Course and the Senior Certificate Course of which the former is of six months and the latter is of one year duration are being conducted for research workers in the field of agriculture and animal husbandry whose primary interest is not statistics but for whom knowledge of statistics is essential for their research work. Two courses called the Professional Statistician's Certificate Course and the Diploma Course, each of one year's duration, are conducted for the benefit of students deputed by State Governments and Research Institutes who have a post-graduate degree in Mathematics or Statistics and possess experience of handling statistical data in a responsible capacity. In the latter course, the student is required to work on a research project for a period of one year and submit a thesis thereon which should be such as to form the basis of a paper of publishable standard. The third group consists of students who wish to qualify for the M.Sc. and the Ph.D. degrees in Agricultural Statistics. These degrees are awarded by the Indian Agricultural Research Institute. All courses in Mathematics, Statistics, Computer Science, etc. for this group of students are offered at this Institute while the courses in agricultural sciences are taught in the Indian Agricultural Research Institute.

The final examinations of the Junior Certificate, the Senior Certificate and the Professional Statistician's Certificate Courses and the qualifying examinations for the M.Sc. and the Ph.D. students were held during the year report. The students of the Senior Certificate and the Professional Statistician's Certificate Courses conducted a survey for the estimation of the benefit of irrigation due to State tube-wells in Nainital district of Uttar Pradesh during June-July, 1972. The officers and staff of the Training Unit of the Institute supervised the work and offered technical suggestions.

A list of the theses approved during the year report for the award of the M.Sc. Degree and the Diploma in Agricultural Statistics is given as Appendix III.

The new session for the Junior Certificate, Senior Certificate and the Professional Statistician's Certificate Courses started in October, 1972 while the sessions for the M.Sc. and the Ph.D. Courses, in September, 1972.

A number of useful seminars/lectures were delivered by eminent statisticians during the year report. The names of the speakers and the titles of the talks are given below:-

1. Dr. C.R. Rao, F.R.S.,
Director,
Indian Statistical Institute. Generalized inverse matrices and their applications in linear models (4 lectures)
2. Dr. Raghava Rao,
Professor of Statistics,
Punjab Agricultural
University, Ludhiana. Graphical methods and its use in the design of Experiments

3. Dr. J.S. Rustagi, Professor of Statistics, Ohio State University, U.S.A. A waiting time distribution related to a two-state Markov Chain.

As usual, seminars by the members of staff and the students of the Institute on various topics of interest were held during the year under report. The names of the speakers and the titles of their talks are listed below:-

1. Sh. K.N. Ponnuswamy Triallel analysis
2. Sh. V. Survya Prakash Rao Application of D^2 Statistics for studying genetic divergence in certain crop plants.
3. Dr. M.S. Avadhani On the optimum utilization of ancillary information in sampling from finite population.
4. Sh. A.S. Tiwari Use of diallel crosses for estimating general and specific combining ability effects in plant breeding work.
5. Sh. Praduman Kumar Generalised least square estimation of linear regression models with random coefficients.
6. Sh. B.S. Dhillón Studies on genotype-environment inter-action with help of stability parameters.
7. Sh. M.N.P. Akhouri Methods of measurement of adoption of farm innovations.
8. Miss R. Sethumadhavi Contribution to 3-P sampling.
9. Dr. A. Dey Some aspects of combinatorics.
10. Sh. O.P. Kathuria Some alternative replacement procedures in two stage sampling upto three occasions.

11. Sh. Kripa Shankar Line x Tester Analysis of combining ability.
12. Sh. I.C. Sethi On an unbiased ratio estimator.
13. Sh. K.V. Sathe Optimum age at disposal of cow calves.
14. Sh. R.K. Mahajan Certain Monte-Carlo studies in Sample Surveys.
15. Sh. K.S. Suchdeva Sire Evaluation in cattle breeding.
16. Miss Ranjana Agarwal Optimum points of stratification in multi-dimensional populations.
17. Sh. C.K. Midha Methods of estimation of area and its bias for High Yielding Varieties.
18. Sh. D.K. Agarwal Use of ancillary information in the analysis of agricultural experiments.
19. Sh. S.K. Agarwal Further developments in Snowball Sampling Technique.
20. Sh. Rupak Chakravarthi Investigation of data collected from the assessment survey under High Yielding Varieties Programme in Belgaum District of Mysore State.
21. Sh. V.K. Bhatia Relationship between survival and wool yield in sheep.
22. Sh. Pranesh Kumar Economic analysis of fertilizer trials on farmers' fields.
23. Sh. Subedar Singh Disequilibrium due to linkage in Inbred populations.
24. Sh. R.P.S. Malik Choice of strata for estimating sheep population.
25. Sh. U.C. Jha Reliability and validity of measuring instruments in social sciences.

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| 25. | Sh. Chandrahas | Comparison of different estimates of wool production. |
| 26. | Sh. Lajpat Rai | Spread of High Yielding Varieties and the extent of adoption of improved practices in Jaipur district of Rajasthan State. |
| 27. | Sh. V.N. Iyer | Economics of fertilisation of maize under cultivators' conditions. |
| 28. | Sh. A.C. Bora | A study of the association of yield and some factors influencing it for high yielding varieties of rice in Tamil Nadu State. |
| 29. | Sh. V.K. Gupta | A study on the efficiency of systematic sampling in estimating lactation yield of a cow. |
| 30. | Sh. C.S. Khind | Response to Nitrogen on Rice in water-logged soils. |
| 31. | Sh. K. Satyanarayana | Use of dummy variables in Economic Analysis. |
| 32. | Sh. R.K. Joshi | Stability and adaptability parameters and their significance in plant breeding. |

In order to acquaint themselves with the research technology being followed at the various Research Institutes, Universities, etc., the students of the different courses conducted by the Institute visited the following institutions during the year under report.

1. National Dairy Research Institute, Karnal.
2. Indian Veterinary Research Institute, Izatnagar (U.P.).
3. Rajendra Agricultural University, Patna.
4. Livestock Research Station, Patna.
5. Jute Agricultural Research Institute, Barrackpore (W.B.)
6. Indian Statistical Institute, Calcutta.
7. Allahabad Agricultural Institute, Allahabad.
8. G.B. Pant Agricultural University, Pantnagar (U.P.).
9. Central Statistical Organisation, New Delhi.
10. Directorate of Economics and Statistics, Govt. of India, New Delhi.

Lectures and p-racticals were also arranged for the trainees/officers of the Central Statistical Organisation, Pre-Investment Survey of Forest Resources (Ministry of Agriculture), Central and State Government Poultry farms and other organisations during the year under report.

A convocation for the award of certificates and prizes to the students who had successfully completed the Diploma, the Professional Statisticians' Certificate, the Senior Certificate, and the Junior Certificate Courses held at the Institute on the 16th of December, 1972. Shri Sukhatme distributed the certificates and the prizes. On this occasion, a symposium on "Agricultural Statistics" was organised under the chairmanship of Shri J.S. Sarma, Member - Secretary, National Commission on Agriculture. Eminent speakers from different Departments participated in the discussions.

7.

DATA PROCESSING

Data processing has been one of the major activities of the Institute since the installation in 1965 of an IBM - 1620 Model II electronic computer with a memory size 40 K. The peripherals of the system are a card read punch, an on - line printer and an auxiliary memory hardware comprising of three discdrives, each having a capacity of storing 2 million digits of information. Besides, there are 32 card punching and verifying machines and 7 pieces of tabulating equipment like sorters, collators, reproducing punch, etc. in the Mechanical Tabulation Unit. Since the number of research workers going in for complicated designs and methods of analysis for their research problems is ever on the increase, the demand for time on the electronic computer has been increasing considerably. On the recommendation of the Direction Committee of the Computer Centre, the facility of EDP is extended free of charge to all Research Institutions under the ICAR, Co-ordinated schemes of the ICAR, Central Agricultural Universities and the Directorate of Economics and Statistics. In addition to data processing, programming help is also extended to research workers, if required.

During the year under report, data processing on the electronic computer was done on 280 working days including Sundays and holidays on which the Computer Centre was kept open for urgent work. The total utilized time (83.4%) was shared by IARS and IARI (61.8%), Directorate of Economics and Statistics (7.7%), other Central Agricultural Institutes and Universities,

including IVRI, H.A.U., P.A.U. and Agricultural Faculty of I.I.T. (28.7%), and National Physical Laboratory, Central Road Research Institute, Pre-Investment Survey of Forest Resources (Ministry of Agriculture), Directorate of Agriculture, Uttar Pradesh and others (1.3%). Of the total un-utilized time, 1.2% was lost due to power failure and 11.6% of it was taken up by the maintenance of the system. Programming help was extended to about 150 research workers from different Institutes and Agricultural Universities for processing their data on the electronic computer.

During the year under report, the Mechanical Tabulation Unit carried out the work of coding, punching, sorting, listing and tabulation pertaining to the various research schemes of the Institute and the different research problems of its students.

Similar help was also rendered to the students and research workers of IARI, IVRI and other Institutes under the ICAR, Agricultural and other universities, and outside agencies like the Investment Survey of Forest Resources (Ministry of Agriculture), Timely Reporting Scheme of the Department of Agriculture, Government of Uttar Pradesh, Rockefeller foundation, and others. About 16.79 lakh cards were punched and verified and about 2400 tables and about 400 tables were prepared. Besides, lectures and seminars on data processing were also arranged by this Unit for the In-service Training of the K.P.O's, Machine Operators and Punch Supervisors of the Institute and also for the training of an Intensive Course in Computer Programming.

The following courses were arranged during the year under report at the Computer Centre.

(1) A training course in symbolic programming language was conducted for the benefit of the staff of the Computer Centre from February to April, 1972.

(2) A training course in computer programming was arranged for the participants from the various Research Institutes under the ICAR, Central Agricultural Universities, and State Departments of Agriculture from 15th May to 9th June, 1972.

(3) Twenty-four lectures in computer programming were arranged for the students of the Professional Statisticians' Certificate and the Senior Certificate Courses of the Institute with a view to familiarizing them with computer programming and data processing.

(4) A short duration course in computer programming was arranged for the recipients of the certificates during the Annual Convocation Week in December, 1972.

During the year under report, a library of programmes useful for workers in agricultural research was built up. The source programmes were stored on disk for immediate use by the users of the Computer. The first volume of a series of intended publications giving programmes for research workers was brought out by the Centre. The publication has since been in good demand. Also, a book on "Computer Programmes for Agricultural Research Workers" edited by Shri S.S. Pillai, Statistician incharge of the Centre was published during the year.

Dr. M.N. Das, Shri S.S. Pillai, Shri S.N. Mathur and Shri K.V. Sathe became members of the Computer Society of India from the Institute during the year under report.

8.
ADVISORY SERVICE

During the year under report, the Institute continued to play its important role of giving technical advice and guidance in regard to problems in agricultural statistics and sampling techniques and particularly in statistical aspects of the schemes financed by the I.C.A.R. Officers of the Institute attended the meetings of the various Scientific Panels/Committees of the I.C.A.R. and some of the workshop meetings under the All India Co-ordinated Projects on crop and animal sciences of the I.C.A.R. held during the year. The research schemes submitted to the I.C.A.R. by the various Research Institutes, Universities and State Departments of Agriculture and Animal Husbandry were examined critically by the Institute from the statistical point of view.

Technical advice and guidance was also rendered to research workers of the various Research Institutes, Universities and other organisations in the processing of their data at the Computer Centre and the Mechanical Data Processing Unit of the Institute.

Some details of the technical advice and guidance given by the Institute during the year under report are briefly given below:

Agricultural Sciences:

(a) During the year under report, the technical progress of 28 new schemes were critically examined and necessary advice was given. The annual reports of 2 schemes in operation were examined and suggestions for proper analysis of the data and interpretation of the results were given.

Besides, 4 final reports were also examined and necessary advice to make them were meaningful was rendered.

(b) As requested by the Principal of the Gram Sevak Training Centre, Burdwan (West Bengal), technical advice in regard to the statistical analysis of the data of the agronomic trials conducted at the Centre was given from time to time.

Animal Sciences:

(a) Technical advice was given to the Officers - in - charge of the following I.C.A.R. schemes in regard to the methods of statistical analysis of the data, interpretation of results and preparation of reports:

1. Improvement of sheep and wool on regional basis, Maharashtra.
2. Study of infertility in cattle, Gujarat.
3. Evolving a new type of pig by cross-breeding, Uttar Pradesh.
4. Improvement of sheep and wool on regional basis, Gujarat.
5. Use of diallel crosses for Broiler production, Mysore.
6. Evolving a new breed of dairy cattle, West Bengal.
7. Improvement of sheep and wool on regional basis, Bihar.
8. Angora Goat Breeding Scheme, Himachal Pradesh.

(b) Technical advice was given to the Regional Poultry Farm, Bhopal in regard to selection of birds on the basis of an index under the Co-ordinated Poultry Breeding Programme of the Govt. of Madhya Pradesh.

(c) Technical advice was given to the Ph.D. students of Animal Nutrition from the U.P. Agricultural University, Pantnagar and the National Dairy Research Institute, Karnal in regard to their statistical requirements.

Sample surveys:

(a) Technical advice was given to the Bureau of Economics and Statistics and the Directorates of Agriculture of various States in the conduct of sample surveys for assessment of the High Yielding Varieties Programme.

(b) Technical advice was given to the Statisticians of the Veterinary and Animal Husbandry Departments of the Government of Haryana, Punjab, Rajasthan, Uttar Pradesh and Madhya Pradesh in regard to the various problems in the conduct of sample surveys on livestock products in their respective States.

(c) As desired by the Ministry of Agriculture, comments were offered on a scheme for collection of data on marketing of fruits to be undertaken by the Directorate of Marketing Inspection and financed under the PL - 480 funds. Advice was also given to this Directorate in planning their survey to study marketable surplus.

(d) Technical guidance was given to two F.A.O. experts, Shri D.Y. Lele and Shri M.P. Jha, in connection with the planning and conducting of sample surveys on fruits and vegetables to be undertaken in Ethiopia and South Korea respectively.

(e) Technical advice was given to an officer of the N.S.I. who visited the Institute a number of times to discuss the sampling design and other technical details for organising All India survey on fresh fruit crops in the following year.

9.
PARTICIPATION IN INTER-ORGANISATIONAL SEMINARS,
WORKSHOPS, ETC.
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During the year under report, officers and members of staff of the Institute participated in several inter-organisational seminars, workshops, etc. The names of the officers and members of staff who participated and the particulars of the seminars, workshops, etc. in which they participated are given below:

1. Sixth Annual Workshop of the All India Co-ordinated Agro-nomic Experiments Scheme held at Coimbatore in January, 1972.
Kum. C.R. Leelavathi, Shri Shanti Swarup and Sh. O.P. Dutta.
2. 59th Session of the Indian Science Congress Association held at Calcutta in February, 1972.
Dr. Aloke Dey.
3. Eleventh Indian Econometric Conference held at Hyderabad in February, 1972.
Shri T. Jacob.
4. Workshop on "Dry Land Farming" held at Hyderabad in February, 1972.
Shri P.N. Bhargava.
5. Silver Jubilee Conference of the Indian Society of Agricultural Statistics held at New Delhi in March, 1972.
Dr. M.N. Das, Dr. P. Narain, Shri V.V.R. Murty, Shri K.C. Raut, Shri T. Jacob, Shri P.N. Bhargava, Shri B.B.P.S. Goel, Dr. A. Dey, Dr. M.S. Avadhani, Shri R. Gopalan, Sh. J.S. Maini, Sh. R.K. Khosla, Sh. P.P. Rao, Sh. D.V. Subba Rao, Sh. H.B. Choudhary, Sh. Basant Lal, Sh. Shivtar Singh, Sh. Randhir Singh, Sh. M.P. Sexana, Miss. Asha Pradhan, Sh. R.K. Bohra, Sh. Bhagat Singh, Sh. Mahesh Kumar, Sh. K.K. Chugh, and Sh. R.L. Rustogi.
6. Symposium on "Measurement of Impact of Green Revolution" Indian Society of Agricultural Statistics at New Delhi in March, 1972.
Shri S.K. Raheja and Shri S.R. Bapat.

7. Symposium on "Design of Agricultural Experiments and Computerization of their Analysis" held during the Silver Jubilee Conference of the Indian Society of Agricultural Statistics at New Delhi in March, 1972.
Dr. M.N. Das, Dr. P. Narain, Shri M.G. Sardana, Shri S.K. Raheja and Dr. Aloke Dey.
8. Seminar on Poultry Breeding and Genetics held at the Inservice Training (Poultry) Institute, Bangalore in April, 1972.
Dr. P. Narain.
9. Seminar on "Data Base of the Indian Economy - A Review and Re-appraisal" organised by the Indian Econometric Society at New Delhi in May, 1972.
Shri A.H. Manwani and Dr. M.S. Avadhani.
10. Second Workshop of All India Co-ordinated Research Project on Poultry for Egg and Meat held at Hyderabad in July, 1972.
Dr. P. Narain.
11. Second Workshop of All India Co-ordinated Research Project on Buffaloes held at Karnal in August, 1972.
Dr. P. Narain.
12. Workshop on Co-ordinated Wheat Project held at Hisar in August, 1972.
Shri P.N. Bhargava.
13. Second Workshop of All India Co-ordinated Research Project on Blood Group and Bio-chemical Polymorphism held at Karnal in September, 1972.
Dr. P. Narain.
14. Twenty - sixth Annual Conference of the Indian Society of Agricultural Statistics held at Kalyani (W.B) in December, 1972.

Dr. M.N. Das, Sh. K.C. Raut, Dr. M.S. Avadhani, Shri A.K. Srivastava, Sh. Padam Singh, Sh. V.N. Iyer, Shri P.P. Rao, Sh. Shivtar Singh, Sh. Randhir Singh, Shri R.K. Bohra, Sh. I.C. Sethi, Sh. K.K. Chugh, Sh. R.L. Rustogi, Sh. K.C. Gupta, and Sh. Bhagwan Das.

15. Symposium on "Use of Combinatorial Mathematics in Design of Experiments " held at New Delhi in December, 1972.

Dr. A. Dey and Dr. A.K. Nigam.

16. Second Workshop of the "All India Co-ordinated Research Project to determine the Economics of Milk Production" held in Jabalpur in December, 1972.

Shri B. Marutiram.

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

During the year under report, officers, members of staff and research students of the Institute presented papers in several inter - organisational seminars, workshops, etc. The particulars of the papers and the seminars, workshops, etc. in which these were presented are given below:

(i) Eleventh Indian Econometric Conference held at Hyderabad in February, 1972.

1. JACOB, T.. Production function approach for estimation of nutrient requirements for milk production.
2. JACOB, T. and SETH, G.R. Levels of inputs for least-variance estimates of production on the iso - product curves of a Cobb - Douglas function.

(ii) Silver Jubilee Conference of the Indian Society of Agricultural Statistics held at New Delhi in March, 1972.

1. BHARGAVA, P.N., NARAIN, P., PRADHAN, ASHA, and ANEJA, K.G. A study of the distribution of rainfall in Raipur District with the help of Stochastic Models.
2. GOEL, B.B.P.S. and SINGH, D. A note on composite sampling.
3. GOEL, B.B.P.S., SINGH, K.B., and SINGH, K.P. Availability and disposal of dung in India.
4. MAINI, J.S., RAO, D.V.S. and MURTY, V.V.R. Integrated approach in sample surveys on livestock products.
5. MANWANI, A.H. A comparative study of different estimation procedures in sample survey on multiple characters through Monte Carlo methods.
6. MURTY, V.V.R., GOEL, B.B.P.S., and RAO, D.V.S. Poultry egg production and its per capita availability in India.
7. NADKARANI, U.G. Generating function of modified branching process.
8. NARAIN, P., SINGH, R. and MISHRA, A.K. The prediction of correlated response in economic traits of Red Sindhi cattle.
9. RAUT, K.C., SINGH, SHIVTAR, and CHAUDHARI, E.S. Index of cost of milk production.

10. RAUT, K.C. and SINGH, SHIVTAR. Economics of milk production by landless cattle owners and farmers of small, medium, and large holdings.
11. SAHA, G.M. and DAS, A.R. Four level second order rotatable designs from partially balanced arrays.
12. SAHA, G.M. and MISHRA, A.K. A class of three - replicate three - associate P.B.I.B. Designs.
13. SINGH, BHAGAT. Improvement of collection of data on inputs and outputs by survey method.
14. SINGH, D. and SINGH, R. Multi-purpose surveys on successive occasions.
15. SINGH, PADAM. On regression method of estimation.
16. SINGH, PADAM and SADASIVAN, G. Double systematic sampling with varying probabilities.

(iii) Symposium on "Design for Agricultural Experiments and Computerisation of their Analysis" held during the Silver Jubilee Conference of the Indian Society of Agricultural Statistics at New Delhi in March, 1972.

1. KHOSLA, R.K., SARDANA, M.G., SAKSENA, M.P. and SAHNI, M.L. Review of agricultural experimentation in India.
2. NARAIN, P. Processing and evaluation of animal breeding experiments on computer.
3. RAHEJA, S.K., KHOSLA, R.K., RAO, P.P. and KUMAR, MAHESH. Design and analysis of agricultural field experiments and computer use.

(iv) Symposium on "Measurement of Impact of Green Revolution" held during the Silver Jubilee Conference of the Indian Society of Agricultural Statistics at New Delhi in March, 1972.

RAHEJA, S.K. and BAPAT, S.R. Profitability of fertilizer use under cultivators' conditions.

(v) Joint Meeting of the Biometric Society and the Indian Society of Agricultural Statistics held at New Delhi in March, 1972.

1. MITTU, K.T. and NARAIN, P. Non-additive interactions in Biometrical genetics.
2. NARAIN, P. The fundamental matrix of a finite Markov Chain with applications in Genetics.

(vi) Workers' Conference on Rabi Crop - All India Research Project on Dry Land Agriculture held at New Delhi in September, 1972.

MAHAPATRA, I.C., SARDANA, M.G., BAPAT, S.R. and BHENDIA, M.L. Fertilizer responses of wheat, gram, and horse - gram under rainfed conditions on farmers' fields.

(vii) Symposium on "Multiple Cropping" at the Annual Conference of the Indian Society of Agronomy held in Hissar in October, 1972.

1. MAHAPATRA, I.C., LEELAVATHI, C.R., SINGH, R.N. and SINGH, RAJ. Multiple cropping in Eastern India.
2. RAHEJA, S.K. and LEELAVATHI, C.R. Production estimates of important food and feed crops in multiple cropping sequences in Northern India.

(viii) Symposium on "Use of Combinatorial Mathematics in Design of Experiments" held at New Delhi in December, 1972.

1. DEY, A. Some methods of construction of Group Divisible Designs.
2. NIGAM, A.K. and AGARWAL, S.K. On construction of balanced and partially balanced n-ary block designs.
3. NIGAM, A.K. On construction of block designs for mixture experiments.

(ix) Twenty - sixth Annual Conference of the Indian Society of Agricultural Statistics held at Kalyani (W.B.) in December, 1972.

1. AGARWAL, D.K. and SARDANA, M.G. Use of ancillary information in the analysis of agronomic experiments.
2. AGGARWAL, S.K. and SADASIVAN, G. Further developments in Snowball Sampling Technique.
3. AVADHANI, M.S. and SUKHATME, B.V. A procedure for designing controlled random sampling-I.
4. BHARGAVA, P.N., NARAIN, PREM and PRADHAN, ASHOK. An application of the theory of runs to the study of occurrence of droughts in relation to crop production.

5. BHATIA, V.K. and NARAIN, P. Relationship between survival and wool yield in sheep.
6. BOHRA, R.K. on a 2 x 3 x 4 factorial design in single replicate.
7. GUPTA, VINOD KUMAR and RAJAGOPALAN, M. A study on the efficiency of systematic sampling in estimating the lactation yield of a cow.
8. IYER, V.N. and SARDANA, M.G. Economics of fertilization of maize under cultivators' conditions.
9. KHOSLA, R.K., RAO, P.P. and DAS, N.N. A study of the experimental errors in groups of agricultural field experiments conducted in different years.
10. KUMAR, PRANESH and SARDANA, M.G. Economic analysis of fertilizer trials on bajra on cultivators' fields.
11. MAKIN, B.K., MEHRA, R.B. and SETHI, I.C. A comparative study of different approaches of stability analysis.
12. MALIK, R.P.S. Choice of strata for estimating sheep population.
13. MARUTIRAM, B., NADKARANI, U.G. and JAIN, T.B. On sampling from fleeces for assessment of wool quality.
14. MIDHA, C.K. and DEY, A. On a method of construction of rectangular designs.
15. NARAIN, PREM and SUCHDEVA, K.S. The increase in the efficiency of corrected daughter average index of a sire due to the use of an auxiliary character.
16. NARAIN, PREM and SUBBARAO, C. Construction and analysis of partial diallel crosses - Extended Triangular Designs.
17. NIGAM, A.K., AGARWAL, S.K. and MEHTA, S.K. On construction of partially balanced n-ary block design.
18. RAI, S.C. and DAS, M.N. Growth of minor irrigation projects and their effect on agriculture in the district of Nainital.
19. RAUT, K.C. and SINGH, SHIVTAR. Influence of organised milk supply schemes on production and allied aspects of commercial milk producers.
20. RAWAT, P.S. and DEY, A. A unified method of construction of second order rotatable designs.

21. SADASIVAN, G. and BARAH, B.C. Bias in the estimation of proportion in a single question model in mail survey.
22. SARKAR, A.K. and DEY, A. On comparison of some fractional plans for 2^n factorials.
23. SATHE, K.V. Optimum age at disposal of cow, calves.
24. SETHI, I.C. A study of a minimum variance unbiased estimator.
25. SETHI, I.C. A note on collapsing of data.
26. SETHUMADHAVI, R. Stratification in surveys on fruit crops.
27. SHARMA, SUKHDEV and SADASIVAN, G. Two dimensional varying probability sampling without replacement.
28. SHARMA, V.K. and DAS, M.N. Use of transformation in pps sampling with replacement.
29. SINGH, PADAM. Quadratic regression estimator in successive sampling.
30. SINGH, R. Non-response in successive sampling.
31. SRIVASTAVA, A.K. and SINGH, SHIVTAR. On some replacement patterns in multi-stage successive sampling.

(x) Symposium on "Statistical Assessment of Intensive Cattle Development Programme" held during the 26th Annual Conference of the Indian Society of Agricultural Statistics held at Kalyani in December, 1972.

1. MARUTIRAM, B., RAUT, K.C. and JACOB, T. Methodological problems in statistical estimation of the indicators of progress of I.C.D. Programmes.
2. NARAIN, P. and JAIN, J.P. Some aspects of a sampling design for measurement of responses in Intensive Cattle Development Programme.

11.

PUBLICATIONS

During the year under report, thirty papers by the officers, members of staff and research students of the *Institute were published in standard journals, while twenty five papers were accepted for publication. A list of these papers is given as Appendix IV.*

The reports mentioned below were published by the Institute as I.C.A.R. publications during the year under report.

1. DAS, M.N., RAJAGOPALAN, M., BANERJEE, A.K., MEHROTRA, P.C. and GUPTA, S.S. Monograph on the results of the "Sample Surveys for the Assessment of High Yielding Varieties Programme (1969-70 and 1970-71).
2. DAS, M.N., PILLAI, S.S. and GARG, J.N. Sample Survey for estimation of yield and extent of cultivation of cashewnut in Andhra Pradesh.
3. DAS, M.N., GARG, J.N. and PILLAI, S.S. Sample Survey for estimation of yield and extent of cultivation of cashewnut in Maharashtra.
4. MAHAPATRA, I.C., GOSWAMI, N.N., PRASAD, RAJENDRA, SINGH, MAHENDRA, BHENDIA, M.L., RISHI, A.K. SARDANA, M.G., LEELAVATHI, C.R., BAPAT, S.R. and MITTAL, M.G.
(1) Annual Report of the All India Co-ordinated Agronomic Experiments Scheme, 1971-72 and (2) Summary of the Annual Report of the All India Co-ordinated Agronomic Experiments Scheme, 1971-72.
5. SINGH, DAROGA, PILLAI, S.S. and GARG, J.N. Sample survey for estimation of number of pepper standards and yield per standard in Kerala State.
6. SUKHATME, B.V., MANWANI, A.H. and BAPAT, S.R. Surveys on

12.

SUMMARY OF THE REPORT

12.1 Statistical research in agricultural sciences.

12.11 Study on size and shape of plots in experiments on a ~~oil~~ crop.

The data utilized for the study were collected from Summer Ford Garden, Ramgarh, Nainital during 1965 and 1969. It was observed that a single tree plot was most suitable as well as optimum for purpose of experiments on apple crop. It was also seen that in experiments with apple trees the positional variation is not so much important as the genetic variation.

12.12 Critical analysis of crop rotational experiments.

The data on crop rotational experiments conducted at Amreli and Jalgaon in Maharashtra over periods of 8 years and 20 years respectively were utilized for the study. It was seen that if groundnut was included as one of the crops in rotation, the production of the other crops in the rotation increased, while the average yield of the groundnut crop remained of the same order. It was further observed that the fertility of the soil appreciated over the years with such rotations and that the economic return per unit area per unit time was also higher.

12.13 Evaluation of yardsticks of additional production from the use of various developmental measures.

The yardsticks of additional production from the use of nitrogenous, phosphatic and potassic fertilizers on high yielding as well as locally improved tall varieties of cereals were evaluated from the data of 9252 experiments conducted on cultivators' fields during the period 1967-71. The doses at which the yardsticks were formulated were 60 and 120 Kg N/ha, 30 and 60 Kg. P_2O_5 /ha. and 60 Kg K_2O /ha.

The responses to potassium were measured over a basal application of 120 Kg N/ha. and 60 Kg. P_2O_5 /ha. The most popular high yielding varieties were IR - 8 rice and S - 227 of wheat. The yardsticks of additional production for IR - 8 and the locally improved tall varieties of rice per tonne of nitrogen at 120 Kg. (with irrigation) were 10.3 tonnes and 9.7 tonnes respectively in kharif season and 12.6 tonnes and 8.6 tonnes respectively in rabi season, whereas for S-227 and the locally improved tall varieties of wheat were 9.8 tonnes and 6.6 tonnes respectively. Yardsticks of additional production per tonne of P_2O_5 or K_2O also higher for IR - 8 and S - 227 vis-a-vis the locally improved tall varieties. The data available on jowar, bajra and maize were too meagre to see the trend.

12.14 Pilot studies on pre-harvest forecasting of yield of crops.

Statistical analysis of the data on wheat, paddy, jute and cotton crops collected at different centres in the previous year was carried out. Four different models, viz., simple, logarithmic, square root, and inverse, were used to examine multiple regressions of yield on the bio-metrical characters of plants recorded at different stages of crop growth. On the basis of the amount of variation in yield explained by the regression equation, it was seen that simple regression of yield on the number of tillers only instead of multiple regression on other variables

like density, height and basal diameter could be used to forecast the yield of wheat and paddy. In the case of jute crop, the logarithmic model was found superior; the partial regression coefficients on the number and the height of plants were found significant in all cases.

12.15 Statistical analysis of summerization of data collected under the All India Co-ordinated Agronomic Experiments Scheme.

(a) Simple fertilizer trials on cultivators' fields.

A study of responses of cereal crops to nitrogen, phosphorus and potassium showed that high responses of rice and wheat to nitrogen upto a level of 160 Kg N/ha ranged from 2900 to 4900 Kg/ha and from 1800 to 2900 Kg/ha respectively, while the responses of jowar, maize and bajra varied between 800 and 2000 Kg/ha. Responses of rice to application of phosphorus from 90 Kg P_2O_5 /ha to 180 Kg P_2O_5 /ha ranged between 500 and 1900 Kg/ha in kharif and between 900 and 2000 Kg/ha in rabi, while the responses of wheat varied from 700 to 1500 Kg/ha. Jowar, maize and bajra showed moderate responses. Application of potassium to rice and wheat showed response between 400 and 1100 Kg/ha. Response of rice, wheat, jowar, maize and bajra to application of zinc were significant and moderate and varied between 200 and 700 Kg/ha.

Trials conducted under dry land conditions on rice, wheat, jowar, maize, bajra, groundnut, castor, mustard, gram and horse-gram showed that fertilizer

application was as important as moisture and that NP fertilization was necessary even under dry land conditions, contrary to the belief that only nitrogen need be applied.

(b) Complex experiments at model agronomic centres.

Significant responses to soil application of zinc and manganese were obtained. It was seen that biuret in urea upto 0.9% for use as foliar spray had no adverse effect. Placement of super - phosphate at 7.5 cm. below seed was found to increase the up - take and utilization of applied fertilizer in case of jowar crop in red loam soils. Similar results had been obtained earlier in case of wheat crop in alluvial sandy loam soils. At most of the locations, nitro-phosphate containing 30% of its phosphate in water soluble form was found to be inferior to combination of straight fertilizers such as ammonium sulphate or urea and super - phosphate and other NP complex fertilizers such as diammonium phosphate and ammonium phosphate sulphate.

12.16 Study of influence of meteorological factors on crop production

The objective of the study was to examine the effect of rainfall on crop production during the crop season, viz. June to September in Raipur District of Madhya Pradesh. Daily rainfall data for 24 years, viz., 1944 to 1967 and the yield rates for paddy during these years were utilized for the study. The distributions of rainfall for the months of June, July,

August and September and for the whole season from June to September were found to be normal. It was seen that rainfall during June and August did not have a significant effect on crop production, but it had a profound effect in the months of July and September. Rainfall 26% below normal in July and 31% below normal in September was found to be deficient for paddy crop. The probability of deficient rainfall in July was calculated to be .2843 and in September, .2206. Deficient rainfall in July was expected to recur every three years and in September, every four years. Studies on rainfall reliability were in progress.

In addition to the above studies, data of about 2500 experiments and about 200 groups of experiments were analysed for incorporation in the National Index of Agricultural Field Experiments, while an index of experiments pertaining to the period 1966-71 as also the compendium of results of the experiments pertaining to the period 1960-65 of Gujarat State were under print.

12.2 Statistical research in animal sciences.

12.21. A genetic simulation study of response to selection in finite populations.

The objective of the study was to simulate genetic systems on computer for investigating the inter - action of population size and directional selection. The simulated genetic populations were to

provide an estimate of rate of advance and selection limits under varying conditions. For studying the nature of random genetic dispersion for varying population sizes, computer programmes for simulating simple genetic models of 30 loci with two alleles per locus with variation in the recombination between loci and without selection were developed.

12.22 Measurement of genetic improvement due to cross-breeding in sheep.

The sheep breeding data collected at the Sheep Breeding Farm, Banihal - Reasi (Kashmir) over a period of 14 years (1952 - 66) were analysed with respect to four characters, viz., greasy fleece weight, fibre diameter, fibre length and fleece density. The techniques of discriminant function and D^2 - statistic were used to compare different grades and to measure the contribution of different characters in comparing the grades. It was found that significant differences existed between different pairs of grades. Local versus pure - bred showed the maximum divergence whereas half - bred versus three - fourths showed the least divergence. The contributions of fibre diameter and greasy fleece weight to D^2 values were about 65 to 75 per cent in different comparisons.

12.23 Statistical methodology for developing efficient selection procedures in poultry breeding.

The data obtained from the Regional Poultry Farm, Bhopal were analysed with respect to four characters, viz., age at maturity, egg production

240 days of age, egg weight and incidence of mortality. Studies on the type of distribution of egg weight and of selection scores based on combining individual performance with that of full - sibs and half - sibs showed that the former followed Pearsonian Type II and the later, Type IV. Studies on heritabilities and genetic as well as phenotypic correlations between egg weight and selection score remained in progress. A theoretical study of combined selection for populations under-going in-breeding was also completed. The most important result was that with inbred population the efficiency of combined selection is increased.

2.24 Statistical studies on data from the scheme on improvement of poultry through family selection.

The data collected on White Leghorn breed under the scheme for improvement of poultry through family selection at the centre at Kodappanakunnu (Kerala) were further analysed to study the efficiency of selection on the basis of part - time production and to estimate genetic parameters on some important characters such as annual egg production, age at maturity, weight at maturity, etc. It was observed that only about half the number of heritabilities estimated were in the admissible range. Even the admissible estimates were not statistically different from zero. Negative estimates resulted in the estimates of genetic correlation being imaginary. Of the non - imaginary estimates, some were either less than - 1 or greater than + 1. The correlation

between part - time production and total production was estimated to be of the order of 0.5.

12.25 Estimation of availability and cost of production of milk and its index.

The final report on the project pertaining to the Krishna Delta region of Andhra Pradesh was prepared. It was observed that the over - all daily production of buffalo milk was 406 tonnes, of which 54.4% was in Krishna area and the remaining 45.6% in Guntur area. The production of cow milk was estimated to be about 36 tonnes per day. The average daily milk yield of a buffalo in milk was about 1.9 Kg in Krishna area whereas that of a cow in milk in Krishna area was 1.2 Kg. The cost of buffalo milk per kilogram was Rs. 1.12 in the first year and Rs. 1.04 in the second year when family labour was included and 91 paise and 85 paise in the two years respectively, when family labour was excluded. The cost of production of cow milk could not be worked out as in most of the stalls selected for cost study, the entire milk was fed to the calves. Feed cost accounted for 76% of the gross cost whereas family labour and paid labour contributed to the extent of 17% and 3-4% of the gross cost. It was also observed that in about 40 per cent of the commercial producer households, the cost of production of buffalo milk was less than 90 paise per kilogram, when family labour was included. Considering 50% of these households as efficient, the average cost of production worked out to be of the order of 91 paise.

per kilogram when family labour was included and 74 paise per kilogram when it was excluded. The overall market rate of milk in the region was 90 paise per kilogram. The average butter fat and solids-not-fat (S.N.F.) contents in buffalo milk were 6.4 per cent. and 9.7 per cent respectively.

It was seen that about 16% of commercial producers in Krishna area sold milk directly to the organised dairy. In Guntur area, there was hardly any collection of milk by an organised dairy. On an average, 56% of buffaloes and 49% of cows were in milk in the region. The proportion of mortality among milch buffaloes was about 3 per cent.

2.26 Index of cost of production of milk.

The final report incorporating the results obtained in Tamil Nadu, West Bengal and the milk collection areas of Delhi Milk scheme was prepared. The salient results were as follows.

(a) Tamil Nadu: During 1957-59, when a detailed enquiry was conducted, the cost of production per kilogram of cow milk in the rural area, the suburban area of Madras and the city of Madras were 48 paise, 67 paise and 59 paise respectively, when family labour was included and 28 paise, 49 paise and 55 paise respectively, when family labour was excluded. For buffalo milk, these costs were 52 paise, 44 paise and 58 paise respectively, when

family labour was included and 33 paise, 32 paise and 57 paise respectively, when family labour was excluded. During 1969-71, the production costs for both cow milk and buffalo milk increased by 75 to 120 percent in the three areas as compared to the costs during 1957-59. The prevailing market rates, too, increased, the rate of increase being higher in the rural area. The producers of both cow milk and buffalo milk in the rural area and of cow milk in the sub-urban area could not meet their production cost, when family labour was included, but the producers in Madras city realised profit for both cow milk and buffalo milk.

(b) West Bengal: During 1960-62, the period of detailed enquiry, the costs of production per kilogram of cow milk, when family labour was included, were 66 paise in the rural area, 65 paise in the sub-urban area and 65 paise in Calcutta city, whereas the costs were respectively 44 paise, 34 paise, and 80 paise, when family labour was ignored. In case of buffalo milk, the cost of production was 92 paise per kilogram in Calcutta city, when family labour was included and 89 paise, when family labour was excluded. During 1969-71, the production cost increased by 70 to 100 per cent, in the rural area, 95 to 110 per cent, in the sub-urban area and 90 to 108 per cent in the urban area, as compared to the costs during 1957-59. The prevailing market rate also increased by 80 to 100 per cent in the three areas, being more in the rural area. The producers of cow milk in the three areas could not meet their production cost, when family labour was included.

but the producers of buffalo milk in Calcutta city realised profit.

(c) D.M.S. Milk collection Areas: During 1966-67, the costs of production of cow milk per kilogram in the supplying and the non-supplying areas were Rs. 1.20 and 93 paise respectively, when family labour was included and 97 paise and 73 paise respectively, when family labour was ignored. For buffalo milk, these costs were respectively 78 paise and 68 paise and 63 paise and 55 paise in the two cases. During 1969-71, the production cost increased by 3 to 13 per cent. In these areas as compared to the cost obtained for 1966-67. The prevailing market rate increased by 8 to 24 per cent, yet the producers of cow milk could not meet the production cost even when family labour was excluded. The producers of buffalo milk in the two areas, however, realised some profit even when family labour was included in the cost of production.

12.27 Pilot survey for estimating area of grazing land and its utilization.

The data collected in the survey carried out in Jhansi District of Uttar Pradesh during 1969-70 were further analysed and the final report on the project was presented to the Scientific Panels of the I.C.A.R. It was seen that the average grazing area per village in the rainy season was 121.42 hectares and in the winter season, 83.47 hectares, which constituted about 15 per cent and 9 per cent respectively of the geographical area. No grazing was available in the

summer season. The estimates of mean yield of herbage per hectare, when cuts were taken before grazing, were 6.24 quintals in the rainy season and 1.78 quintals in the winter season, while the estimates based on cuts taken after grazing were 5.44 quintals and 1.52 quintals respectively. The average daily consumption of grass per animal was 19 Kg in the rainy season and 7 Kg. in winter. In both the seasons, half of the weight of grass samples was nitrogen free extract and one - fourth, crude fibres. The per-~~centage~~ of ash, crude protein and ether extract were 13, 8, and 1.7 respectively in the rainy season and 11, 8 and 11.5 respectively in the winter season.

12.28 Study of the impact of milk supply schemes on rural economy in milk collection areas.

The data collected in the bench - mark survey conducted in the milk shed areas of Dudhsagar Dairy in Mehsena District of Gujarat during 1967-68 were analyzed for the study. It was seen that, in commercial milk producer households, the average daily milk yield per cow in milk was 2.5 Kg. in the supplying areas and 2.1 Kg. in the non-supplying areas. The averages for a buffalo in milk were 4.6 Kg. and 4.1 Kg. respectively. On an average, 216 tonnes of milk was produced per day in the district, of which 40 per cent was from the supplying areas. The commercial and the private milk producers contributed equally to the total milk production, which was from buffaloes. 66% of the buffaloes in the supplying areas were in milk, whereas the percentage

the cows in milk was as low as 42. In the non-supplying areas, the corresponding percentages were 56 and 42 respectively.

12.29 Standardization of the procedure of sampling from fleeces for study of wool quality.

Data on quality characters, viz., fibre diameter, crimps per cm., fibre length, staple length, medullation percentage and fleece density of regional and composite samples of ewes of Nilgiri, Nilgiri X Romney Marsh farm flocks and Nilgiri sheep of village flocks collected from the Sheep Breeding Farm, Kumrajsagar, Ootacamund (Tamil Nadu) and of ewes of Chokla and Polworth X Rampur Bushair crosses collected from the Central Sheep and Wool Research Institute, Avikanagar (Rajasthan) were utilized for the study. Having obtained the estimates of average and their standard errors for all the quality characters, the data were utilized to estimate the number of sheep to be selected from groups of sheep of sizes ranging from 20 sheep to 500 sheep to estimate the mean with standard error of 1%, 2% and 5% of the mean. In all the cases, it was generally observed that the sample of sheep to be selected remained almost constant with increase of flock size above 100 for 5% level, it gradually attained a constant value for 2% level as the flock size increased upto 450, and it showed a linearly increasing trend for 1% level. The number of sheep to be selected differed widely over the three levels of standard errors of the mean, over the age groups and also over the

different quality characters. It was also seen that, on the whole, composite sampling may be adopted when the regional means and variation are not to be estimated for grading of wool.

12.2.10 Statistical studies of data on artificial insemination in sheep.

The object of the investigation was to compare the differences among breeds and among rams within breeds in respect of semen quality as also the results obtained with different diluents in relation to keeping quality. Data on volume of semen ejaculated, p^H value, number of sperms per unit of volume, per-cent live spermatozoa, M.B.R. time and initial motility were available for 24 rams belonging to six breeds. Data on keeping quality of semen were also available for semen diluted at the rate of 1:3 or 1:4 and preserved in E.Y.S. at temperature between $0-1^{\circ}\text{C}$ and in E.Y.P. at temperature between $0-1^{\circ}\text{C}$ and $15-20^{\circ}\text{C}$. Comparison of differences among breeds and among rams within breeds in respect of semen quality were made. The comparison of keeping quality with different diluents was made after adjusting differences in the initial motility. It was seen that differences among breeds were significant only in respect of volume of semen ejaculated and p^H value and not significant in respect of other characters. Rams within breeds were not significant in respect of abnormal sperms and M.B.R. time, while they differed in respect of other characters. A comparison of keeping quality of semen diluted at the rates 1:3 and 1:4 showed that different diluents and temperatures had different keeping quality of semen.

In addition to the above investigations studies were also conducted on resource productivity in poultry under commercial conditions and for estimation of birth and death rates in bovines for preparation of life tables. Statistical analysis of the data collected from the Dasuya and Tanda regions of Hoshiarpur District in Punjab and from Delhi and its surrounding areas was continued to study the cost of poultry and egg production. Also, the scrutiny and coding of the data collected under a repeat sample survey to study the impact of milk supply schemes in milk collection areas of Delhi Milk Scheme and Dudhsagar Dairy, Mehsana (Gujarat) was in progress. Besides, the work of preparation of compendia of the results of experiments on animals carried out in the country was also continued under the National Index of Animal Experiments Scheme.

12.3 Sample survey investigations.

21.31 A study on the mortality of bovines.

The data collected in the cattle mortality surveys conducted during 1966-67 in Krishna District of Andhra Pradesh and Chingleput District of Tamil Nadu for implementing a pilot scheme of cattle insurance, were utilized for the study. It was seen that 70% of the bovines in the selected villages of Krishna District were buffaloes and the remaining 30% were cattle. Among cattle, 44.3% were working bullocks, 23.3% milch cattle, 31.6% young stock below 3 years of age and the remaining 0.8% belonged to other categories. The corresponding figures for buffaloes were 3.3%, 53.0%, 42.7% and 1.0% respectively. The annual mortality rate for young stock of cattle was

estimated at 2.1% for males and 1.7% for females. The annual mortality rates for working bullocks, cows in milk and dry cows in the age group of 3 to 10 years were 3.1% and 2.3% respectively, while for those above 10 years of age these were 4.1%, 10.8% and 10.7% respectively. The annual mortality rate for buffalo calves below 3 years of age was 19.3% for males and 8.3% for females, while for buffaloes in the age group of 3 to 10 years, it was 1.1% for working bullocks and 1.1% for both buffaloes in milk and dry buffaloes. The annual mortality rate for buffaloes in milk above 10 years of age was 2.6% and for dry buffaloes 5.7%. No deaths were reported for working buffaloes above the age of 10 years.

Of the bovines in the selected villages of Chitwan District, 73.5% were cattle and the remaining 26.5% were buffaloes. Among cattle, 37% were working bullocks, 37% milch cattle, 28.5% young stock below 3 years of age and the remaining 2.5% belonged to other categories. The corresponding figures for buffaloes were 10%, 57%, 21% and 4% respectively. The annual mortality rate for young stock and female young stock of cattle were 5.4% and 7.7% respectively. In the age group of 3 to 10 years working bullocks had an annual mortality rate of 3.1%, cows in milk, 1.4% and dry cows, 5.3%. The rates for these categories in the age group above 10 years were 4.1%, 3.7%, 5.7% and 21.6% respectively. The mortality rates for young buffalo calves were very high, being 19.3% for males and 21.6% for females. The annual mortality rates for working bullocks, buffaloes in milk and dry buffaloes

in the age group of 3 to 10 years were 3.5%, 0.9% and 2.3% respectively, while the rates for those above 10 years of age were 13.0%, 1.3% and 14.5% respectively.

12.32 Pilot sample survey for the study of yield and cultivation practices of fresh fruits.

The final report on the state-wide integrated survey carried out in Andhra Pradesh during the years 1965-67 was prepared. The total area under all fruit crops was estimated at 2, 54, 000 hectares of which 64% was under mango, 19.7% under citrus and 15.3% under banana. 88% of the total number of orchards estimated at 3.5 lakhs were bearing ones, of which 50% were of mangoes, 42% of banana and 15% of citrus, about 14% being mixed orchards. The average size of an orchard was estimated at 1.01 ha for mango, 0.69 ha for citrus and 0.31 ha for banana. It was seen that 75% of fresh fruit cultivation was concentrated in the coastal region, while Rayalseema and Telengana accounted for 22% and 3% of it respectively. The coastal region accounted for 69% of the cultivation of mangoes and 85% of the cultivation of banana, while Rayalseema accounted for 62% of the cultivation of citrus. On an average, a bearing tree of mango yielded 231 fruits weighing 48.35 Kg., that of citrus, 532 fruits weighing 81.51 Kg., and that of banana, 136 fingers weighing 11.45 Kg. Bangam -palli variety of mango gave the maximum yield of 51 Kg. per tree, while Swarna rekha had the minimum yield of 34 Kg. per tree. Amongst citrus fruit trees, the varietal group including Sethgudi, Bataria and Chinni had the maximum yielding

capacity of 605 fruits weighing 130 Kg. per tree. The average yield of lime was 975 fruits weighing only 36 Kg. per tree. All the major varieties of banana except Tellichakrakelli had more or less the same yielding capacity of 135 fingers per stalk; Tellichakra - Kelli had the minimum yield of 66 fingers per stalk.

The average distance between plants was of the order of 12.12 metres, 8.08 metres and 3.08 metres respectively for the mango, citrus, and banana crops. In majority of the cases, the soil type of mango orchards was sandy loam and that of banana orchard was loam, while citrus orchards were planted on all types of soil. Only 30% of the mango orchards received irrigation, while citrus and banana orchards were commonly irrigated. The main source of irrigation was well followed by canal and tank. The use of chemical fertilizers was found to be quite common for banana, while only 12% of the mango orchards and 32% of the citrus orchards received chemical fertilizers. The most common fertilizer was ammonium sulphate, the average rate of application being 2.57 Kg. per tree of citrus and 0.44 Kg. per banana plant. Digging and pruning was a rare practice in mango orchards but pruning was reported in about 30% of the citrus orchards.

12.33 Sample surveys for assessment of high yielding varieties programme.

The yield data pertaining to rabi, 1970-71 received from the State of Assam, Bihar, Gujarat, Haryana, Madhya Pradesh, Maharashtra, Mysore, Punjab, Rajasthan and Uttar Pradesh were analysed. The high yielding varieties of rice tried were IR - 8, CO-29, TN - 1, IR - 5, Jaya, Padma and ADT - 27, of which IR - 8 was the most popular with the selected farmers. The highest average yield of 48.8 Q/ha. was recorded for IR - 8 in Mysore District of Mysore. The average yield pooled over all the high yielding varieties of rice was the highest in Mysore (40.5 Q/ha.) and the lowest in Orissa (24.6 Q/ha). The rates of application of N, P, and K were, however, highest in Tamil Nadu. The most common high yielding varieties of wheat grown were Sonalika and Kalyan Sona. The other varieties tried were Sonora-64, Lerma Rojo, Safed Lerma, NP - 8241, NI-917, NI-747-19, Choti Lerma, PV-18, Lal Bahadur, Sharbati Sonora and HDM-1593. A record average yield of 54.7 Q/ha. was observed for the variety Kalyan Sona in Mandsaur District of Madhya Pradesh followed by 42.4 Q/ha. for HDM-1593 in Bulandshahr District of Uttar Pradesh. The average yield pooled over all the high yielding varieties of wheat was the highest in Madhya Pradesh (47.7 Q/ha) and the lowest in Mysore (12.3 Q/ha.). The rates of application of N, P, and K, too, were the highest in Madhya Pradesh and the lowest in Mysore. The most common variety of hybrid maize was Deccan hybrid. The other hybrids tried were Ganga -3 and Ganga -5. The highest average yield of 47.6 Q/ha was observed for Deccan hybrid in Mysore Distt.

of Mysore. The yield rate of hybrid maize was higher in Mysore than in Andhra Pradesh, although the rates of application of N, P, and K were almost of the same order. CSH - 1 variety of hybrid jowar was the only variety grown by all the selected farmers. The highest average yield was observed in Mysore State, where the rates of application of N, P, and K were also higher. Bajra was covered only in the State of Tamil Nadu. The hybrid variety HB - 4 gave the highest average yield of 24.3 Q/ha. in Coimbatore District; the rates of application of N, P and K were, however, much lower than recommended for the State.

12.34 Growth of minor irrigation projects and their effect on agriculture.

A sample survey conducted in the district of Nainital of Uttar Pradesh during July, 1972 to study the benefits of irrigation from minor irrigation projects (State tube-wells) showed that, on an average, a tube well could irrigate only about 112 acres during 1969-72 and about 123 acres during 1970 - 71. Some of the tube - wells did not function to full capacity due to defective and inadequate irrigation channels. The other contributing factors for the unsatisfactory working of tube - wells were lack of electric power when required, uneconomical working and unsuitable location of tube - wells, and the indifference of illiterate and poor cultivators in regard to availing of irrigation facilities created by the tube - wells.

12.35 Sample surveys to study the impact of the recent war on the agricultural and animal husbandry activities in the border areas.

It was observed that there was a considerable impact of the hostilities on the agricultural and animal husbandry activities in the border areas in terms of loss of crop production and livestock, adverse effect on the supply of agricultural inputs, fall in wages of agricultural labourers in some areas and rise in others. In many areas, certain commodities were cheaper while others were costlier. In certain other areas, the effect on prices of these commodities was in the opposite direction.

In addition to the above survey investigations, collection of additional data and critical analysis of the data already collected were in progress in connection with the pilot sample surveys for developing sample survey techniques for estimation of production of vegetables and fresh fruit crops and the pilot surveys initiated during the fourth Plan period, one in the Northern Region comprising Punjab, Haryana and Himachal Pradesh and the other in Andhra Pradesh of the Southern Region, for evolving an integrated techniques for studying simultaneously the annual output of livestock products. Studies for preparation of a monograph on methodology of estimation of meat production as also a monograph on methodology of estimation of poultry egg production and poultry practices were also continued. Studies were also taken up on availability of feeds to cattle and buffaloes in India, estimation of annual meat production

and its per capita availability in India, and methodology for estimation of inter-censal livestock numbers through livestock products surveys. Also, data were collected for a pilot study for evolving sample survey techniques for estimation of production of cultivated fodders. Besides, field work was initiated in October, 1972 in connection with a survey for estimation of the cost of production of apples and study of their marketing practices in the Himalayan region of Uttar Pradesh and preliminary planning work was completed for a pilot study for evolving sample survey techniques for estimation of crop losses in storage.

12.4 Basic research in statistics.

(a) Sampling.

When sample size is sufficiently large, it was shown that the variance of the ratio estimate under Midzuno-Sen sampling is exactly the same as the mean square error of the classical ratio estimator, the mean square error being evaluated to the first order of approximation. Application of Midzuno-sen ratio strategy to successive sampling was also studied. Further, it was shown that the Midzuno-Sen ratio strategy defined with reference to suitably transferred ancillary variable is asymptotically the best in the class of all T3-type unbiased pps strategy. A new approach for utilizing ancillary information for providing better estimates was also initiated. A sample size stratification on the basis of ancillary data depending on whether the ancillary data is discrete or continuous, was suggested.

and a new estimator was proposed. It was shown that the estimator is superior in the sense of smaller variance than many a pps sampling strategy in several situations.

(b) Genetic statistics.

Partial diallel crosses based on extended triangular designs were constructed. The analysis of full and partial diallel crosses with several characters was studied with the help of data on wheat and triticale.

(c) Design of experiments.

The combinatorial properties of association schemes were studied with the help of a matrix, known as the characteristic matrix of the association scheme. New methods of construction of 2 - class G.D. designs were studied. Some new association schemes and PBIB designs based on such schemes were developed.

Publications.

During the year under report, thirty papers by the officers, members of staff and research students of the Institute were published in standard journals. Besides, five technical reports, an annual report and its summary were published as ICAR publications. Twenty five papers were accepted for publication in different journals.

APPENDIX-I

List of Class I Officers in position as on
31.12.1972.

<u>Name</u>	<u>Designation</u>
M.N. Das	Director.
Prem Narain	Senior Statistician.
S.K. Raheja	Senior Statistician.
K.S. Krishnan	Senior Statistician.
S.D. Bokil	Statistician-cum-Associate Professor.
B. Marutiram	Statistician-cum-Associate Professor.
V.V.R. Murty	Statistician-cum-Associate Professor.
S.S. Pillai	Statistician-cum-Associate Professor.
K.C. Raut	Statistician-cum-Associate Professor.
M. Rajagopalan	Statistician-cum-Associate Professor.
T. Jacob	Statistician-cum-Associate Professor.
S.S. Narula	Statistician-cum-Associate Professor.
H.P. Singh	Statistician-cum-Associate Professor.
A.H. Manwani	Statistician-cum-Associate Professor.
B.B.P.S. Goel	Statistician-cum-Associate Professor.
P.N. Bhargava	Statistician-cum-Associate Professor.
Aloke Dey	Statistician-cum-Associate Professor.
M.S. Avadhani	Statistician-cum-Associate Professor.
A.K. Nigam	Statistician-cum-Associate Professor.
J.P. Jain	Statistician-cum-Associate Professor.
R.K. Pande	Agricultural Economist.
S.C. Rai	Assistant Professor.
U.G. Nadkarni	Junior Statistician.
C.R. Leelavathi	Junior Statistician.
R. Gopalan	Junior Statistician.
J.N. Garg	Junior Statistician.
S.R. Bapat	Junior Statistician.
A.K. Banerjee	Junior Statistician.
J.S. Maini	Junior Statistician.
P.C. Mehrotra	Junior Statistician.
V.S. Rastogi	Junior Statistician.
B.K. Garg	Junior Statistician.
M.G. Mittal	Junior Statistician.
P.N. Soni	Junior Statistician.
S.N. Mathur	Junior Statistician.
A.K. Srivastava	Junior Statistician.
R.K. Khosla	Junior Statistician.
K.V. Sathe	Junior Statistician.
Padam Singh	Junior Statistician.
A.C. Kaistha	Mechanical Tabulation Officer.
R.C. Aggarwal	Field Officer.
Rajinder Singh	Field Officer.

Administration

R.S. Saksena	Chief Administrative Officer.
M.R. Garg	Administrative Officer.
S.S. Grewal	Assistant Administrative Officer.

APPENDIX-II

List of sanctioned posts as on 31.12.1972.

<u>S1 No:</u>	<u>Post</u>	<u>Scale of Pay</u>
<u>Class-I</u>		
1.	Director	Rs. 1600-2000
2.	Joint Director	Rs. 1300-1800
3.	Senior Professor	Rs. 1100-1600
4.	Senior Statistician	Rs. 1100-1400
5.	Chief Scientist.	Rs. 1100-1400
6.	Chief Administrative Officer	Rs. 1100-1400
7.	Administrative Officer	Rs. 700-1250
8.	Statistician	Rs. 700-1250
9.	Agricultural Economist	Rs. 700-1250
10.	Programmer (cc)	Rs. 700-1250
11.	Junior Statistician	Rs. 400-950
12.	Assistant Professor	Rs. 400-950
13.	Mechanical Tabulation Officer	Rs. 400-950
14.	Junior Technical Officer	Rs. 400-950
15.	Field Officer	Rs. 400-950
16.	Assistant Administrative Officer (cc).	Rs. 400-950
<u>Class-II</u>		
1.	Accounts Officer	Rs. 590-900
2.	Section Officer	Rs. 350(400)-900
3.	Statistical Investigator	Rs. 325-575
4.	Electronic Computer Operator	Rs. 325-575
<u>Class-III</u>		
1.	Assistant Incharge	Rs. 210-530 plus Rs. 40/-
2.	Assistant	Rs. 210-530
3.	Cashier	Rs. 210-530 plus Rs. 40/-
4.	Personal Assistant	Rs. 210-530
5.	Junior Accounts Officer	Rs. 270-575
6.	Statistical Assistant	Rs. 210-425
7.	Technical Assistant	Rs. 210-425
8.	Asstt. Electronic Computer Operator.	Rs. 210-425
9.	Caretaker	Rs. 210-425
10.	Senior Storekeeper	Rs. 210-425
11.	Senior Librarian Asstt. (Grade II)	Rs. 210-425
12.	Junior Accountant	Rs. 180-400
13.	Senior Computer	Rs. 168-300
14.	Card Librarian	Rs. 168-300
15.	Stenographer	Rs. 130-300
16.	Upper Division Clerk	Rs. 130-300
17.	Upper Division Clerk(Hostel)	Rs. 130-300
18.	Punch Supervisor	Rs. 110-200 plus Rs. 40/- special pay
19.	Machine Operator	Rs. 110-200 plus Rs. 40/- special pay
20.	Key Punch Operator	Rs. 110-200 plus Rs. 40/- special pay
21.	Lower Division Clerk	Rs. 110-180

Telephone Operator	Rs. 110-180	2
Staff Car Driver	Rs. 110-180	1
Jeep Driver	Rs. 110-139	1
Carpenter	Rs. 125-155	1
Tubewell Operator	Rs. 125-180	1
Library Attendant	Rs. 85-128	1

Field Staff

Class-IV

Junior Gestetner Operator	Rs. 80-110	1
Daftry	Rs. 75-95	4
Laboratory Attendant	Rs. 75-95	12
Jamadar	Rs. 75-95	1
Chowkidar	Rs. 70-85	8
Frash	Rs. 70-85	4
Mali	Rs. 70-85	5
Beldar	Rs. 70-85	2
Peon	Rs. 70-85	13
Sweeper	Rs. 70-85	8

Class-II

Assistant Field Officer.	Rs. 350-900	1
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Class-III

Inspector	Rs. 210-425	5
Supervisor	Rs. 130-300	11
Enumerator	Rs. 110-200	46

APPENDIX - III

List of the theses approved during the year 1972
for the award of the M.Sc. Degree and the Diploma
in Agricultural Statistics.

M.Sc. Degree

1. AGGARWAL, D.K. Use of ancillary information in the analysis of agronomic experiments.
2. AGGARWAL, RANJANA. Optimum points of stratification in multi-dimensional populations.
3. AGGARWAL, S.K. Further developments in Snowball Sampling Technique.
4. BHATIA, V.K. Relationship between survival and wool yield in sheep.
5. BORA, A.C. A study of association of yield and some factors influencing it for high yielding varieties of rice in Tamil Nadu State.
6. CHAKRAVARTY, RUPAK. Investigation of data collected from the assessment survey under High Yielding Varieties Programme in Belgaun District of Mysore State.
7. CHANDRAHAS. Comparison of different estimates of wool production.
8. GUPTA, V.K. A study on the efficiency of systematic sampling in estimating lactation yield of a cow.
9. KUMAR, PRANESH. Economic analysis of fertilizer trials of bajra on cultivators' fields.
10. MALIK, R.P.S. Choice of strata for estimating sheep population.
11. MIDHA, C.K. Methods of estimation of area and its bias for high yielding varieties.
12. RAI, LAJPAT. Spread of high yielding varieties and the extent of adoption of improved practices in Jaipur district of Rajasthan.
13. SINGH, SUBEDAR. Disequilibrium due to linkage in Inbred Populations.
14. SUCHDEVA, K.S. Sire evaluation in cattle breeding.

Diploma

1. RAO, C. SUBBA. Some aspects of partial diallel crosses.
2. SHANKAR, GAURI. Some contributions to incomplete block designs.
3. TRIVEDI, H.T. Some studies on partially balanced incomplete block designs.

APPENDIX IV

List of papers published or accepted for publication during the year 1972.

Papers published:

1. AVADHANI, M.S. and SHRIVASTAVA, A.K. A comparison of MIDZUNO - Sen scheme with p.p.s sampling without replacement and its application to succession sampling Ann. Inst. Stat. Maths., Vol 24, No.I, pp.153-164.
2. BHARGAVA, P.N. and RASTOGI, V.S. Study of the marketable surplus of paddy in Burdwan District. Ind. Jour. of Agri.Eco., July-September,1972.
3. DAS, M.N., SARDANA, M.G., KHOSLA, R.K. and RAO, P.P. Crop responses to fertilizers. Fert. News, Vol.17 No.11 (1972).
4. DAS, M.N. and RAHEJA, S.K. Yield rates of high yielding varieties of rice and wheat and associated fertilizer and management practices adopted by cultivators in different States during 1970-71. Special Number of Indian Farming, August,1972.
5. DEY, A. Some remarks on chemical balance weighing designs. Jour. Ind. Soc. Agri. Stat. Vol.24.
6. DEY, A., KULSHRESTHA, A.C. and SAHA, G.M. Three symbol partially balanced arrays. Ann. Inst.Stat. MATHS., Vol.24.
7. GARG, R.C. and MURTY, V.V.R. Efficiency of Stratification in livestock surveys. Jour. Ind. Soc. Agri. Stat. Vol.24, No.2.
8. JACOB, T. Use of linear programming technique in feed compounding Ind. Jour. Anim. Sci. Vol.42, No.7 pp 476-479.
9. JAIN, J.P., AMBLE, V.N. and MARUTIRAM, B. Plan for systematic improvement of dairy herds through progeny testing. Ind. Jour. Anim. Sci.42 (8): 549-57(1972)
10. KANNIAR, J.S., DAS, M.N., SARDANA, M.G. and BAPAT, S.R. Balanced fertilizer use for maximising returns from wheat on cultivators' fields. Fertilizer News 17 (11): pp.19-30(1972).
11. KHOSLA, R.K., SEN, A.R. and RAO, U.M.B. Pre-harvest estimation of crop acreage. Jour. Food, Farm., Agri. Vol.4, No.10(1972).
12. KISHEN, K., SARDANA, M.G., KHOSLA, R.K. and DUBE, R.C. Estimates of the incidence of pests and diseases and consequent field losses in the yield of wheat (*Triticum aestivum* L.) Ind. Jour. Agri.Sci., Vol.42 No.10(1972).

13. KRISHNAN, K.S. and MEHROTRA, P.C. Yield rates and profit margin in fertilizer use to high yielding varieties in IADP districts. Jour of Ind. Soc. of Agri. Stat. Vol. 24, No. 1, pp. 77-82 (June, 1972).
14. KRISHNAN, K.S., RUSTOGI, V.S. and SONI, P.N. Irrigation and fertilizer responses of wheat, jowar and gram in IADP districts, Fertilizer News, Vol. 17, No. 9 (September, 1972).
15. KULSHRESTHA, A.C., DEY, A. and SAHA, G.M. Balanced designs with unequal replications and unequal block sizes. Ann. Math. Stat., Vol. 43.
16. LEEIAVATHI, C.R. and ABRAHAM, T.P. On determination of yardsticks of additional production, Jour. Ind. Soc. Agri. Stat., Vol. 24, No. 2.
17. MAHAPATRA, I.C., RAHEJA, S.K. and BAPAT, S.R. Response of rice varieties to NPK fertilizers and micro - nutrients. Il Riso, Italy, December, 1972.
18. MEHROTRA, P.C. and KRISHNAN, K.S. Adoption of high yielding varieties of rice and wheat by small, medium and large farmers. Indian Farming, Vol. 22, No. 4, pp 21-23 (July, 1972).
19. NARAIN, P. Statistical problems in improving the cattle population through breeding. Silver Jubilee Souvenir, Ind. Soc. Agri. Stat.
20. NARAIN, P. Construction of selection index and its use in poultry breeding. Proc. of seminar on "Poultry Breeding and Genetics" (U. D.P.) held at I.V.R.I., Izatnagar (U.P.).
21. NARAIN, P. Methods of analysing diallel crosses in poultry, Proc. of Seminar on "Poultry Breeding and Genetics" (U.N.D.P.) held at I.V.R.I., Izatnagar.
22. NARAIN, P. and GARG, L.K. The estimation of genetic change in some Indian herds of cattle. Ind. Anim. Prod., Vol. 3 No. 4 pp. 143-153 (1972).
23. RAHEJA, S.K., KHOSLA, R.K., RAO, P.P. and KUMAR, MAHESH. Agricultural field experiments and computer use. Eastern Economist, Vol. 59, No. 7 (1972).
24. RAHEJA, S.K., KHOSLA, R.K., RAO, P.P. and KUMAR, MAHESH. Design and analysis of agricultural field experiments and computer use (i) Electronics for You, Vol. 5, No. 8 (1972) (ii) Independence Number of Eastern Economist, August, 1972 and (iii) Proc. of the Symp. on "Design of Agricultural Experiments and computerisation of their Analysis" held at Delhi in March, 1972.

25. RAHEJA, S.K. and LEEUWRIK, P.M. Yield potential of important field crops in multiple cropping Silver Jubilee Souvenir of the Ind. Soc. of Agri. Stat. (1972).
26. RAJAGOPALAN, M., MEHROTRA, P.C., BANERJEE, A.K. and GUPTA, S.S. A statistical appraisal of the performance of Kalyan Sona in Punjab. Fertilizer News, Vol. 17, No.7, pp. 27-29 (July, 1972).
27. RAUT, K.C. and SINGH, SHIVTAR. Economics of calf rearing in rural areas. Indian Farming, Dec., 1972.
28. REDDY, K.M. and NARAIN, P. The effect of incomplete penetrance of a gene on the genetical consequences of assortative mating Ind. Jour. of Genetics and Plant Breeding, Vol. 32, No.1, 1972.
29. SINGH, D, SARDANA, M.G. and KHOSLA, R.K. Rice pests and diseases. Jour. Food, Farm, Agri., Vol.4, No.8 (1972)
30. SINGH, K.B., GOEL, B.B.P.S. and MURTY, V.V.R. Estimation of availability of bullock power in certain tracts of India. Agri. Situ. Ind., Oct. 1971. pp.483-487.

(b)

Papers accepted for publication

1. AVADHANI, M.S. On the optimum utilisation of ancillary information in sampling from finite population. Jour. Roy.Stat. Soc.
2. CAPEL, R.E. and PANDEY, R.K. Estimation of benefits from deer and moose hunting in Manitoba. CANADIAN Jour. Agri. Eco.
3. DAS, M.N. and PONNUSWAMY, K.N. Design and analysis for triallel crosses. Biometrics.
4. DAS, M.N. and LAL, BASANT. On design for qualitative - cum-quantitative experiments Jour. Ind. Soc. of Agri. Stat.
5. DEY, A. and SAHA, G.M. An inequality for tactical configurations. Ann. Ind. Stat. Maths.
6. DEY, A and KULSHRESHTHA, A.C. Further second order rotatable designs. Jour. Ind. Soc. Agri. Stat.
7. GOEL, B.B.P.S., SINGH, K.B. and SINGH, K.P. Availability and disposal of dung in India. Ind. Jour. Anim.Sci.
8. GOPALAN, R. and JACOB, T. Tables for orthogonal polynomials for un-equi-spaced intervals of the independent variate - Jour. Ind. Soc. Agri. Stat.

9. GOSWAMI, N.N., RAHEJA, S.K. and BAPAT, S.R. Fertilizer recommendations on cultivators' fields - soil fertility approach. Fertilizer News.
10. KHOSLA, R.K., SARDANA, M.G., SAKSENA, M.P. and SAINI, R. Review of agricultural experimentation in India during 1965-70. Ind. Jour. Agri. Sci.
11. MURTY, V.V.R., GOEL, B.B.P.S. and RAO, D.V.S. Poultry egg production and its per capita availability in India. Ind. Jour. Anim. Prod.
12. NARAIN, P. and REDDY, K.M. A note on the generalisation of homozygote x heterozygote matings. Ind. Jour of Heredity.
13. NARAIN, P. and MISRA, A.K. The use of ancillary traits in increasing the efficiency of selective breeding. Genetical Research.
14. NIGAM, A.K. Multifactor mixture experiments Jour. Roy. Stat. Soc. 'B'.
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