ANNUAL REPORT
1974

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

Compiled and edited
by

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and

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PREFACE

I take pleasure in presenting to the reader this annual report of the Institute of Agricultural Research Statistics, New Delhi for the year 1974. Efforts have been made to cover, as far as possible, all the aspects of the functions and the activities of the Institute during the year under report.

I hope this report would prove useful to research workers in the field of agricultural statistics and others who may use it. Comments and suggestions offered for improvement in the presentation of future annual reports of the Institute would be welcome and much appreciated.

I take this opportunity to place on record my sincere thanks to the officers and other members of the staff of the Institute who extended willing co-operation in preparing and supplying the material required for this report.

I am also grateful to my colleague, Dr. Prem Narain, Senior Professor for going through the report.

D. Singh
Director,
Institute of Agricultural
Research Statistics,
New Delhi - 110012.

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1. 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 played a very important role in the progress in the application of statistical methods to agricultural research in India and has achieved international recognition for the high quality of its research work and training. A number of research workers from the Institute have served as consultants and advisers in Asian, African and Latin American countries. Also, a number of statisticians and trainees of the Institute are at present occupying high positions in the universities and other research Institutions of the U.S.A., Canada and other countries.

It was in the year 1930 that, in pursuance of the recommendations of the Royal Commission of Agriculture, the Institute made a modest beginning as a Statistical Section of the Indian Council of Agricultural Research. It was then manned by only one Statistician and a limited staff. Initially, 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. In 1933, he was also made 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 Branch', as it now came to be called, was re-organised in 1945 into two separate units, each under the charge of a Statistician, dealing with statistical applications to research in agriculture and in animal husbandry and was now headed by the Statistical Adviser to the Council. Also, the Council now 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 eventually constituted for organising the various courses of study. The 'Statistical Branch' 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 international seminars for the Food and Agriculture Organisation of the United Nations.

Valuable contributions were made by the 'Statistical Branch' 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 September, 1952, the services of two F.A.O. experts, Dr. Frank Yates, Chief Statistician, Rothamstead Experimental Station, Harpenden (U.K.) and Dr. D. J. Finney of the Oxford University (U.K.) 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 Branch' were expanded in many directions and 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 and was now called 'Statistical Wing' of the I.C.A.R. The campus provided adequate space not only for office accommodation for the technical and the ministerial staff but also for facilities of a library, reading rooms, class-rooms for the training

classes, an auditorium and a hostel with the usual amenities including a playground for the students admitted to the various courses of study. Also, in recognition of its important role as a training and research institution, the 'Statistical Wing' was re-designated by the Government of India as the "Institute of Agricultural Research Statistics" in June, 1959. A mechanical data processing unit was also then 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, while 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. Also, there was now a better accommodation for the co-operative canteen of the Institute on the first floor and a spacious auditorium on the third floor which also provided 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. In October, 1964. new courses leading to M.Sc. and Ph.D. degrees in Agricultural Statistics were started in collaboration with the Indian Agricultural Research Institute.

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 Director.

1.1 Organisational Structure of the Institute

The research and technical work of the Institute is organised in five broad Divisions as indicated below :—

1. Statistical Research in Agricultural Sciences.
2. Statistical Research in Animal Sciences.
3. Sample Survey Investigations.
4. Training and Basic Research.
5. Computer Science and Numerical Analyis.

The number of Class I Officers in position as on 31st December, 1974 was 47. A list of these officers is given as Appendix I. On the research and training side, the Director was assisted by 3 Senior Statisticians, 14 Statisticians-cum-Associate Professors, 1 Agricultural Economist, 20 Junior Statisticians, 2 Assistant Professors 1 Mechanical Tabulation Officer, 1 Junior Technical Officer and 2 Field Officers

and on the administrative side, by a Chief Administrative Officer and an Administrative Officer.

The number of posts (including out-station posts) sanctioned as on 31st December, 1974 was 580 comprising 73 Class I, 54 Class II, 377 Class III and 76 Class IV posts. A list of these posts is given as Appendix II.

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 in May, 1966, a Staff Research Council was constituted at the Institute early in the year 1970. The objectives of the Staff Research Council are to carefully choose the research programmes of the Institute, to decide on priorities, and to watch the progress of the various research schemes with a view to remove bottle-necks, if any, in their execution. It discusses the progress of research problems in Statistics involving inter-disciplinary collaborations. It also considers publication of the results of statistical research which are worthy of being passed on to the research workers in various disciplines of agricultural and animal sciences.

The Staff Research Council continued to function during the year under report. Shri H. P. Singh took over as Member-Secretary from Dr. A.K. Nigam in January, 1974. The Staff Research Council met in the months of March, July and November, 1974 under the Chairmanship of the Director to discuss the progress of the various research projects in operation. The progress of about 35 research projects was discussed in the different meetings. All the officers of the Institute holding charge of the various projects attended the meetings to explain the progress of their respective projects. The discussions held in the different meetings helped the concerned research workers to further modify the line of action for improving the quality of rearch aspects involved in the projects. During the discussions, the Director gave very useful suggestions from time to time and laid greater emphais on developing problem-oriented research methodology in order to cater to the needs of other research workers engaged in the field of agriculture and animal husbandry. The research problems in statistics involving inter-disciplinary collaboration were also discussed from time to time. The results of statistical research which were worthy of being passed on to the research workers in various disciplines of agricultural and animal sciences were also considered. Thus, the Staff Research Council served a very useful purpose in giving direction to the concerned research workers for improvement of research activities of the Institute.

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.

The students celebrated their Annual Day on the 10th August, 1974. Dr. N. K. Ananta Rao, Deputy Director General, I. C. A. R., was the chief guest.

Dr. Prem Narain, Senior Statistician, took over as Warden of the Hostel from Dr. M. N. Das, Senior Professor of Statistics with effect from 12th November, 1973 on Dr. Das proceeding on leave abroad and continued till 30th August, 1974. He again took over as Warden from Dr. Das with effect from 21st December, 1974 on his relinquishing charge of his post to join the National Sample Survey Organisation.

1.4 Library

During the year under report, 150 new books and about 275 other publications were added to the Library. There was, as usual, a constantly increasing number of short and long range reference queries about location of literature and for procurement of research papers, which were duly attended to. About 14,000 persons visited the Library for borrowing or reading purposes and for consulting references. About 21,500 books, journals and other periodicals were issued on loan to the students and members of the staff of the Institute. The practice of imposing fine for late return of books and other periodicals was continued during the year under report. The service hours of the Library were from 9.00 A. M. to 5.00 P. M.

As usual, inter-library loan factilities were exchanged with other libraries in the country in general and with those in Delhi in particular. As in the past, re-

prints of the articles by the scientists of the Institute were sent to scientists in the country and abroad. A catalogue of reprints was under preparation during the year under report.

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

1.5 Exhibition Room

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

During the year under report, many distinguished visitors were taken round the Exhibition Room. Prominent among them were Dr. J. N. Srivastava, Professor of Statistics, Colorado State University, U.S.A., Dr. T. V. Hanurav, Dean of Studies, Indian Statistical Institute, Calcutta, and Dr. O. P. Aggarwal, UNESCO Expert, Mexico.

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 :

Course	*Value*	*Period*
(*a*) Ph. D.	Rs. 400 per month	Two years (The period may be extended, if necessary)
(*b*) Diploma	Rs. 250/-per month	One year
(*c*) M. Sc.	Rs. 300/- per month	Two years
(*d*) P. S. C.	Rs. 200/- per month	One year

During the year under report, 25 fellowships were awarded as detailed below :

(*i*) Ph. D.	I Year	1
	II Year	1
	III Year	2

(*ii*) Diploma	6
(*iii*) M.Sc. I Year	7
II Year	7
(*iv*) P. S. C.	1

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

(*a*) 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 Research Project 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 Social Test Crop Response Scheme.

(*b*) The scheme for determining the cost of cultivation and study of marketing of apples in the Himalayan Region of Uttar Pradesh (vide Section 4.8) was, as mentioned in the annual reports for the years 1972 and 1973, undertaken by the Institute in active collaboration with the Directorate of Marketing and Inspection, Government of India, the Directorate of Agriculture, Uttar Pradesh and the Directorate of Fruit Utilization, Uttar Pradesh. The scheme was being 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.

1.8 Advanced training

(*a*) Shri S. S. Pillai, Statistician-cum-Associate Professor, was deputed to attend the "International Training Course for Senior Applications Programmers" held at Budapest (Hungary) from 14th October to 14th December, 1974 under the aegis of the United Nations Development Progrmme.

(*b*) Shri S. N. Mathur and Shri K. V. Sathe, Junior Statisticians, were deputed to receive advanced training in hardware and software capabilities including applications to teleprocessing for the IBM System 370 at the IBM Educational Centre, New Delhi during August, 1974.

1.9 Visitors

During the year under report, seven eminent statisticians, Shri R. C. Khera, Scientist, I.C.A.R., New Delhi, Dr. J. N. Srivastava, Professor of Statistics,

Colorado University, U.S.A., Dr. T. V. Hanurav, Dean of Studies, Indian Satistical Institute, Calcutta, Dr. A. L. Nagar, Professor of Econometrics, Delhi University, Dr. O. P. Aggarwal, UNESCO Expert, Mexico, Dr. J. S. Rustogi, Professor of Statistics, Ohio State University, U.S.A. and Dr. G. R. Seth, F.A.O. Expert, Haiti visited the Institute and delivered lectures on topics of current research. Dr. K. M. Cellier, Principal Research Scientist, Division of Mathematical Statistics, C.S.I.R.O., Sydney (Australia) visited the Institute to discuss the fellowship scheme for visiting statisticians to Australia, while Shri K. C. Sharma of the Agricultural Refinance Corporation, Bombay who was incharge of an Evaluation Study on "Haryana Minor Irrigation Project : Shallow tube-wells—Karnal I" visited the Institute for technical advice in regard to the sampling design and methodology to be adopted for the project.

Besides, students of Andhra University, Waltair and the Indian Statistical Institute, Calcutta and trainees of the Central Statistical Organisation, New Delhi visited the Institute at different times during the year to attend the lectures and the practicals specially arranged for them. Also, a large number of M.Sc. and Ph.D. students and research workers from the various ICAR Research Institutes and Central Argicultural Universities visited the Institute to receive help in preparation of computer programmes for computerisation of their research problems.

1.10. Participation in Scientific Committees, Panels, etc.

(*a*) During the year under report, several Officers of the Institute represented the Institute at the meetings of the various I.C.A.R. Scientific Panels as indicated below:

Name of Officer	*Name of Scientific Panel*
Dr. P. Narain	(*a*) Scientific Panel on Plant Breeding.
	(*b*) Scientific Panel on Fisheries Research.
Sh. K. S. Krishnan	(*a*) Scientific Panel on Plant Breeding.
	(*b*) Scientific Panel on Medicinal Plants.
Sh. B. Marutiram	(*a*) Scientific Panel on Animal Breeding.
	(*b*) Scientific Panel on Animal Diseases and Pests.
	(*c*) Scientific Panel on Animal Products and Technology.
Sh. K. C. Raut	Scientific Panel on Dairy Science.

Sh. T. Jacob	Scientific Panel on Animal Nutrition and Physiology.
Dr. R. K. Pandey	Scientific Panel on Agricultural Economics and Marketing.

(b) During the year under report, the Officers of the Institute named below were members of the Scientific Associations, Committees, Panels, etc. mentioned against their names.

Name of Officer	*Name of Scientific Committee, etc.*
Dr. D. Singh	(a) The International Statistical Institute, The Hague, Holland.
	(b) The Indian Science Congress Association, Calcutta.
	(c) The International Standards Institution, Paris.
	(d) The ICAR Scientific Panel for Agricultural Statistics.
	(e) The ICAR Scientific Panel for Agricultural Economics and Marketing.
	(f) Statistics Courses Committee, Rajendra Agricultural University, Bihar.
	(g) Committee on Agricultural Statistics, University of Kalyani.
	(h) Committee of Direction of the Scheme on Marketable Surpluses and Post-harvest Losses, Directorate of Marketing & Inspection (Ministry of Agriculture).
	(i) ICAR Study Group of "Utility of Gram Sewaks".
	(j) Working Group on "Strategy for Agricultural Planning in Drought and Flood Prone Areas" constituted by the All India Coordinated Research Project for Dryland Agriculture.

(*k*) Board of Studies, Meerut University.

(*l*) Direction Committee on Evaluation of the Agricultural Refinance Corporation Schemes constituted by the Agricultural Refinance Corporation, Bombay.

(*m*) Working Group for the Survey on Livestock Enterprizes, National Sample Survey Organisation.

(*n*) Editorial Board for 1974 of the Indian Journal of Agricultural Research of the Agricultural Research Communication Centre, Central Soil Salinity Research Institute, Karnal.

(*o*) The Indian Society of Agricultural Statistics, New Delhi.

(*p*) Post-Graduate Faculty of the P. G. School, I.A.R.I., New Delhi.

(*q*) Statistical Sectional Committee of the Indian Standards Institution, New Delhi.

Dr. M. N. Das

(*a*) The Indian Society of Agricultural Statistics.

(*b*) The Indian Association of Statistics, Bombay.

(*c*) The Calcutta Statistical Association.

(*d*) The Indian Science Congress Association.

(*e*) P.G. Faculty of the P.G. School, I.A.R.I., New Delhi.

(*f*) ICAR Scientific Panel on Agricultural Statistics.

(*g*) Special Team on Sound Sampling Methods for Determination of Quality of Jute Fibre, Jute Technological Research Laboratories, Calcutta.

Dr. P. Narain	(*a*) The Indian Science Congress Association.
	(*b*) The Indian Society of Agricultural Statistics (Also, Editor of its Journal).
	(*c*) The Indian Society of Plant Breeding and Genetics.
	(*d*) The International Biometric Society, U.S.A.
	(*e*) The Society of Advancement of Breeding Research in Asia and Oceania (SABRAO), Japan.
	(*f*) The Genetic Association of India.
	(*g*) The Indian Association for Animal Production (Also, a member of the Editorial Board of its Journal).
	(*h*) The General Council of the University of Edinburgh, U.K.
	(*i*) The Post-Graduate Faculty of the P.G. School, I.A.R.I., New Delhi.
	(*j*) The Royal Statistical Society of Britain, U. K. (Elected as a Fellow).
Sh. S. K. Raheja	(*a*) The Indian Society of Agricultural Statistics.
	(*b*) P.G. Faculty of the P.G. School, I.A.R.I., New Delhi.
	(*c*) The Computer Society of India.
	(*d*) Panel of Judges for the All-India Crop Competition Scheme of the Directorate of Extension, Ministry of Agriculture.
	(*e*) Expert Committee on Fertilizer Requirements during the Fifth Five Year Plan, Ministry of Agriculture.
Sh. K. S. Krishnan	(*a*) Sectional Committee on Agricultural Products of the Indian Standards Institution.

	(*b*) Standing Committee of the All India Co-ordinated Agronomic Research Project.
Sh. S. D. Bokil	(*a*) The Indian Society of Agricultural Statistics (Hony. Joint Secretary).
	(*b*) The Indian Society of Agricultural Economics.
	(*c*) P.G. Faculty of the P.G. School, I.A.R.I., New Delhi.
Sh. S. S. Pillai	I.C.A.R. Evaluation Committee for a new Computer at the I.A.R.S. (Convener).
Sh. M. P. Jha	The Indian Society of Agricultural Statistics.
Sh. B. Marutiram	(*a*) The Indian Society of Agricultural Statistics.
	(*b*) The Indian Dairy Science Association.
	(*c*) The Indian Association for Animal Production.
Sh. K. C. Raut	(*a*) The Indian Society of Agricultural Statistics.
	(*b*) Sensory (Organoleptic) Tests Sub-Committee of the Indian Standards Institution.
Sh. H. P. Singh	The Indian Society of Agricultural Statistics.
Dr. A. H. Manwani	(*a*) Study Team on Fruits and Vegetables Statistics of the National Commission on Agriculture. (Convener)
	(*b*) Sub-committee on Food Sampling of the Indian Standards Institution.
Dr. B. B. P. S. Goel	(*a*) The Indian Society of Agricultural Statistics (Hony. Joint Secretary).
	(*b*) Study Team on Livestock Statistics in the National Commission on Agriculture.
Dr. Aloke Dey	(*a*) The Indian Society of Agricultural Statistics.
	(*b*) The Indian Science Congress Association.

Sh. J. N. Garg	P. G. Faculty of the P.G. School, I.A.R.I., New Delhi.
Sh. R. Gopalan	The Indian Society of Agricultural Statistics.
Sh. J. S. Maini	The Indian Society of Agricultural Statistics.
Sh. L. K. Garg	The Indian Society of Agricultural Statistics.
Sh. V. S. Rustogi	The Association of Scientific Workers of India.
Sh. P. N. Soni	The Association of Scientific Workers of India.
Sh. S. N. Mathur	The Computer Society of India. (Institutional Member)
Sh. R. K. Khosla	(*a*) The Indian Society of Agricultural Statistics, New Delhi.
	(*b*) The Association of Rice Research Workers, Cuttack.
	(*c*) The Association of Scientifie Workers of India, New Delhi.
Sh. A. C. Kaistha	(*a*) The Indian Society of Agricultural Statistics.
	(*b*) The Computer Society of India. (Institutional Member)
Sh. S. C. Rai	The Indian Society of Agricultural Statistics.
Sh. K. V. Sathe	The Computer Society of India. (Institutional Member)

(*c*) The Director of the Institute was ex-officio member of the following scientific 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. General Body, I.C.A.R.
5. Standing Committee for Agricultural Economic, Statistical and Marketing Research, I.C.A.R.
6. Working Group on Agricultural Statistics, National Commission on Agriculture.

7. Working Group on Classification of the Country into suitable Agro-climatic Regions and their Production Potential, National Commission on Agriculture.

8. Technical Committee for Studies on Evaluation of Special Employment Programme, Department of Agriculture.

9. Working Group on Crop Weather Relationship, Meteorological Department.

10. Technical Committee on Farm Mechanisation, Department of Agriculture.

11. Expert Committee on the I.A.D.P., Department of Agriculture.

12. Committee on Improvement of Agricultural Statistics, National Sample Survey Organisation.

13. Expert Team for Assessment of Fertilizer Requirements for achieving the Agricultural Production Targets, Department of Agriculture.

14. Standing Committee of Experts on Manures and Fertilizers, Department of Agriculture.

15. Sub-working Group on Agricultural Statistics, Department of Economics and Statistics.

16. Working Group on Crop Weather Relationship Studies, National Commission on Agriculture, New Delhi.

17. Technical Advisory Committee for Agro-climatic Studies of Drought, Indian Meteorological Department, Poona.

18. Study Group on Rainfall Reliability Analysis, I.C.A.R., New Delhi.

19. The Computer Society of India.

20. Advisory Committee on Training in "Official Statistics & Related Methodology", Department of Statistics, Cabinet Secretariat.

21. Expert Committee for Revision of the Syllabus for the Diploma Course in Agricultural Marketing, Directorate of Marketing & Inspection, Ministry of Agriculture.

22. Quality Control & Industrial Statistics Sectional Committee, Indian Standards Institution, New Delhi.

1.11 Appointments, Promotions, Transfers, etc.

S/Shri K. V. Sathe, Shivtar Singh and D. V. Subbarao, Statistical Investigators were appointed as Junior Statisticians with effect from 1.2.1974, 16.11.1974 and 2.12.1974 respectivly and S/Shri Randhir Singh and V. N. Iyer, Statistical Investigators were appointed as Assistant Professor of Statistics w.e.f. 18.11.1974 and Junior Technical Officer w.e.f. 30.11.1974 respectively.

Shri S. C. Basu, Under Secretary, I.C.A R., joined the Institute as Chief Administrative Officer on 24.6.1974 *vice* Shri R. S. Saksena who left the Institute on 15.2.1974 to join the Ministry of Agriculture as Deputy Secretary.

Shri K. G. Aneja, who was on deputation as Deputy Director (Statistics) in the National Commission on Agriculture w.e.f. 16.9.1971, re-joined the Institute as Junior Statistician on 17.10.1974.

Shri S. S. Grewal, Assistant Administrative Officer, left the Institute on 4. 1. 1974 to join the I C.A.R. Headquarters as Under Secretary.

It is sad to report that the Institute lost a capable officer in the demise of Shri V. V. R. Murty, Statistician-cum-Associate Professor on 10.3.1974.

Shri S. S. Narula, Statistician-cum-Associate Professor was relieved on 23.3.1974 to join as Agricultural Statistician on an F.A.O. assignment at Accra (Ghana).

Dr. M. S. Avadhani, Statistician-cum-Associate Professor, left the Institute on 30.6.1974 to join the National Sample Survey Organisation (Field Operations Division) as Officer on Special Duty. Also, Dr. M. N. Das, who had returned from his foreign research assignment in Canada on 3.6.1974, relinquished the charge of his post of Senior Professor of Statistics on 18.12.1974 to join that Organisation as Joint Director.

1.12 Representation of Scheduled Castes and Scheduled Tribes in the services at the Institute

To comply with the recommendation made at a Conference of the Directors of the Research Institutes under the administrative control of the I. C. A. R. held at New Delhi in May, 1975, the representation of the Scheduled Castes and Scheduled Tribes in the services at the Institute as on 31st December, 1974 is shown below:—

Classification of posts	*Number of Employees*	*Number of S.C./S.T. Employees*	*Percentage*
Class I	47	1	2.13
Class II	119	4	3.36
Class III	291	13	4.47
Class IV (Excluding Sweepers)	42	3	7.14
Class IV (Sweepers)	7	7	100. 00

1.13 Staff Council

In pursuance of a directive received from the I. C. A. R. in their letter No. 23(4)/69-Estt. II., dated 1.4.1970, a Staff Council was constituted at the Institute in January, 1972 with a view to securing the greatest measure of co-operation between the Administration and the employees of the Institute and increased efficiency in public service, combined with the welfare of the employees. The Staff Council is an advisory body. Any matter relating to (i) the conditions under which the members of staff are required to work, (ii) general principles regulating conditions of service, (iii) the welfare of the members of staff and (iv) improvement of efficiency and standards of work may be brought before the Staff Council for discussion. Questions relating to conditions of service are, however, discussed only with reference to general principles underlying them; discussion of individual cases is not permissible.

The Staff Council comprises representatives of the Institute and of the members of staff below the rank of Class I Officers. The Director is the Chairman of the Staff Council, who nominates one of the staff representatives, in consultation with them, to work as Secretary of the Council. The staff representatives hold office of a term of two years.

During the year under report, meetings of the Staff Council were held in the months of January, June, August and November, 1974. In May, 1974, Shri S. N. Bajpai, Statistical Investigator, took over as Secretary of the Staff Council from Shri B. N. Mehta, Statistical Investigator.

1.14 Grievance Cell

As mentioned above, it was not permissible to discuss individual, personal grievances of the members of staff (below the rank of Class I Officers) relating to

official matters in the meetings of the Staff Council. Therefore, with a view to providing a forum for ventilation, prompt consideration and redress of such grievances, the Director constituted a Grievance Cell in January, 1974 under the Chairmanship of Shri K. S. Krishnan, Senior Statistician-cum-Welfare Officer and with Shri M. R. Garg, Administrative Officer and Shri S. S. Pillai, Dr. A. Dey and Shri J. P. Jain, Statisticians-cum-Associate Professors as members.

Such grievances of the members of staff as were brought to the notice of the Grievance Cell were considered in its meetings held during the year under report and suitable action was taken, where considered necessary, for redress of the same.

1.15 Staff Amenities

(a) Staff Quarters

There are at present only 16 Type I residential quarters in the campus of the Institute which are allotted to Class IV employees of the Institute. Also, there are 2 Type III residential quarters as well as a bungalow for the Warden of the Hostel. Efforts are, however, being made to acquire land from the Delhi Development Authority for purpose of constructing quarters to provide housing accommodation to the members of the staff of the Institute.

It may be mentioned that about one and a half acres of land adjacent to the premises of the Institute was acquired during the year under report for purpose of construction of a hostel for visiting scientists and a few residential flats for the employees required to render essential services of the Institute.

(b) Recreation and Welfare Club

With a view to providing means of recreation and welfare to the Officers and other members of staff of the Institute, a Recreation and Welfare Club was formed at the Institute in the year 1965. The main objectives of the Club are (i) to provide facilities for indoor and outdoor games, (ii) to provide facilities of a library and reading rooms, (iii) to promote social and friendly relations among the members, and (iv) to undertake such other activities as may be decided by the Managing Committee from time to time for general welfare of the members. The activities of the Club are managed by a Managing Committee comprising a Secretary and 11 members, who are elected from amongst the members of the Club every year. The Committee elects a President and two Vice-Presidents, who are generally Senior Officers of the Institute.

The Club arranges indoor and outdoor games, runs a library consisting of useful and interesting books in four languages, viz., Hindi, English, Punjabi and

Urdu and popular magazines and also organises picnics and sight-seeing tours to historical places in Delhi and outside. The Club celebrates its Annual Day every year when prizes are distributed to the winners in different tournaments organised by it and a Variety Entertainment Programme is presented.

The Club celebrated its Annual Day in March, 1974. Shri K. P. Singh, Secretary, I.C.A.R. was the Chief Guest. In April, 1974, Shri R. K. Singh, Statistical Assistant took over as Secretary of the Club from Shri K. C. Mehta, Cashier, while Shri S. K. Raheja, Senior Statistician continued to be the President of the Club. It may also be mentioned that during the financial year 1973-74, a sum of Rs. 878.60 was realised as subscription from 206 members and a sum of Rs. 1359 was received as grant-in-aid from the Institute while the expenditure incurred during the year was Rs. 3,649.82, the deficit being met from entry fees for tournaments, sale of old books, magazines, playing cards, etc., etc. The subscription rate for membership was raised from Rs. 4 per year to Rs. 6 per year with effect from the year 1974-75.

(c) Co-operative Canteen

Soon after the Annapoorna wound up its little canteen at the Institute in the year 1957, some officers and members of staff of the Institute formed a co-operative society to run a canteen at the Institute for the benefit of the employees of the Institute. Two years later, in 1959, this society was registered with the Registrar, Co-operative Societies, Delhi under the name "I.C.A.R. (Statistical Wing) Cooperative Store Limited" on adopting a set of bye-laws of its own. The affairs of the Society are managed by a Managing Committee elected every year in a general body meeting of the Society.

The Canteen run by the Society provides facilities of service of tea, coffee, soft drinks, snacks, sweets and other eatables both at the Canteen and in the various rooms occupied by officers and members of staff of the Institute.

Shri S. K. Raheja, Senior Statistician, continued to be the President of the Managing Committee of the Society during the year under report.

(d) Benevolent Fund

A Benevolent Fund for the employees of the Institute was constituted by the Director in November, 1974. Whereas the object of the Compassionate Fund constituted by the I.C.A.R. and fed exclusively by an annual grant from its budget is primarily to provide relief, where needed, to the bereaved family of a Council employee who dies in harness, for its sustenance, the objectives of the

Benevolent Fund are to provide, where needed, immediate financial assistance to the bereaved family of an employee of the Institute who dies in service to perform religious rites as well as to provide such assistance to the employees of the Institute in the event of unforeseen calamities like accident, prolonged illness, etc. The Fund will be fed primarily by contributions from the members of the Fund, who would contribute a minium sum of Rs. 6 per annum in three instalments payable in the months of January, May and September.

The Fund is managed by a Managing Committee comprising the Chief Administrative Officer as Chairman, the Section Officer of the Administration-I Section as Secretary, the Junior Accounts Officer (Cash) as Treasurer and the Secretary, Staff Council and three nominess of his as members. Shri S. N. Bajpai, Secretary, Staff Council nominated Shri R. L. Rustogi, Statistical Assistant, Shri S. L. Dua, Senior Store Keeper and Shri Maha Nand, Peon as members of the Managing Committee of the Fund. The number of members of the Fund as on 31st December, 1974 was 28 of whom 8 were officers of gazetted status.

1.16 Receipts and Expenditure during the year 1973-74

A statement of the reciepts and the expenditure for the financial year 1973-74 is given below:

A. Receipts

		(Rs.)
1.	Rents	16,989.28
2.	Application fees for recruitment	80.50
3.	Tuition fees, etc.	12,592.02
4.	Interest on loans	2,005.50
5.	Leave salary, pension contribution, etc.	13,771.10
6.	Miscellaneous	29,306.69
	Total:	74,745.09

B. Expenditure

	Head	*B. Estimates* (Rs.)	*Expenditure* (Rs.)
1.	Main Institute (Non-Plan)	19,27,000	18,54,518.97
2.	Strengthening of I.A.R.S. (Committed) (Non-Plan)	1,30,000	1,11,318.12

3.	Fruits and Vegetables (Plan)	88,300	83,965.95
4.	National Index of Experiments (Plan)	2,81,000	2,60,411.22
5.	Strengthening of I.A.R.S. (Plan)	5,00,000	5,00,000.00
6.	Co-ordinated Agronomic Experiments (Plan)	2,42,000	2,22,789.90
7.	High Yielding Varieties (Plan)	1,99,000	1,95,414.55
8.	Pre-harvest forecasting of crops (Plan)	46,691	42,399.40
9.	Cost of production of apples, etc. (Plan)	40,000	38,418.55
10.	Summer Institute (Plan)	32,000	27,331.34
11.	Strengthening of Research and Training Facilities at I.A.R.S. (Plan)	4,57,000	3,84,112.07
12.	Strengthening of Computer Centre (Plan)	1,60,000	1,30,726.65
13.	Poultry and eggs (Plan)	87,000	83,589.25
14.	Livestock Products (Plan)	1,28,000	1,33,305.25
15.	Availability and cost of production of milk (Plan)	40,000	38,798.85
16.	Impact of Milk Supply (Plan)	2,71,000	2,79,979.85
17.	Estimation of bovine death rates, etc. (Plan)	46,000	44,254.87
		TOTAL:	44,31,334.79

1.17 Miscellaneous

(*a*) Dr. D. Singh, Director delivered in January, 1974 two lectures, one on "Agricultural Statistics in India" and the other on "Role of Statistics in Agriculture and Animal Husbandry Research at I.A.R.S.", at the Central Statistical Organisation, New Delhi for the benefit of I. S. S. probationers. In February,

1974, he delivered two lectures on "Role of Statistics in Agricultural and Animal Husbandry Research" at the C.S.O. for the benefit of Statistical Officers trainees in "Official Statistics" as also a lecture on "Production Fuction of Water" at the UNDP Centre of Excellence in Soil and Water Management, Haryana Agricultural University, Hissar for the benefit of trainees in "Optimisation Techniques in Water Resources Development and Utilization." Again, in August, 1974, he delivered two lectures, one on "Agricultural Census, 1970" and the other on "Activities of I.A.R.S. with reference to Training and Research in Agriculture," at the C.S.O. for the benefit of Senior Statistical Officers trainees in "Official Statistics & Related Methodology."

Dr. Singh prepared papers titled "Statistical problems in pre-harvest forecasting of yield of crops" (jointly with Shri M. P. Jha) and "Measurement problems in agricultural surveys" to be presented at the joint meeting of the International Statistical Institute and the International Association of Survey Statisticians on "Statistical problems of the less developed countries" and a paper titled "Establishment of sampling frames to increase efficiency and reliability of agricultural censuses" to be presented at their joint meeting on "Methodological problems of the 1980 World Census of Agriculture" to be held at Warsaw (Poland) in September, 1975.

Dr. Singh was elected a member of the Sectional Committee of the Section of Statistics for the 62nd Session (1974-75) of the Indian Science Congress.

(b) Dr. P. Narain, Senior Statistician, delivered in January, 1974 a lecture on "Relevance of our course curricula to emerging needs of agricultural research and development—An introspection" at the P. G. School Seminar at the I.A.R.I., New Delhi and on "Statistical Research on Animal Sciences" for the benefit of probationers of the Indian Statistical Service at the Central Statistical Organisation, New Delhi. He also delivered in Februray, 1974 a seminar talk on "Diffusion processes in population genetics" at the Department of Mathematics and Statistics, Poona University, Poona.

(c) Shri S. K. Raheja, Senior Statistician, delivered special lectures to I.S.S. probationers at the Central Statistical Organisation, New Delhi. Also, he represented the Institute as a special invitee at the various meetings of the Standing Committee of Experts on Manures and Fertilizers constituted by the Department of Agriculture. He also acted as Convener of the I.C.A.R. Evaluation Committee for a new Computer at the I.A.R.S. from mid-October to December, 1974 during the absence of Shri S. S. Pillai, Statistician-cum-Associate Professor on

deputation abroad for advanced training and prepared notes/papers for the Evaluation Committee and the Director General, I.C.A.R. in regard to finalisation of a scheme for a new Computer at the I.A.R.S.

(d) Shri K. S. Krishnan, Senior Statistician, delivered lectures to the trainees of the Indian Economics Service and the Indian Statistical Service at the Central Statistical Organisation, New Delhi.

(e) Shri S. D. Bokil, Statistician-cum-Associate Professor, attended some of the meetings of the Sub-Committee constituted by the Directorate of Marketing and Inspection for their survey for estimating marketable surplus of rice and wheat and post-harvest crop losses.

(f) Shri S. S. Pillai, Statistician-cum-Associate Professor, attended the "International Training Course for Senior Applications Programmers" held in Budapest (Hungary) from 14th October to 14th December, 1974 under the aegis of the United Nations Development Programme and secured the first position among 19 participants from Europe, Asia, Africa and Latin America. He also visited the Food & Agriculture Organisation at Rome (Italy) to discuss the problems connected with implementation of "Agricultural Research Information System (AGRIS)" at the Computer Centre of the Institute.

(g) Shri M. P. Jha, Statistician-cum-Associate Professor, prepared a paper (jointly with Dr. D. Singh, Director) entitled "Statistical problems in pre-harvest forecasting of yield of crops" to be presented at the joint meeting of the International Statistical Institute and the International Association of Survey Statisticians to be held at Warsaw (Poland) in September, 1975 on the occasion of the 40th Session of that Institute.

(h) Shri K. C. Raut, Statistician-cum-Associate Professor, gave technical comments on a paper sent by the Editorial Board of the Indian Journal of Agricultural Economics regarding its suitability of publication in the Journal. He also delivered a lecture on "Cost of production and allied studies" to the C.S.O. trainees in June, 1974.

(i) As Convener of the Study Team on Fruits & Vegetables Statistics of the National Commission on Agriculture, Dr. A. H. Manwani, Statistician-cum-Associate Professor, prepared the final report of the Study Team, which was adopted by the Working Group on Agricultural Statistics of the Commission. He also received his Ph.D. Degree during the year under report.

(j) Dr. B. B. P. S. Goel, Statistician-cum-Associate Professor received his Ph.D. Degree and also the I.C.A.R. Gold Medal for the best student in Agricultural Statistics at the Convocation held at the Indian Agricultural Research Institute, New Delhi in February, 1974. He was also selected for the Indian Statistical Service.

(k) Dr. A K. Nigam, Statistician-cum-Associate Professor, was handling a project for writing a "Handbook on Analysis of Experiments for Agricultural Workers" for the use of agricultural workers. The first two chapters had been written out.

(l) Dr. R. K. Pandey, Agricultural Economist, delivered a series of lectures on "Economic Model Building" to the post-graduate students and faculty members of the Agricultural Economics Department at the R.B.S. College, Agra. He also delivered a talk on the occasion of inauguration of the Planning Forum at Kalindi College, New Delhi.

(m) Shri R. K. Khosla, Junior Statistician, delivered a lecture on "Estimation of incidence of pests and diseases and consequent crop losses" to the I.S.S. probationers at the Central Statistical Organisation, New Delhi in Jaunary, 1974.

(n) Shri S. C. Rai, Assistant Professor, organised and conducted an educational tour for the benefit of the students of the Institute.

(o) Shri Padam Singh, Junior Statistician and Shri Randhir Singh, Assistant Professor of Statistics attended an Advanced Level Summer Institute on "Multivariate Analysis and Statistical Inference" at the Punjab University, Chandigarh from 6th May to 1st June, 1974.

2. STATISTICAL RESEARCH IN CROP SCIENCES

The work of statistical research in crop sciences was continued during the year under report as per the programme laid down. The progress of work in respect of the various items of research included in the programme is described below in brief and the names of the concerned principal investigator and his associate or associates are given in brackets at the end of the description.

2.1 Statistical analysis of data relating to complex experiments conducted at Model Agronomic Research Centres under the All-India Co-ordinated Agronomic Research Project.

The objectives of the experiments conducted at the Model Agronomic Centres are (i) to determine the production potential in different agro-climatic regions of the country under optimum input conditions as well as under resource constraints operating in the area, (ii) to develop intensive farming system for small and medium holdings in different agro-climatic regions of the country, (iii) to study the possibility of increasing crop production by inter-cropping in widely spaced crops, (iv) to study the direct, residual and cumulative effects of farm yard manure, phosphorus and potassium fertilization in fixed crop rotations for developing ferti lizer practices for different cropping systems, (v) to study the response of newly developed high yielding varieties/hybrids of cereals to phosphorus and potassium in relation to time of application, (vi) to study the possibilities of substitution of present crops by better and more efficient ones in different regions, (vii) to study the crop response to micro-nutrients, (viii) to evaluate the slow release nitrogenous and newly developed fertilizers, (ix) to study the relative efficiency of rock phosphates of varying particle sizes in acid soils and basic slag as a source of phosphorus to cereals, (x) to study thc critical periods for irrigations of dwarf *durum* and aesytivum wheats, and (xi) to study the effectiveness of various herbicides for weed control in different cropping systems.

Data of about 600 complex experiments conducted during the year 1973-74 at 45 Model Agronomic Centres were analysed during the year under report. The experiments were conducted as per the technical programme decided at the Annual Workshop of the Scheme. Standard analysis-of-variance techniques were adopted for the analysis of the data. In long term experiments, combined analyses over years were also carried out for the centres where 3-year cycles were completed.

In the production potential experiments planned and conducted at the Research Centres during the year 1973-74 for developing cropping patterns suitable for the regions, at as many as 15 centres suitable high intensity crop sequences including cereals and pulses were identified, where grain yields of over 10 tonnes/ha could be obtained. The highest annual yield of 18 tonnes/ha was obtained at Mangalore with rice-rice-rice rotation. In an experiment to develop an intensive farming system for small holders, the scope for getting high profits from small holdings of size one hectare was established at a number of centres. The net income from one hectare holding was assessed as Rs. 9089/- at Pantnagar, Rs. 7140/- at Navsari and between Rs. 3000-6000/- at Hissar, Akola, Talabtillo, Mangalore, Kathulia Farm and Karaiyiruppu. Inter-cropping with legumes such as green gram, black gram, cowpea, soyabean and groundnut generally increased the yield of the principal *arhar* crop and gave additional profits at Tirupati, Gwalior, Kathulia Farm and Bichpuri. Inter-cropping with green gram in cotton at Akola was more profitable compared to pure stand of cotton by about 38%.

Significant direct as well as residual responses to farm yard manure were established through long term experiments conducted in a number of centres. Farm yard manure was most effective at Ludhiana, where its application at 15 tonnes/ha in kharif season benefited not only the maize crop grown in that season but also the ensuing wheat crop, thereby increasing the annual grain yield by about 25 q/ha.

In an experiment designed to screen pre-release varieties in respect of their fertiliser responsiveness, significant interaction of varieties and nitrogen application was established at a number of centres. At Maruteru, with moderate levels of nitrogen (60 kg N/ha), Pankaj gave the highest yield in kharif while RP-4-14 did so during rabi. At Karaiyiruppu, 'Karakalan' was the best variety during kharif but IR—20 was superior during rabi. At Pantnagar, Raj-821 and UP-310 gave higher yields at native fertility but UP-309 was superior with regard to response per unit of nitrogen. At Rahuri, Kalyansona was the best at all the levels of fertility tried. At Varanasi, Kalyansona was superior at native fertility but HD-2028 was found to be the best in its response to nitrogen.

Maintenance of the field free from weeds resulted in higher yields (between 14 to 18 q/ha) of Bala variety of rice-drill sown and grown under unirrigated conditions. At Kalyani and Chiplima, the responses to hand weeding 3-6 weeks after sowing were 65 and 58 per cent of those to weed-free check at these centres respectively. Amog the test herbicides, the highest response was obtained to the application of Tok-E-25 at 3 kg ai/ha applied in split dose 10 and 20 days after

germination at Kalyani and applied in single dose 7 days after germination at Chiplima. In both these cases, yield rates in plots receiving herbicide treatments were significantly higher compared to those obtained in plots benefited by two hand weedings. In an experiment on transplanted unirrigated rice conducted at Chiplima, best performance was obtained with Machete granule at 1.0 kg ai/ha applied 8 days after transplanting. At Bhubaneswar, a higher dose i.e. 1.5 kg ai/ha of this herbicide gave the best response (about 21 q/ha).

(K. S. KRISHNAN, C. R. LEELAVATHI, H. C. JAIN and SHANTI SWARUP)

2.2 Statistical analysis of data of simple experiments conducted on cultivators' fields under the All-India Co-ordinated Agronomic Research Project.

The objectives of the experiments conducted on cultivators' fields were (i) to study the response of high yielding crop varieties of cereals to N, P, K, and Zn with a view to formulating fertiliser recommendations for different agro-climatic regions of the country under irrigated or assured rainfall conditions, (ii) to study the relationship between soil test and crop response to fertilisers, (iii) to determine the response of important cereal, leguminous and oilseed crops to nitrogen, phosphorus and potassium under dry farming conditions and (iv) to determine the efficient crops under rainfed conditions for different regions which involves substitution possibilities of present oilseed, pulse and other food crops by new crops and/or varieties.

Data of about 7,630 simple experiments conducted during the year 1973-74 in 56 districts spread over different soil and agro-climatic regions of the country were analysed during the year under report. The experiments were conducted as per the technical programme decided at the Annual Workshop of the Project. Standard analysis-of-variance techniques were adopted for analysing the data. For such expriments as had completed three years, combined analyses over years were also carried out.

Data from experiments conducted on cultivators' fields under irrigated conditions were available for three years, viz., 1971-72 to 1973-74 for 25 districts in the case of kharif rice. Of these, in 10 districts, namely, Kangra, Midnapore, Jammu, Mysore, Champaran, Bilaspur, Bandha, Karimnagar, Bulsar and Goa, responses of over 15 q/ha of rice were obtained to the application of fertiliser at the rate of $N_{80}P_{60}K_{60}$. In the first two districts, response exceeded even 20 q/ha. In respect of rabi rice the results were available for 13 districts of which, in four, namely,

Mysore, Goa, Balasore and Midnapore, response to $N_{80}P_{60}K_{60}$ exceeded 15 q/ha. In Mysore a high response of 22.8 q/ha of rice was obtained. Another interesting result was the moderate to good response of rice to potassium at the higher level of 90 kg K_2O/ha, when applied over adequate levels of N and P in some districts of Karnataka, Andhra Pradesh, Tripura, Orissa, West Bengal, Goa, Pondicherry and Bihar.

In expriments on high yielding varieties of wheat, an average response of 15 q/ha to $N_{80}P_{60}K_{60}$ was obtained in 7 districts, namely, Jammu, Fatehpur, Bulandshahr, Sehore, Rohtak, Delhi and Patna.

Data from experiments conducted under rainfed/dry land conditions for the two years 1972-73 and 1973-74 showed that response of rice to $N_{60}P_{40}K_{30}$ exceeded 10 q/ha in Rewa, Mayurbhanj, Dhenkanal and Ramanathapuram. In respect of other crops, response to $N_{60}P_{40}K_{30}$ exceeded 10 q/ha for wheat in Rewa and Hoshiarpur, for jowar in Kurnool, Dharwar and Jhalawar and for maize in Gaya and Hoshiarpur. Significant response of about 2 q/ha to potassium at 30 kg K_2O/ha was obtained for rice, wheat, jowar and bajra in quite a few districts.

(K. S. KRISHNAN, S. R. BAPAT and Y. R. DESHMUKH)

2.3 Analysis of data relating to irrigation experiments.

The objective of the project was to collect from all available sources data relating to experiments with irrigation as treatment and to critically analyse them.

During the year under report, data relating to 400 experiments on irrigation, irrigation-cum-manuring, irrigation-cum-varietal, irrigation-cum-cultural practices, etc. were collected from different sources such as Model Agronomic Research Centres, State Research Centres and Agricultural Universities for the period 1960-61 to 1971-72 in respect of wheat crop. The data were transferred to punched cards and analysed critically through computer programming, using appropriate statistical tools. The results of various irrigation factors influencing wheat yield were summarised variety group-wise and soil type-wise and were being published in the form of a research monograph.

For tall aesytivum wheat varieties in medium soils, significant responses were obtained for the first and second irrigations (average response being 2.5 and 2.3 quintals per hectare respectively). In respect of both double and triple dwarf varieties raised in medium soils, substantial increases in the yield rates were obtainad for every rise in the frequency of irrigations upto five. The response to

first irrigation in medium soil was the highest (6.4 q/ha) for double dwarf gene varieties but in heavy soils the highest response for the first irrigation was observed for durum tall varieties (3.3 q/ha).

For light soil, in respect of triple gene varieties (Hira, Lal Bahadur, UP-301, etc.), at least two irrigations, one at crown root initiation stage and another at flowering stage, were found to be essential to obtain good yield rates. In medium soils, three irrigations for aesytivum tall varieties, that is, one each at tillering, jointing and heading stages were needed. Appropriate stages of three irrigations for single dwarf varieties were crown root initiation, tillering and flowering. For double dwarf gene varieties (Kalyan Sona, Sonara-64, etc.), five irrigations, one each, at the stages of crown root initiation, tillering, flowering, milk and dough gave maximum yield. For triple dwarf gene varieties, good yields were obtained with four irrigations, one each, at crown root initiation, late tillering, jointing and flowering stages.

Irrigation at 20 per cent soil moisture was found to be adequate for aesytivum tall varieties grown in medium soils. But in heavy soils irrigations at increased level of soil moisture (30%) gave the highest yield. For dwarf varieties (single and double gene) raised in medium soils, irrigations at soil moisture level varying from 40 to 50 per cent were needed. In heavy soils, irrigations even to the extent of 75 per cent soil moisture level were found to be useful.

(K. S. KRISHNAN, P. N. SONI and P. P. RAO)

2.4 Evaluation of yard-sticks of additional production from the use of various developmental measures.

The objective of the project was to evaluate the yard-sticks of additional production from the use of fertilizers under dry farming conditions.

Data of nearly 3,000 experiments conducted on cultivators' fields on cereals, gram and groundnut during the years 1969-72 were collected and analysed during the year under report. The district-wise responses to N, P_2O_5 and K_2O were pooled over years. The yardsticks of additional production were formulated at 25 and 50 kg. N/ha, 25 kg. P_2O_5/ha and 25 kg. K_2O/ha for cereals, 15 and 30 kg. N/ha, 30 and 60 kg. P_2O_5/ha and 30 kg. K_2O/ha for gram and 20 and 40 kg. N/ha, 40 and 80 kg. P_2O_5/ha and 40 kg. K_2O/ha for groundnut. The yardsticks of additional production from the use of fertilisers on cereals, gram and groundnut under dry farming conditions were evaluated. Data of 2425 experiments on rice, wheat, jowar, maize and bajra, 339 on gram and 209 on groundnut conducted on cultivators' fields during the years 1969-72 were summarised.

The estimates of yardsticks of additional production of rice were between 13-17 tonnes per tonne of nitrogen at 25 kg. N/ha and between 11-17 tonnes per tonne of nitrogen at 50 kg. N/ha for Bala variety in Hazaribagh and Mayurbhanj districts while in Jabalpur both Bala and locally improved tall varieties gave additional production of 17 tonnes per tonne of nitrogen at thc higher dose, the response to application on nitrogen being 20 units at the lower dose for the locally improved tall varieties in the district. Application of phosphorus to rice at 25 kg. P_2O_5/ha resulted in additional production of 25-28 tonnes per tonne of P_2O_5 in Jabalpur and Mayurbhanj districts. The yardsticks of additional production for the locally improved tall varieties also were of the same order as that for Bala in Jabalpur. While Bala variety gave additional production of 6-7 tonnes per tonne of K_2O, the locally improved tall varieties showed variation between 3-11 units in different districts.

The variation range in the yardsticks of additional production of wheat was between 9-11 tonnes per tonne of nitrogen at 25 kg. N/ha and about 11 units at double this dose for Kalyanasona in Ambala and Gaya districts. A high estimate of 21 units at the lower dose and 17 units at the higher dose was obtained for the locally improved tall varieties in Hoshiarpur district while in the remaining districts they were between 7-11 tonnes per tonne of nitrogen. The additional production of wheat from the use of phosphorus was about 20 tonnes per tonne of P_2O_5 in Ambala district, both for Kalyansona and the locally improved tall varieties. The output per unit input was between 13-15 tonnes per tonne of P_2O_5 for Kalyansona in Gaya and for the locally improved tall varieties in Gwalior, Jabalpur and Hoshiarpur. About 4 tonnes of Kalyansona were obtained to the application of a tonne of K_2O as compared to 1-6 tonnes of the locally improved tall varieties.

The yardsticks of additional production on jowar, maize and bajra for the three nutrients showed considerable variation from district to district for the different varieties.

Higher yardsticks of additional production, i.e. 10-13 tonnes per tonne of nitrogen were obtained with G-2 variety of gram in Gwalior as compared to 5-6 units for the local variety in Panch Mahal and Allahabad districts. The output per unit input was between 4 to 9 tonnes per tonne of P_2O_5 and 1 to 6 tonnes per tonne of K_2O for these varieties.

The yardsticks of additional production were higher for AK-12-24 variety of groundnut, i.e. 6-11 tonnes per tonne of nitrogen, 6-13 tonnes per tonne of P_2O_5

and about 4 tonnes per tonne of K_2O in Koraput and Mayurbhanj districts, as compared to 6-8 tonnes per tonne of nitrogen, 4-6 tonnes per tonne of P_2O_5 and 2 tonnes per tonne of K_2O for the local variety in Bijapur district. Those for TMV varieties were low in Kurnool and Ramanathapuram districts.

(C. R. LEELAVATHI, S. R. BAPAT and D. SINGH)

2.5 National Index of Agricultural Field Experiments

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

During the year under report, data of about 2,800 experiments conducted since 1961 were reported by the regional staff posted in different centres in the country. Analysis of about 980 experiments and of 380 groups of experiments conducted during the period 1960-65 was undertaken with the assistance of the electronic computer.

Under the project, data relating to agricultural field experiments other than purely varietal trials conducted at the various agricultural research institutes and stations in the country were being collected, consolidated and published in the form of compendia series. Two such series for the periods 1948-53 and 1954-59 had been published earlier. For the third series which pertains to the period 1960-65, compendia volumes for Gujrat, Rajasthan, Orissa, Eastern Region, Kerala, and Tamil Nadu were received from the press and printing was practically completed in respect of Mysore, West Bengal, Andhra Pradesh and Madhya Pradesh. The printing of the experimental data for Maharashtra and the processing of exprimental data for Bihar and Uttar Pradesh were in progress during the year under report. Also, Volume II of the Index of Agricultural Field Experiments in respect of experiments reported by the regional staff during the year 1972 was printed and meterial for Volume III of this Index in respect of experiments reported by the regional staff during the year 1973 was under preparation.

(P. N. BHARGAVA, K. S. KRISHNAN, P. N. SONI, M. P. SAXENA and P. R. YERI)

2.6 Crop weather relationship studies.

The objective of the project was to study the effect of rainfall on crop production and the behaviour of rainfall.

Data on daily rainfall for Jalgoan District for the period 1946 to 1971 were collected from the Meteorological Department, Poona during the year under report. The data were examined to study the rainfall distribution for periods of 20 days and one month. An attempt was made to fit a suitable stochastic model to describe the distribution for the above intervals. In addition to this, investigations on the pattern and behaviour of the rainfall for the entire rainy season from June to September were also made. The pattern and behaviour was studied by fitting a suitable Markov Chain model.

It was seen that there was high variation in the monthly rainfall for the months of June and September whereas it was low for the months of July and August. As the period was reduced to 20 days, the variation increased for each of the intervals. The distribution of rainfall for the months of July and August could be described by a normal curve while for June and September, the distribution was normalised by the application of a suitable logarithmic transformation. In respect of the periods of 20 days, it was seen that the distribution for the period 1st June to 20th June followed a normal distribution after transforming the data on logarithmic scale while for the remaining intervals of the season, the distribution was either normal or could be made normal by transforming the data to the square root scale. The study of the pattern and behaviour of rainfall through the stochastic model was still continuing. However, the preliminary results showed that the weather of a particular day is independent of the weather of the previous day.

(P. N. Bhargava, Prem Narain and Asha Saksena)

2.7 Pilot studies on per-harvest forecasting of crop yield-Jute, Cotton, Paddy & Wheat.

The objective of the project was to evolve a suitable statistical methodology for pre-harvest forecasting of crop yield on the basis of observations on biometrical characters such as plant density, plant height, basal diameter, etc. recorded at different stages of crop growth.

During the year under report, field work was in progress for the following crops at the centres shown against each.

Cotton :	Jalgaon (Maha), Baroda (Guj.) and Aligarh (U.P.).
Paddy :	Sambalpur (Orissa), West Godavari (A.P.) and Ludhiana (Punjab).

Wheat : Ludhiana (Punjab) and Aligarh (U.P.).

A combined analysis of the data collected during the years 1970-71 to 1973-74 on jute from Bihar and West Bengal States was carried out and a consolidated report prepared. The data on cotton collected from Jalgoan and Baroda Centres were analysed for all the years. Also, statistical analysis was carried out for the data collected on paddy and wheat during the previous years.

In each district, about 250 fields were selected by adopting a stratified multi-stage random sampling design and data on biometrical characters were recorded at periodical intervals. Multiple regression analysis was carried out for indentifying the nature of relationship between yield and different biometrical characters. The analysis was carried out under four different models separately for each period of observation. Four regression models, (i) simple, where dependent (yield) and independent (biometrial characters) variables were in original scale, (ii) logarithmic, where both the dependent and independent variables were in logarithmic scale, (iii) square root, where the dependent as well as independent variables were in square root scale, and (iv) reciprocal, were both dependent and independent variables were in reciprocal scale, were tried. The suitability of models was judged on the basis of the amount of variation in yield explained due to the multiple regression. The average estimates of different biometrical characters along with their standard errors were worked out.

The regession analysis of yield on biometrical characters was carried out after adjusting the data for differences between villages and fields (on plot basis). Results of the consolidated report of the data on jute collected from the States of Bihar and West Bengal revealed that multiple correlation co-efficients were generally significant. The contribution to the amount of variation in yield explained by the regression equation was found to range from 30 to 50 per cent in different periods and years. The partial regression co-efficients of fibre yield with the plant population were found significant in all the cases. The partial regression coefficients with height of the plant were found significant in about 75 per cent of the cases whereas with the basal diameter significance was observed in rare cases. On partitioning the total variation due to regression based on three degrees of freedom it was found that 80 to 90 per cent of the total variation due to regression was explained by the plant populaion alone. The inclusion of plant height in the regression model further increased the contribution and the third variable, basal diameter, did not appear to have much contribution in the regression analysis. The analysis of data also showed that there was no appreciable gain by taansforming data under

different models. The suitable time of pre-harvest forecasting of jute yield based on biometrical characters appeared to be about 2 months before harvest of the crop or when the crop is about 2-3 months old.

The results of analysis of data on cotton showed that the biometrical characters influencing yield are plant population and number of bolls per plant. The addition of the first picking yield in addition to biometrical characters in the regression equation improved the forecast considerably.

The results on wheat and paddy showed that the characters—number of plants and number of tillers per plant—contributed for most of the variation in yield explained by the regression. The suitable time of forecasting appeared to be about two to three months of sowing/transplanting.

(M. P. JHA and PADAM SINGH)

3. STATISTICAL RESEARCH IN ANIMAL SCIENCES

The work of statistical research in Animal Sciences was continued during the year under report as per the programme laid down. The progress of work in respect of each of the various items of research included in the programme is described below in brief and the names of the concerned project leader and his associates are given in brackets at the end of the description.

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

The objective of the project was to investigate alternative selection procedures in poultry breeding based on combining information from relatives as well as on combination of characters. In addition, concrete help in the operation of the Coordinated Poultry Breeding Programme at the Regional Poultry Farm, Bhopal was given in so far as selection of birds and their matings were concerned. This was based on a rapid and a critical analysis of the data on the computer as soon as these were received from the Farm.

During the year under report, data on the performance of the progenies obtained on selecting the birds on the basis of an index for rate of lay computed for the second generation were received. These data were subjected to a critical analysis and the selection scores of the birds were obtained separately for males as well as for females. The selection scores were calculated on the basis of an index with appropriate weights attached to full-sib family average; half-sib family average and individual records for rate of lay which was expressed as the total egg production upto 260 days of age divided by 261 minus age at first egg. Before working out the index for each bird, the data were adjusted for location as well as hatch effects. These scores were sent to the Regional Poultry Farm, Bhopal for selecting the birds for propagating the third generation.

An analysis of the data collected during the laying periods of 1971-72 was also conducted with a view to studying the distribution of scores of birds based on different selection indices. Selection scores were worked out for each bird, using three methods of selection, viz., (a) selection on the basis of an index with optimum weights attached to the individual performance and its full-sib family average, (b) selection on the basis of an index with optimum weights attached to the individual's performance and its half-sib family average and (c) selection on the

basis of an index with optimum weights attached to individual's performance, full-sib family average and half-sib family average. For each of the three cases, suitable frequency distribution was fitted. For the scores based on the methods (a) and (b), Pearsonian Type I was found to be the proper distribution, whereas for the scores based on the method (c) normal distribution was found to be the appropriate one. There appeared to be a tendency in the distribution of selection scores to tend to normality as the information from more than two sources was combined. The variability for the scores was also found to increase when information from both the half-sib as well as full-sib families was combined with the individual's performance. It appeared that the selection based on the method (c) could be better exploited than those based on either of the methods (a) or (b).

(PREM NARAIN, J. P. JAIN and L. K. GARG)

3.2 Measurement of genetic improvement due to scientific breeding in cattle and buffaloes.

The objective of the project was to develop statistical methods for assessing genetic changes accruing due to cross-breeding of Indian breeds of cattle with exotic breeds. The data on the cross-bred cattle of nine Military Dairy Farms for the period 1934-55 consisting mostly of the crosses (i) Sahiwal × Friesian, (ii) Sindhi × Friesian and (iii) Sahiwal × Ayrshire × Friesian, which were available at the Institute were analysed in the first instance, using Harvey's technique of the analysis of non-orthogonal data. Effects of farms and grades were found to be highly significant in respect of several characters. Further analysis was in progress.

Steps were being taken to collect such data from all the Military Dairy Farms regularly and computerise them for statistical analysis.

(PREM NARAIN, H. P. SINGH and L. K. GARG)

3.3 Design and analysis of experiments for studies on bovine semen metabolism

The objective of the project was to develop suitable experimental designs on bovine semen metabolism as well as the methodology for their analysis for ultimate use in animal experimentation.

To begin with, during the year under report, the N.D.R.I., Karnal was approached for intiating experiments on metabolic behaviour of sperms in bovines. Expriments for studying the metabolic activity of bull spermatozoa suspended in

seminal plasma of buffalo semen as well as of buffalo spermatozoa suspended in seminal plasma of bull semen were under way. The factors under study were pH, osmatic pressure and potassium/calcium concentration. The characters chosen were oxygen uptake, fructose utilisation, lactate formation and motility. The data on these experiments were yet to be received.

(L. K. GARG and PREM NARAIN)

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

The objective of the project was to study the efficiency of selection on the basis of part time production and to estimate heritability of important characters such as annual egg production, age at maturity, weight at maturity, etc. Attempts were also to be made to explore the possibilities of estimating genetic correlations between these characters.

During the year under report, the data collected on White Leghorn under the Scheme for Improvement of Poultry through Family Selection at the centre at Katpadi (Tamil Nadu) were scrutinised. 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 for those raised as foundation stock and first generation birds. In addition, data on egg production in the 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 paternal half-sib families. Heritabilities and genetic correlations were estimated by intra-sire regression of progeny on dam as well as by the method of sib analysis. Relationship between part time production and total production was studied, using regression technique. The correlation between part time production and total production was estimated to be of the order +0.4. Further analysis was in progress

(R. GOPALAN and B. MARUTIRAM)

3.5 Study of comparative performance of different grades of cross-bred cattle under village conditions.

The objective of the project was to make a critical assessment of the relative performance of different grades of cross-bred cattle in hilly and heavy rainfall areas with a view to deciding the best grade suited to local conditions.

The data for this study during the year under report were obtained from the centres at Chalakudy (Kerala) and Neyyattinkara (Kerala) and comprised of observations on lactation yield, lactation length, dry period, and calving interval of all

completed lactations, abnormal calvings, and mortality in different age groups in respect of local and various grades of cross-bred animals. The data pertained to the period beginning from the inception of the scheme, i.e. 1955 to 1974. The data on lactation yield, lactation length, dry period and calving interval were analysed separately for each order of lactation to study the differences between local and various grades of cross-bred cattle after making adjustments due to period differences.

A preliminary analysis of the data showed that the cross-bred animals gave significantly higher yield and had a longer lactation length than the local animals in all the lactations. Among the different grades of cross-bred cattle, 3/4 Jersey animals gave significantly higher lactation yield in their first lactation than half-bred animals. The differences between 3/4 Jersey and half-bred animals were not significant in respect of lactation length. The proportion of abnormal calvings was significantly different among local and cross-bred animals while it was of the same order among the various grades of cross-bred animals. In general, the mortality rate was comparatively higher among local cattle than in half-bred animals in all the categories. Further analysis was in progress.

(R. GOPALAN and B. MARUTIRAM)

3.6 Study of cost of poultry and egg production.

The objectives of the project were (a) to evolve a suitable methodology for estimation of cost of poultry and egg production under commercial management conditions which involves (i) estimation of cost of production of table and hatching type of eggs, cost of rearing of birds upto various ages covering from day old chick to adult stage and cost of maintenance of layers and cocks with a reasonable degree of precision and (ii) estimation of various components of cost and their variation both in monetary terms and in terms of physical quantities, (b) to secure information on factors helpful in lowering the cost, (c) to secure information on prices of eggs and birds at various stages of marketing from producer to consumer so as to study the price spread; and (d) 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 Tanda 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, sexed 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 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 collected in the selected areas of Dasuya and Tanda in Punjab and in Delhi and the surrounding areas for a further period of two years after completion of the main enquiry.

Keping in view the objectives of the survey, cost acccounting approach was followed. Estimates of different components of cost, viz. feeds fed, labour put in, management, investments, depreciation on assets and equipment, depreciation on adult birds and miscellaneous expenditure were obtained separately for different categories of birds in rural and urban areas. These components of cost were added up to get the gross cost of production of poultry and eggs. From these estimates of 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 were obtained. Data on income from items other than sale of birds and eggs were utilised to obtain estimates of net cost of production.

During the year under report, the analysis of the data collected from about 130 farms in Tanda—Dasuya area of Punjab was completed. The studies covered estimation of cost of maintenance of an adult bird, cost of production of table and hatching type of eggs, cost of a day-old chick and cost of rearing of birds upto various ages from day-old to maturity. The variation of cost over seasons and flock sizes and comparison of estimates of feed cost through enquiry and by observation were also studied. The data were also analysed for studying the price spread from producer to consumer in regard to eggs and table birds. Deeper statistical analysis was also carried out to study the relationship of fixed and working capitals in relation to the productivity of different farms. The data collected from the second survey in Delhi and surrounding villages were being analysed on the same lines. Simultaneously, investigations were being carried out to develop a suitable index for estimation of cost of egg production and poultry rearing.

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

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

The objectives of the project 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 of the survey in Dhulia region of Maharashtra State was initiated in December, 1969. After the completion of detailed enquiry in February, 1972, the collection of data for buildig up an appropriate index of cost of production of milk was initiated in the area in March, 1972 and completed in February, 1974. In the region, 48 villages selected for cost study remained fixed throughout the period of enquiry, while another 48 villages selected for the study of availability of milk were selected afresh 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 weighment and other information such as details of paid and family labour, capital investment, recurring expenditure etc. through observation and careful 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. 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.

It was found that the overall daily production of milk in the area was 298 tonnes, of which as much as 76 per cent was accounted for by buffalo milk. The average daily milk yield of a buffalo in milk was about 3.5 kg as compared to only 1 kilogram per cow in milk. In commercial milk producer households, the cost per kilogram of buffalo milk was about Rs. 1.30 when the family labour was included and Rs. 1.25 when family labour was excluded. The estimates of cost were obtained with a reasonable degree of precision, the standard error being 6.8 per cent or less. The average maintenance cost of a milch buffalo was about Rs. 2.30 per day including family labour and Rs. 2.15 excluding family labour. The corresponding maintenance costs for a milch cow were Rs. 1.25 and Rs. 1.10 respectively. Feed was the major component of cost accounting for about 80 per cent of the gross cost. The analysis of the data to build an apporiate index of cost of production

of milk remained in progress.

(K. C. RAUT and SHIVTAR SINGH)

3.8 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 offered by organised milk supply schemes 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.

During the year under report, the data of the benchmark survey in the milk shed areas of Dudhsagar Dairy, Mehsana (Gujarat) collected during 1967-68 were processed further for statistical analysis and the final report pertaining to the benchmark survey was prepared. The data pertained to milk production, its quality, quantity and composition of feed given to animals, breed composition of animals and their age composition, main and subsidiary occupations of house-holders, cropping pattern, cost of production of various crops, income from dairying, fodder production, etc. Also, the scrutiny and coding of the data collected during 1972-73 in respect of the repeat survey in the rural milk collection areas of Delhi Milk Scheme was completed and suitable card designs were prepared to transfer the data on cards. About 90% of the data was punched by the end of the year for further statistical analysis. The field work of the repeat survey in the milk-shed areas of Dudhsagar Dairy, Mehsana (Gujarat) was over in October, 1974 and a part of the data was also scrutinized for further statistical analysis.

The estimates of average daily milk yield per animal and milk production in the areas were obtained by using appropriate formulae for stratified two-stage sampling design. It was found that the average daily milk yield per cow in milk was 2.1 kg. in the area from where milk was lifted by the organised agencies (supplying area) and 2.2 kg in the area from where no milk was drawn by the organised agencies (non-supplying area). The corresponding averages per buffalo in milk were 4.4 kg. and 3.8 kg. respectively. On an average, 200 tonnes of milk was produced per day in the milk-shed areas of Dudhsagar Dairy, Mehsana. Buffaloes contributed as much as 95% of the total production.

The average production cost of the two rabi food crops viz., wheat and barley, ranged from Rs. 26 to Rs. 45 per quintal and that of kharif crops, viz., *jowar* and

bajra, from Rs. 16 to Rs. 27 per quintal. The corresponding figures for the two fodder crops, viz., *rizka* and *jowar*, ranged from Rs. 7 to Rs. 8 and Rs. 4 to Rs. 5 per quintal respectively. Further, the average cost of production of each crop was appreciably less than the market rate except in the case of *rizka* where the production cost and market rates were more or less of the same order.

A milch cow was fed on an average 3.3 kg. of greens, 3.4 kg. of dry matter and 200 gms. of concentrates per day while a milch buffalo was given 9.0 kg. of greens, 8.1 kg. of dry matter and 980 gms. of concentrates per day. The cost of production of one kilogram of cow milk was about 80 paise in the supplying area and twice as much in the non-supplying area when feed cost was evaluated both on the basis of market rates and cost of production rates. The corresponding figures for buffalo milk were 70 and 100 paise respectively. The prevailing market rates for sale of milk were 70 p/kg. to 79 p/kg for cow milk and 78 p/kg to 95 p/kg for buffalo milk.

On an average, a family consisted of seven persons, four adults and the remaining below 14 years of age. One out of two persons in a family was a worker, i.e. a person who was directly or indirectly occupied in a job or enterprise during the last seven days (irrespective of the time spent) reckoned from the day of visit of the enumerator. Non-milk producing families had a lesser proportion of workers. Of the total number of workers in commercial households, 50 to 57 per cent were engaged in crop production, 30 to 37 per cent in milk production and the remaining in other vocations. The pattern of employment in private households was quite similar to the one observed in commercial households, workers engaged in agriculture constituting 55 to 64 per cent of the working force and those engaged in milk production 25 to 34 per cent. On the other hand, in non-milk producer households, as many as 72 to 82 per cent of the workers had field work as their main occupation. Trade, artisan work and skilled work were the next three vocations, each accounting for about 5 to 8 per cent of the working force. The average annual gross income of a commercial milk producing family was of the order of Rs. 7,600 in the supplying area and Rs. 6,500 in the non-supplying area. The corresponding figures for a private milk producer family in the supplying and non-supplying areas were Rs. 6,300 and Rs. 6,000 respectively. The estimates in respect of a non-milk producer family were Rs. 1,600 and Rs, 1,700 in the supplying and the non-supplying areas respectively.

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

3.9 Study of the impact of milk supply schemes on rural economy in milk collection areas of Madhavaram Milk supply Scheme, Madras and Greater Calcutta Milk Scheme, Calcutta.

The objective of the scheme was to study the impact of urban milk supply schemes on rural economy in milk collection areas with a view to develop a suitable assessment technique for the purpose.

The schedules to be used in the survey were finalised along with the Handbook of Instructions to be used by the field staff during the survey. The actual collection of the data could not be started due to some administrative delay on the part of the State Governments concerned.

(H. P. SINGH, PREM NARAIN and RANDHIR SINGH)

3.10 National Index of Animal Experiments.

The objective of the project was to collect and analyse data pertaining to experimental investigations on animals carried out at the various research centres/ institutes in the country with a view to preparing a compendium of the processed results so as to enable research workers in the field of animal sciences to review the work already done in a particular subject and to plan future investigations on proper lines. The experimental data collected from the various research stations were first scrutinized and those which were amenable to statistical analysis were processed and analysed by applying the techniques of analysis of variance and covariance. Some multiple regession analysis was also made for growth and requirement studies. The results obtained were then categorised and put in the appropriate format for inclusion in the compendium.

During the year under report, data on 60 experiments pertaining to Animal Nutrition conducted at the N.D.R.I., Karnal and data relating to general experimental conditions under which experiments on Animal Nutrition are conducted at U.P. College of Veterinary Science and Animal Husbandry, Mathura, were collected. Also, data pertaining to 120 experiments on Animal Nutrition conducted at U.P. College of Veterinary Science and Animal Husbandry, Mahura, were analysed and the results were compiled in the prescribed format.

(ALOKE DEY, T. JACOB, and S. N. BAJPAI)

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

The objective of the project was to evolve a suitable methodology for the estimation of age-specific fertility and mortality rates for cattle and buffaloes with a view to constructing life-tables for bovines.

During the year under report, complete enumeration of households under the preliminary survey in the 150 selected villages in Amritsar area of Punjab was carried out. Thirty households having bovines were then selected from each village. The field staff were imparted training for the detailed enquiry from these households and information on items like breeds, classification, age, sex, birth, death/disposal, etc., and general information about villages was collected during seccessive visits of the selected households. Data being received from Punjab and those received earlier from Andhra Pradesh were being scrutinized and processed.

(T. JACOB and S. N. ARYA)

4. SAMPLE SURVEY INVESTIGATIONS

Sample survey investigations are undertaken by the Institute with a view to evolving suitable sample survey techniques and demonstrating the feasibility of using them for the collection of information relating to a wide variety of disciplines in agriculture and animal husbandry The investigations which were in progress during the year under report, as per the programme laid down, are briefly described in the following sub-sections and the names of the concerned principal investigator and his associate(s) are given at the end of each sub-section.

4.1 Sample surveys for assessment of the 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 of these crops and (iii) the extent of adoption of improved practices such as fertilizer application, plant protection measures, etc. associated with the cultivation of high yielding varieties of these crops.

During the year under report, data pertaining to crop cutting experiments and A.A.E. enquiry for kharif 1973-74 were received from all the 15 States. Some data collected during rabi 1973-74 were also received from a few States. Data collected during 1972-73 were scrutinized and analysed. Analysis of the data was done employing statistical procedures appropriate to stratified multistage random sampling design. Ratio method of estimation was employed wherever found feasible and necessary. Volume II of the Annual Report for the year 1971-72, embodying the results of A.A.E. enquiry giving the area under high yielding varieties of the five programme crops and extent of adoption of package of associated practices by cultivators was prepared and Volume I of the Report was published.

A brief summary of the results embodied in Volume II of the Annual Report for 1971-72 is given below :

(i) *Kharif 1971-72*

(*a*) *Rice* : Estimates of area under high yielding varieties of rice were worked out for 38 districts in 12 States. In the districts of Monghyr (Bihar), Amritsar, Gurdaspur and Patiala (Punjab) and Faizabad and Gonda (Uttar Pradesh) more than 52 thousand hectares of rice area was covered by HYV. In East Godavari, Krishna, Guntur and Nellore (Andhra Pradesh) Gaya (Bihar), Ferozepur (Punjab) and Basti (U.P.) 31 to 48 thousand hectares were covered by HYV of rice. In Kamrup and Sibsagar (Assam) ; Darbhanga and Saharsa (Bihar), Ambala (Haryana), Coimbatore and Madurai (T. N.), Shimoga (Karnatka) and Cuttak (Orissa) the corresponding estimates varied between 12-20 thousand hectares. In the remaining 16 districts, the area under HYV of rice was below 12 thousand hectares. The proportion of the area under HYV of rice to the total area under rice was worked out for 36 districts in 11 States. In Amritsar, Patiala, Gurdaspur and Ferozepur (Punjab) and Cuttack (Orissa) the area under HYV of rice was more than 55 per cent of the total area under the crop. In 9 districts, 20 to 42 per cent of the total area under the crop was under its HYV. In 16 districts, the corresponding proportion was between 5 to 20 per cent, In the remaining 6 districts, less than 5 per cent of the total area under rice was covered by HYV. A comparison of the estimates of area under H.Y.V. from the survey and the corresponding figures according to State authorities showed that in the case of only 3 districts, viz., East Godavari (A.P.), Monghyr (Bihar) and Gurdaspur (Punjab), the two sets of figures were in agreement. In the remaining districts the official estimates were either much less or higher than the survey estimates.

(*b*) *Maize* : Estimates of area under HYV of maize crop were worked out for 21 districts covering 7 States. In the districts of Monghyr and Muzaffarpur (Bihar), Amritsar and Jullundur (Punjab) and Chittorgarh (Rajasthan) the area under HYV of maize was above 15 thousand hectares, while in the districts of Ambala (Haryana) and Kanpur and Gonda (U.P.) it was between 10 to 15 thousand hectares. In the

remaining districts except Warangal (A.P.), Belgaum (Karnataka) and Basti and Faizabad (U.P.) the area under HYV of maize was below 5 thousand hectares. The estimates of area showed that in Belgaum and Bijapur districts of Karnataka State about 80 per cent of the total area under maize was under HYV. In Amritsar and Jullundur (Punjab), Faizabad and Kanpur (U.P.), Muzaffarpur and Monghyr (Bihar) and Ambala (Haryana) the corresponding percentage ranged between 30 to 55. In Basti and Gonda (U.P.), Chittorgarh (Rajasthan), Patiala (Punjab), Saharsa (Bihar) and Warrangal (A.P.) it ranged between 10 to 30 per cent. In the rest of the districts, the area under HYV of maize was less than 10 per cent of the tolal area under the crop. The official estimates of area under HYV agreed with the survey estimates only in 3 districts, viz. Bijapur (Karnataka) Chittorgarh (Rajasthan) and Muzaffarpur (Bihar).

(c) *Jowar*: Estimates of area under high yielding varieties of jowar were worked out for all the 13 districts covered for this crop in the States of Madhya Pradesh, Maharashtra, Karnataka and Rajasthan. In districts of Wardha and Buldhana (Maharashtra) and Bellary (Karnataka) the area under HYV of jowar varied between 30 to 50 thousand hectares while in the districts of Mysore, Shimoga and Belgaum (Karnataka) and Amravati, Akola and Aurangabad (Maharashtra) it ranged between 10 to 25 thousand hectares. In the remaining 4 districts the area under HYV of jowar was below 10 thousand hectares. The area under HYV of jowar in Shimoga and Bellary (Karnataka), Mandsaur (M.P.) and Nagpur (Maharastra) was about 67, 52, 37 and 34 per cent of the total area under the crop while in the districts of Wardha, Aurangabad, Bhir and Buldhana (Maharashtra) the corresponding percentages were between 14 and 25. In the remaining districts the area Under HYV of jowar was between 7 to 10 per cent of the total area under the crop. In all the districts except Shimoga (Karnataka) the corresponding official estimate was very much on the higher or lower side as compared to the survey estimate.

(d) *Bajra*: Estimates of area under HYV of bajra were worked out for 18 districts in 8 States, viz. Andhra Pradesh, Gujarat, Haryana, Tamil Nadu, Maharashtra, Karnataka, Punjab and Rajasthan. In the districts of Hissar (Haryana), and Banaskantha, Kaira and

Rajkot (Gujarat) more than 65 thousand hectares of area was covered by HYV of bajra. In the case of Rohtak (Haryana) and Bijapur (Karnataka) the corresponding estimate was around 42 thousand hectares each. In the case of Nellore and Chittoor (A.P.), Ferozepur and Sangrur (Punjab), Jaipur (Rajasthan) and Coimbatore (T.N.) the area under HYV was between 5 to 20 thousand hectares. In the remaining 5 districts the estimate of area under HYV of bajra was below 5 thousand hectares. In Rajkot (Gujarat) and Nellore (Andhra Pradesh) about 75 and 59 per cent respectively of the total area under the crop was covered by HYV. In the districts of Kaira and Banaskantha (Gujarat), Hissar and Rohtak (Haryana), Coimbatore (T.N.), and Ferozpur and Sangrur (Punjab) 25 to 46 per cent of the total area under bajra was covered by HYV. In the remaining districts the area under HYV was less than 2 . 5 per cent of the total area under the crop. A comparison of the official estimates with those of the survey indicated that the two sets of figures agreed only in the case of Chittoor (A.P.) and Aurangabad (Maharashtra). In most of the remaining districts official estimates were very much on the high side.

Rabi 1971-72 :

(a) *Wheat*: Estimates of area under high yielding varieties of wheat were worked out for 40 districts in the States of Bihar, Gujarat, Haryana, Madhya Pradesh, Maharashtra, Karnataka, Punjab, Rajasthan, Uttar Pradesh and West Bengal. In the districts of Patiala, Amritsar and Jullundur (Punjab), Basti (U.P.) and Hissar (Haryana) the area under HYV of wheat was as high as 228, 207, 192, 146 and 124 thousand hectares respectively, while in the districts of Darbhanga, Monghyr, Saharsa, Gaya, Muzaffarpur and Purnea (Bihar), Rohtak and Ambala (Haryana), Morena (M.P.), Aurangabad (Maharashtra), Gurdaspur (Punjab), Rajkot (Gujarat), Faizabad and Deoria (U.P.), Chittorgarh (Rajasthan), Bijapur (Karanataka), and Murshidabad and Birbhum (West Bengal) the area under HYV of wheat was between 25 to 100 thousand hectares. In the remaining 17 districts the corresponding estimates were less than 25 thousand hectares. The proportion of the area under HYV of wheat to the area under wheat was worked out for 35 districts in 9 States. In the districts of Jullundur, Patiala and Amritsar (Punjab) and Faizabad (U.P) more than 85 per cent of

wheat area was under HYV. In 16 districts, 40 to 75 per cent of the total wheat area was estimated to have been sown with HYV while in the remaining 15 districts the percentage varied between 13 to 39. A comparison of the survey estimates of the area under HYV of wheat with the corresponding official estimates indicated a fairly close agreement between the two sets of figures only in three districts. In all other districts official figures were very much different from the survey estimates.

(b) *Rice*: Estimates of area under high yielding varieties of rice were worked out for 25 districts spread over the States of Andhra Pradesh, Kerala, Tamil Nadu, Karnataka, Orissa and West Bengal. In the districts of East Godavari and Nellore (A.P.) and Chingleput and Madurai (Tamil Nadu) the area under HYV of rice was between 40 to 65 thousand hectares, while in the districts of Chittoor, Guntur and Krishna (A.P.), Kottayam (Kerala), Coimbatore and Tirunelveli (T.N.), Shimoga (Karnataka), Cuttack (Orissa) and Midnapur and Birbhum (W.Bengal) it was between 10 to 35 thousand hectares. In the remaining 11 districts less than 10 thousand hectares of area was under HYV of rice. In the districts of Kottayam and Trichur (Kerala), Guntur (A.P.), and Shimoga and Bellary (Karnataka) about 70 per cent or more of the total area under the crop was under its high yielding varieties while in the districts of East Godavari, Nellore and Chittoor (A.P.), Mallapuram and Ernakulam (Kerala), Coimbatore, Chingleput and Madurai (Tamil Nadu), and Mysore (Karnataka) the corresponding percentages varied between 40 to 67. In the remaining 7 districts this percentage was between 6 to 37. The official estimate of area under HYV of rice agreed with the survey estimate only for the district of Madurai (Tamil Nadu).

(c) *Maize* :— The estimates of area under HYV of maize were worked out for 6 districts in the States of Andhra Pradesh and Karnataka. In the district of Karimnagar (A.P.) the area under HYV of maize was 5.5 thousand hectares. The corresponding estimates for Warangal (A.P.) and Mysore (Karnataka) were around 2 thousand hectares and in the remaining districts around 1 thousand hectares or less of area was under HYV of maize. Expressed as a percentage of the total area under maize, the area under HYV was about 71 and 54 per cent in

the districts of Bijapur and Mysore (Karnataka) respectively. In the remaining districts the corresponding percentages were between 13 to 34. In the 6 districts the official estimates were more or less in agreement with the survey estimates.

(*d*) *Jowar* : The estimate of area under HYV of jowar was worked out for the district of Shimoga (Karnataka). About 2 thousand hectares area covering almost all the area under jowar was under HYV and was in close agreement with the corresponding official estimate.

(*e*) *Bajra* : Estimates of area under HYV of bajra were worked out for 4 districts in Tamil Nadu and only for Bellary dlstrict of Karnataka. Except in Chingleput district (T.N.), the area under HYV of bajra was between 1 to 7 thousand hectares. About 78 per cent of the total area under bajra was under its HYV in Bellary while in the remaining 4 districts this percentage was between 8 to 36. In Bellary district the corresponding official estimate was in close agreement with the survey estimate.

(S. K. RAHEJA, B.B.P.S. GOEL, A.K. BANERJEE, P.C. MEHROTRA AND V.S. RUSTOGI)

4.2 Sample surveys for methodological investigations into the High Yielding Varieties Programme.

The objectives of the project were (i) to develop a suitable sampling methodology for studying the changes in area, productivity and adoption of improved agricultural practices under cultivators' conditions for high yielding/improved varieties of important cereal and cash crops and (ii) to study the extent to which potential of high yielding/improved varieties was realized under field conditons and investigate the limiting factors.

During the year under report, the tcchnical programme of the project was formulated and sample surveys were initiated in 15 States. Some data relating to kharif 1974-75 were collected in most of the States. No data were, however, received at the Institute.

(S.K. RAHEJA, B.B.P.S. GOEL, A.K. BANERJEE, P.C. MEHROTRA, AND V.S. RUSTOGI)

4.3 Extent and intensity of adoption of high yielding varieties of cereal crops by farmers of different holding size groups.

The objectives of the project were (i) to determine the relative extent and intensity of adoption of high yielding varieties of crops by farmers in different holding size groups and (ii) to investigate the factors limiting the large scale adoption of these varieties.

The data collected under the agronomic and agro-economic enquiry of the scheme "Sample Surveys for Assessment of High Yielding Varieties Programme" during Autumn, 1972-73 in Ernakulam district of Kerala State were taken up for the study. The same were scrutinized, tabulated and punched during the year under report for the purpose of analysis.

(P.C. MEHROTRA, S.K. RAHEJA AND V.S. RUSTOGI)

4.4 Extent of adoption of associated improved practices in growing high yielding varieties of cereal crops.

The objectives of the project were (i) to determine the extent of adoption of recommended improved practices like irrigation, fertilizer application and plant protection measures by different holding size classes of cultivators and (ii) to investigate the factors that inhibit the adoption of these practices.

The data collected under the agronomic and agro-economic enquiry of the Scheme "Sample Surveys for Assessment of High Yielding Varieties Programme" during Autumn, 1972-73 in Ernakulam district of Kerala State were taken up for the study and were scrutinized and tabulated for the purpose of analysis during the year under report.

(V.S. RUSTOGI, S.K. RAHEJA AND P.C. MEHROTRA)

4.5 Factors influencing yield rates of high yielding varieties of rice—a regression analysis.

The objectives of the project were to study the contribution of improved agronomic practices to the yield rate of HYV of rice under cultivators' management and resource constraints and to determine the adoption rate of HYV in terms of extent of area brought under cultivation of these varieties from year to year.

The data pertaining to the yield estimation survey conducted in Tamil Nadu during Kharif 1972-73 under the Scheme "Sample Surveys for Assessment of

High Yielding Varieties Programme" were taken up for the study. During the year under report, certain regression equations were fitted and further analysis was in progress.

(A.K. BANERJEE, S.K. RAHEJA AND S,S. GUPTA)

4.6 Pilot sample survey for evolving a technique for estimation of production of cultivated fodders.

The objectives of the Scheme were (i) to evolve a suitable sampling technique for objective estimation of (a) acreage under cultivated fodders, (b) yield per unit area under each fodder and (c) nutrients available from different cultivated fodders, and (ii) to obtain information on cultivation practices followed in growing fodder crops and associated crop rotations.

During the year under report, the data collected during 1972-73 kharif and rabi in Meerut District (U.P.) were analysed and the report for the year was prepared and being vetted. Considerable progress was also made in the analysis of the data for the year 1973-74. It was clear from the report that the production of fodder crops could be estimated anually on the basis of crop cutting surveys as was being done for all principal crops.

(S.D. BOKIL AND ANAND PRAKASH)

4.7 Pilot sample survey for evolving a technique for estimation of crop losses in storage.

The objectives of the survey were (i) to develop a sampling technique for estimation of crop losses in storage under cultivators' conditions; (ii) to collect data on the mode of storage, and (iii) to determine causes of losses, etc.,

Data collected in Aligarh district of Uttar Pradesh for about 150 cultivators were scrutinised during the year under report and were found to be not quite satisfactory in quality. Further processing of the data was contemplated.

(S.D. BOKIL AND ANAND PRAKASH)

4.8 Pilot sample survey for determining the cost of cultivation and study of marketing of apples in Himalayan region of Uttar Pradesh.

The objectives of the project were (i) to examine problems connected with the determination of fairly reliable estimates of cost of cultivation of apple, (ii) to

standardise sampling techniques for obtaining reasonably precise estimates of various components of the cost of cultivation, (iii) to examine various problems connected with the organisation of field work of the survey for collecting the data on cost of cultivation and marketing of apples in Himalayan region of U.P., (iv) to standardise the programme and instructions for the field staff for collecting the data relating to the cost of cultivation studies on fruits through cost accounting method, (v) to determine realistic cost of different components and possibly to work out index which could be used for determininig the cost of cultivation from year to year taking into account the fluctuations in the cost of various inputs and (vi) to collect reliable data for studying the existing marketing practices of apples in the region.

The survey covered selected areas in the districts of Nainital, Almora and Tehri-Garhwal in Kumaon region and Uttar-Kashi district in Uttar-Kashi division of U.P. The first round of the survey (harvesting season of apple) was conducted from October, 1972 to September 1973 and the second round which started in October, 1973 was completed in December, 1974. The data collected under the survey related to cost of cultivation of apple in hilly areas and were collected by ad hoc field staff. Also, the data on arrivals and prices of apples during the different months were collected from nine city markets out of the thirteen selected all over the State. The entire data collected in the survey could be divided into the following main heads.

(a) *Cost of cultivation of young orchards.*

On expenditure side under this head, the data were collected on investment on land and the money spent in bringing up young orchards to full bearing age. On the income side, the imputed value of produce realized on account of raising of intercrops grown in the young orchards during the first six years of plantation was also considered.

(b) *Recurring cost of the bearing orchards.*

This included the cost of pruning, digging, manuring, irrigation, plant protection measures, spraying, weeding, root exposing, etc. and protection of fruits, watch and ward charges and the cost of management of the orchard. The expenditure on account of purchase of material, human labour and bullock labour was appropriately accounted for.

(c) *Expenditure on field stock, implements and livestock of the orchard.*

Under this head, the data were collected on farm assets of the orchardists with

speeific reference on investments on purchases of implements and machines, construction of godowns for storage and their depreciation, etc.

(d) *Marketing cost.*

The data were collected on the cost of harvesting, grading, storage, packing and transportation charges paid for exporting the fruits from orchards to the collection centres and from collection centres to the terminal markets.

(e) *Marketing practices.*

Data were collected on the arrivals of fruits in the collection centres and the fruits marketed through different agencies, viz., contractors, forwarding agencies, commission agents and direct sales so as to study the existing marketing channels and relative volume of fruit traded through different channels. The above mentioned data were being collected in a set of four schedules.

During the year under report, various types of data received at the Institute were scrutinized. Also, a study comparing the marketing of apples in different city markets was undertaken and a paper published during the year. The methodological problems connected with the determination of cost of cultivation of apples were investigated and a plan for working out the various components of cost was chalked out.

(A.H. Manwani, B,L. Kaul, Bhagat Singh, M.S. Batra, Jagmohan Singh And S.K. Mahajan).

4.9 Pilot sample survey for developing a sampling technique for estimation of production of fresh fruits in Tamil Nadu.

The objectives of the project were (i) to study the technical and organisational problems associated with the conduct of large scale sample surveys on fruit crops, (ii) to obtain reliable estimates of acreage under major fruit crops as well as total acreage under all fruits, (iii) to obtain reliable estimates of yield rates and total production of major fruit crops grown in the region and (iv) to collect reliable data concerning manurial and cultivation practices of major fruits and incidence of pests and diseases on these crops.

The data which were collected in the survey might be classified as (a) extent of cultivation of fruits as indicated by their acreage, number of orchards and fruit trees under different categories, (b) yield of selected trees according to variety,

both in terms of weight and count of fruits (mango, banana, citrus fruits and grape) during the entire harvesting season and (c) cultivation practices such as spacing, method of planting, manuring and other cultural operations for major fruit crops, incidence of pests and diseases on these crops, etc. All the districts of Tamil Nadu state were covered under the survey. The data were collected from 599 villages in respect of extent of cultivation and from 120 villages in respect of yield and cultivation practices. The data collected during the survey were fully analysed during the year under report and a report was under compilation.

The design adopted for the survey was one of stratified multistage random sampling, with taluks or groups of taluks as the strata. The grouping of taluks for the purpose of stratification was carried out as per size classification (area under different types of fruit crops) and pattern of cultivation of fruits. The units under different stages of sampling in relation to nature of study were selected according to appropriate probability sampling procedures, viz. (a) for the estimation of extent of cultivation, the design was two stage sampling with talukas covered under the survey as primary units and villages, as secondary units, (b) for the study of yield of the fruit crops selected, the sampling design was of two phase, four stage sampling with orchards and clusters of trees constituting two more stages, and (c) the study of cultivation practices of fruit crops was carried out in all the orchards selected under yield study.

The results of the survey indicated that the area under fresh fruits in the State during the year 1972-73 was 80.6 thousand hectares under regular orchards and 12.1 thousand hectares under stray plantation. Out of these, banana as well as mango accounted for nearly 44 per cent each followed by citrus (5%). The area under grapes in the entire State was estimated to be only 800 hectares.

The distribution of trees planted in the State indicated that 75 million banana plants, 3 million mango trees, about 1.1 million citrus trees and 1.4 million grape vines were planted in the State during the agricultural year 1972-73. The plantation of young trees of fresh fruits other than banana accounted for nearly 20% of the total number of trees in the State. The stray plantation was estimated at 6 million plants of which as many as 4.5 millions were of banana followed by mango (0.8 million) and citrus fruit (0.5 million). The total number of orchards in the State were estimated at 261 thousand of which 156 thousand were of banana. In the orchards other than those of banana, mango was found to be planted in 77 thousand, citrus fruit in 26 thousand and grapes in 13 thousand orchards. In addition to these major fruit crops, the other miscellaneous fresh fruits were planted in as many as 23 thousand orchards in the State. The average size of a

banana orchard was estimated to be 0.25 ha. while that of mango as 0.43 ha. It was significant to note that average size of a grape vine-yard was extremely small, being only 0.06 ha.

The most important varieties of banana planted in the State were Mauritius (38.3%), Hillplantain (22.1%), Poovan (16.3%) and Rasthali (10.6%). Among grafted varieties of mango planted in the State, the most important ones were Neelam and Bangalora, each accounting for 35 per cent of the total mango trees of bearing age planted in the State, the non-grafted local varieties accounting for 23 per cent. Among the citrus fruits, lime was the most important variety accounting for 44.5 per cent of the total number of trees of bearing age in the State followed by sweet orange (27.4%) and other miscellaneous varieties put together (28%). The most important varieties of grapes in the state were Muskat and Patchai-Draksha accounting for 55.4 and 36.9 per cent respectively of the total number of bearing vines in the State.

The information on yield rates was collected separately for two bearing seasons of mango, viz., 1972 and 1973 and one bearing season of banana, viz., 1972-73 (agricultural year). So far as citrus fruit and grapes were concerned, data on yield were collected for both the bearing seasons in a year (1972-73) and the pooled estimates of yield per tree were worked out over both the seasons. During 1972, on an average, a mango tree of bearing age was found to yield 283 fruits weighing 74 kg. while during 1973 it was found to bear 433 fruits weighing about 98 kg. The average yield per grape vine was estimated as 16.7 kg. The yield of grapes per hectare was estimated as 309 quintals. So far as citrus fruit was concerned, due to wide differences in size of the fruit of different varieties, the yield was found to vary considerably from variety to variety. Thus, while the average yield per tree of lime was 243 fruits weighing 7.4 kg., that of a tree fo sweet orange was 253 fruits weighing 20 kg.

The data on cultivation practices indicated that the average distance between plants was 2.26 meters in a banana orchard, 10.0 meters in a mango orchard and 5.1 meters in a citrus orchard. As many as 86 per cent of banana orchards and 96 per cent of grape orchards received irrigation. The percentages of citrus and mango orchards receiving irrigation were found to be 61 and 24 respectively. The source of irrigation was mostly well. The irrigation by tube-well was very rare as it was given in only three orchards out of the entire sample of 700 orchards, The data on fertilizer application in fruit orchards indicated that fertilizer was applied in the case of 71 per cent of banana, 23 per cent of grapes, 10 per cent of citrus fruit and 3 per cent of mango orchards in the State. The most common

fertilizer applied on mango was Ammonium Sulphate. On citrus fruit, ammonium sulphate, urea and other chemical mixtures were applied while the majority of area under grape orchards received urea. In the case of banana orchards, different fertilizers were found to have been applied in the form of mixtures. The average rate of application per tree was found to be 3.8 kg. of ammonium sulphate on mango, 3.0 kg. of urea on citrus fruit and 0.9 kg. of urea per grape vine pit (one pit contained 2-3 vines). The average rates of application of different fertilizers on banana varied between 0.2 to 0.5 kg. per plant.

The data on prices collected from the survey indicated that, on an average, the orchardist during the peak harvest season received Rs. 3.60 to Rs. 6.00 per stalk of banana depending upon the variety, Rs. 8.00 to Rs. 34.00 per 100 fruits of mango and Rs. 5.15 to Rs. 6.50 per 100 limes. The maximum price per 100 fruits of mango received by the orchardist varied between Rs. 10.00 to Rs.50.00 depending upon variety and the minimum between Rs. 5.00 to Rs. 18.00 So far as grapes were concerned, the minimum price of Bangalore Blue variety was quoted as Rs. 125 a quintal and the maximum Rs. 200 a quintal. Patchai-Draksha variety fetched Rs. 50 to Rs. 105 per quintal during the different seasons.

(A.H. MANWANI, A.K. SRIVASTAVA, K.R. RAJAGOPALACHAR K. CHUG, R.C. GOLA AND RAMJI LAL)

4.10 Pilot sample survey for developing a sampling technique for estimation of production of vegetables in Bangalore District of Karnataka State.

The objectives of the project were to examine the feasibility of estimating the area, yield rate and production of different vegetables through random sampling technique and to collect reliable data on manurial and cultivation practices of important vegetable crops.

During the year under report, the data for the first round were analysed. Field work of the third and final round of the survey was completed in December, 1974. Analysis of the data of the second and the third rounds was in progress.

The data collected under the survey might be classified as (i) enumeration of all fields growing vegetables in the selected villages for the purpose of estimation of the area under vegetables, (ii) yield data collected from crop-cutting plots on major vegetables grown in the region, viz., cabbage, tomato, brinjal, beans, lady finger, cucumber and root crops like potato, carrot and sweet-potato, and (iii) cultivation practices of vegetables grown in the selected fields.

The sampling design adopted in the survey was one of stratified multistage random sampling with taluks in the district as strata, clusters of villages as primary sampling units and fields growing vegetables as secondary units of sampling. Crop-cutting experiments were conducted for studying the production and average yield of important vegetable crops.

(A.K. Srivastava, A.H. Manwani, Satya Pal, D.C. Mathur, S.C. Sethi and Rajendra Prakash)

4.11 Methodology for estimation of milk production and other related studies in Northern Region of India.

The objective of the project was to develop a sampling technique for estimation of annual milk production and study of animal husbandry practices.

Two pilot sample surveys were conducted under the main project ' Pilot sample surveys for developing an integrated technique for estimation of principal livestock products and study of attendant animal husbandry practices"—one in the Northern region comprising Punjab, Haryana and Himachal Pradesh and the other in Andhra Pradesh of the Southern region. The field work in the first centre was successfully completed during the year 1972. In the Southern region, data on wool and meat as main products were collected during the year under report. Statistical studies on the data pertaining to milk production collected in the survey during the period 1969-72 were continued during the year under report and the results of the analysis were presented in the form of a report.

The sampling design adopted in the pilot investigations was such that the primary units in the sample consisted of matched and unmatched units. Successive sampling methodology was used on the data collected in the first year 1969-70 as milk was the main product under investigation in that year and in the subsequent two years 1970-71 and 1971-72, when milk was covered on a reduced scale, double sampling procedure was utilized by using the information collected on a large scale in the first year. The studies were made on estimation of changes in milk production from season to season and year to year.

The total milk production in the Northern region was estimated at 4565 thousand tonnes in 1969-70, 4857 thousand tonnes in 1970-71 and 4953 thousand tonnes during the year 1971-72, of which buffalo milk accounted for 77.5 per cent in 1969-70, 79.3 per cent in 1970-71 and 80 per cent in the year 1971-72. Milk production showed an increase of 4.25 per cent per year on the level of production during the year 1969-70. It was seen that in case of buffaloes, season-wise estimates of milk production varied considerably. The milk production in case

of cows was the highest during rainy season and the lowest during summer season. In case of buffaloes, the highest milk production was during winter season and the lowest during summer season. This trend was observed in all the three years.

During the year 1969-70, the per capita per day availability of milk in the region was 486 gms. of which 377 gms. was from buffaloes and 109 gms. from cows. The per capita per day availabilily increased to 505 gms. during the year 1971-72.

The results of the analysis of the data clearly demonstrated the feasibility of using sampling methodology adopted in the investigation.

(J.N. GARG, K.B. SINGH AND M. RAJAGOPALAN)

4.12 Sample survey for estimation of milk production and study of bovine keeping practices—Madhya Pradesh (1966-67).

The survey was conducted in Madhya Pradesh during the year 1966-67 to demonstrate to the State Animal Husbandary Departments, the utility of the sampling technique developed by the Institute during the Second and Third Five Year Plans for the estimation of milk production and study of bovine keeping practices. It was conducted by the Animal Husbandary Department of the State of Madhya Pradesh under the technical guidance of the Institute and covered the entire State to provide estimates of milk production, etc.

The design adopted was one of multistage stratified random sampling. A cluster of two villages was the primary stage unit, while a cluster of two households and an animal in milk were the secondary and the ultimate units respectively. The data on milk production and feed fed to the animals in the sample were collected by physical observation and weighment while the method of physical observation and enquiry was adopted to obtain information on breed composition and other management practices.

It was estimated that the State had 6·09 million milch cattle and 2.26 million milch buffaloes in the year of the survey. The total milk production in the State was 1,031 thousand tonnes of which 406 thousand tonnes was from cows and the rest from buffaloes. The various breeds among milch cows in the State were Malvi (6.1 per cent), Hariana (3.1 per cent), Nimari (0.8 per cent) and Golao (0.1 per cent), and the rest were non-descript. In the case of milch buffaloes, Murrah formed 6.2 per cent, the rest being non-descript. The average milk yield

per day per cow in milk was 0.51 kg. with a standard error of 6.1 per cent while the corresponding estimate for buffalo was 1.70 kg. with a standard error of 6.6 per cent.

(D.V. SUBBARAO, M. RAJAGOPALAN AND J.S. MAINI).

4.13 Preparation of a monograph on sample survey techniques for estimation of egg production.

The objective of the project was to publish the results of the various pilot and large scale sample surveys conducted by the Institute on estimation of egg production and study of poultry practices in the various States of the country and the details of the techniques evolved as a result of these surveys and recommended to the State Animal Husbandry/Veterinary Departments for collecting such statistics in their States.

During the year under report, the results of the data collected and analysed in the past were consolidated. The monograph was finalised and sent for publication.

(D. SINGH, B.B.P.S. GOEL, J.N. GARG AND D.V.S. RAO)

4.14 Preparation of a monograph on methodology for estimation of meat production.

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

Pilot surveys were conducted in Tamil Nadu and Haryana during 1966-67 and 1968-69 respectively. In these surveys data were collected on the number of animals slaughtered in registered slaughter houses and also privately, namely, unregistered slaughter houses (butcher houses) and households. Information was also collected on the average production of meat per animal from a sample of registered slaughter houses. These data provided an estimate of total meat production in registered slaughter houses as well as from the animals slaughtered privately. In addition, data were also collected on the utilization of meat, disposal of hides and skins, etc.

The monograph was being finalised.

(J.S. MAINI, M. RAJAGOPALAN AND K.B. SINGH)

4.15 Inter-censal estimates of livestock numbers.

The principal objective of the project was to build up an appropriate stochastic model, making use of the data from pilot sample surveys on livestock products, for working out estimates of livestock numbers in the inter-censal years.

During the year under report, a suitable stochastic model was built up, making use of livestock census data, for working out estimates of livestock numbers pertaining to inter-censal years for the country as a whole. But work was still going on to build a suitable stochastic model for finding out estimates of livestock numbers for the inter-censal years for a State.

(J.S. MAINI AND J.P. GOEL)

4.16 Estimates of feed fed to cattle and buffaloes.

The objectives of the study were (i) to estimate the quantities of roughage and concentrates supplied to the different categories of bovines in the country in the year 1966 and (ii) to estimate the total quantity of feed fed to them in the year 1972, excluding grazing in both the cases.

The Institute conducted a series of sample surveys in the country during the years 1960-70 for estimation of production of milk and study of bovine keeping practices. In these investigations, detailed data on a day's supply of feeds given by the households to the bovines kept by them, were collected. These data were used for the study.

The average feed supply for the different categories of animals, viz., animals in milk, dry animals, working animals and young stock was worked out for each season in the year 1966, as these surveys were conducted around the quinquennial census year, 1966. Assuming the same average feed supply to the animals, the estimates of total supply of green fodder, dry fodder and concentrates during the year 1972 were obtained.

It was observed that, on an average, a cow in milk received 8.6 kg. of roughage and 350 gms. of concentrates, a dry cow received 6.0 kg. of roughage and 260 gms. of concentrates, a working animal received 10.4 kg. of roughage and 260 gms. of concentrates and a young stock received 3.4 kg. of roughage and 130 gms. of concentrates per day in the year 1966. The corresponding figures in the case of buffaloes were 13.4 kg. and 680 gms. for buffalo in milk, 9.4 kg. and 230 gms. for a dry buffalo, 8.7 kg. and 360 gms. for a working buffalo and 4.8 kg. and 150 gms. for a young stock.

Further, it was estimated that during the year 1972, 294.9 million tonnes of green fodder (excluding grazing), 345.9 million tonnes of dry fodder and 21.6 million tonnes of concentrates were given to the bovines in the country.

(D.V. SUBBARAO, M. RAJAGOPALAN AND J.S. MAINI)

4.17 Employment and income effects of the new agricultural strategy in Aligarh District (U.P.).

The objectives of the project were (i) to measure the impact of the new agricultural strategy on the total employment and (ii) to quantify the effects on income of various classes of farmers and agricultural labour.

The data were collected on a sample basis to cover the entire district of Aligarh for the agricultural year 1973-74 (i.e. July, 1973 to June, 1974). Out of 17 blocks, 10 blocks were selected by Rao—Hartley and Cochrane technique with probability proportional to their size, i.e., total cultivated area for the block. In each selected block, 4 villages were selected with simple random sample without replacement. With each selected village, an adjoining village was attached to form a cluster of 2 villages. In this way, there were 4 clusters in each block. A list of cultivators and labour house-holds was prepared. From each cluster, 15 households comprising small, medium, large farmers and labour families were randomly selected. Since this was the first survey with the above mentioned objectives, it was not possible to measure the impact over previous years. Hence a new technique was evolved to measure this impact as follows : All the cultivators were grouped into 3 classes viz. (i) progressive cultivators, (ii) less progressive cultivators and (iii) traditional cultivators. The classification was made on the basis of scores on different aspects of agricultural strategy, e.g., proportion of area under HYV of cereal crops, proportion of area under cash crops, improved breeds of live stock, proper storage and availing of organised form of marketing facilities. Different maximum scores were attached with each of the above mentioned aspects and then scores were given to each cultivator. On the basis of total scoring, the cultivators were grouped into three categories, viz., A,B,C, i.e., progressive, less progressive and traditional cultivators. Within each group, studies were to be made on (1) fitting of response for the crops and finding the marginal productivity of each input, (2) income per hectare of land for the different crops, (3) labour employment per hectare, and (4) income per milch animal.

Comparison in above mentioned aspects would be made between these groups to have an indication of impact of new agricultural strategy on employment and income. It would also be tested whether the two attributes, viz., holding size and the extent of adoption of new agricultural strategy are connected, by applying appropriate statistical tools.

The above comparison would be made for the classes of small, medium and large farmers.

(R.K. Pandey and M.G. Mittal)

5. BASIC RESEARCH IN STATISTICS

During the year under report, important contributions were made both in theory as well as in the application of statistical techniques to problems in Sampling, Genetical Statistics and Design of Experiments. Some of these are given below.

(*a*) *Sampling*

The problem of estimation of multiple characters in sample surveys relating to finite populations was attempted. Different models in 3-p-sampling were suggested. Some Monte-Carlo studies were undertaken for comparing different methods of estimation. New pps sampling schemes were proposed and their efficiencies compared with the existing sampling schemes. Studies on non-response errors in successive sampling were undertaken. Some new systematic sampling schemes were suggested where it was possible to estimate unbiasedly the variance of the mean.

(*b*) *Genetical Statistics*

Studies on the parent-offspring and full-sib correlations separately under full-sib mating and parent-offspring mating systems, both for autosomal as well as sexlinked genes, were conducted. Relationship between retention of a cow in a herd and its milk yield in the first lactation was studied and a method for estimating the heritability of survival was developed.

(*c*) *Designs of Experiments* :

Important contributions were made in the realm of change-over designs. Development of new designs for paired comparisons, namely, standard comparison pairs and symmetrical pairs, and designs for sensory evaluation were reported.

6. TRAINING ACTIVITIES

The Institute conducts training in agricultural 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 Diploma 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 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 at the Indian Agricultural Research Institute.

The final examinations for the Junior Certificate, the Senior Certificate and the Professional Statistician's Certificate Courses and the qualifying examinations for the M Sc. and Ph. D. students were held during the year under report.

A list of the dissertations approved during the year under report for award of the Ph. D. and the M.Sc. Degrees and the Diploma in Agricultural Statistics is appended (Appendix III).

The new session for the Junior Certificate, the Senior Certificate and the Professional Statistician's Certificate Courses started from 1st October, 1974 and for the M.Sc. and the Ph. D. Courses from 16th September, 1974. The number of students admitted to these courses were 12, 26, 1, 8 and 3 respectively. 7 students joined the Diploma Course during the year.

A number of important seminars/lectures were delivered by seven eminent statisticians during the year under report. The names of the speakers and the titles of their talks are given on next page :

	Name of the Speaker	*Seminar Title*	*No. of lectures delivered.*
1.	Sh. R.C. Khera, Scientist, I.C.A.R., New Delhi.	Recent advances in experiments with live-stock, feed resources and their requirements.	1
2.	Dr. J.N. Shrivastava, Professor of Statistics, Colorado State University, U.S.A.	Search Designs	8
3.	Dr. T.V. Hanurav, Dean of Studies, Indian Statistical Institute, Calcutta.	Theory of sampling from finite population.	3
4.	Dr. A.L. Nagar, Professor of Econometrics, Delhi University.	Specification and estimation of Econometric Method.	4
5.	Dr. O.P. Aggarwal, UNESCO Expert, Mexico.	General Talk	1
6.	Dr. J.S. Rustogi, Professor of Statistics, Ohio State University, U.S.A.	Statistics in Environmental Sciences.	1
7.	Dr. G.R. Seth, F.A.O. Expert, Haiti.	General Talk	1

Seminars by the members of staff and the students of the Institute on various topics of interest were, as usual, held during the year under report. The names of the speakers and the titles of their talks are given in Appendix IV.

Lectures and practicals were arranged for the trainees of other organisations as indicated below :—

1.	Andhra University, Waltair.	M.Sc. students	25.6.1974
2.	Indian Statistical Institute, Calcutta.	B. Stat. and M. Stat. students.	20.7.1974
3.	Central Statistical Organisation, New Delhi.	Trainees from foreign countries.	1.11.1974 11.11.1974 12.11.1974 16.11.1974 1.12.1974 6.12.1974

An educational tour was arranged for the benefit of the students of the Professional Statistician's Certificate and the Senior Certificate Courses during the year under report. The various laboratories were shown and different methods of experimentations were explained to them during the educational tour. The students visited the following Research Organisations/Universities during this tour.

1. Madras Veterinary College, Madras.
2. Tamilnadu Agricultural University, Coimbatore.
3. Sugarcane Breeding Institute, Coimbatore.
4. Central Marine Fishery Research Institute, Cochin.
5. Central Institute of Fishery Technology, Cochin.
6. University of Agricultural Sciences, Bangalore.
7. National Dairy Research Institute, Southern Region, Bangalore.
8. Horticultural Research Institute, Bangalore.
9. A.P. Agricultural University, Rajendranagar, Hyderabad.
10. International Crops Research Institute for the Semi-Arid Tropics, Hyderabad.

The students also visited the Directorate of Economics and Statistics, New Delhi, the Central Statistical Organisation, New Delhi and the Indian Agricultural Research Institute, New Delhi and they were explained the research findings of the various projects of these organisations. They were also explained the technical details of different projects undertaken by this Institute. They were imparted field training in the conduct of a survey on "Growth of Minor Irrigation Projects and their Impact on Agriculture" in the district of Udaipur. They collected and analysed the data for this survey under the supervision of the Officers of the Training Unit of the Institute.

7· DATA PROCESSING

Data processing has been an important activity 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 three disc drives, each having a capacity of storing two million digits of information. Besides, there are thirty-two card punching and verifying machines and five pieces of unit record equipment consisting of a tabulator, two sorters, a collator, and a reproducing punch in the Mechanical Tabulation Unit.

Since the number of research workers and students going in for complicated designs and methods of analysis of their research problems is ever on the increase, the demand for time on the computer has been increasing considerably. The Computer Centre is, therefore, functioning round the clock in three shifts and is catering, free of charge, to the needs of agricultural research workers of the Research Institutes under the I. C. A, R., Central Agricultural Universities, Directorate of Economics & Statistics, and All India Co-ordinated Research Projects of the I. C. A. R. The Centre also gives guidance and necessary help in tabulation of data, punching of data, and preparation of computer programmes.

During the year under report, the Computer was utilized for 4650 hours. Of the total utilized time, the Institute shared 32% ; the Indian Agricultural Research Institute, 20%; the Directorate of Economics and Statistics, 15% and the various other Research Institutes under the I. C. A. R. and Central Agricultural Universities, 32%; while about 30 hours (0.7%) were utilized by users like the National Physical Laboratory on payment basis.

About 75 M.Sc. and Ph.D. students and 30 officers and research workers from the various Institutes under the I. C. A. R. and Central Agricultural Universities were extended help in preparation of computer programmes for computerization of their research problems.

During the year under report, the Mechanical Tabulation Unit carried out the work of punching, sorting, and listing pertaining to the data of the various research schemes of the Institute and the various research problems of students. Similar help was also rendered to the research workers and students of I.A.R.I., I.V.R.I. and other Research Institutes under the I. C. A. R., Agricultural Universities,

Directorate of Economics and Statistics, Department of Agricultural Research & Education, and various other agencies like the Timely Reporting Scheme of the Department of Agriculture, Government of Uttar Pradesh,, and the Directorate of Marketing and Inspection. About 16 lakh cards were punched, about 3100 listings were prepared, and about 250 sorting jobs were carried out during the year. A large number of students and research workers were also guided in the processing of the data pertaining to their research problems.

The Electronics Commission of the Government of India gave clearance for procurement of a modern Computer System by global tender. The System was being procured under a credit agreement with the International Development Association, a subsidiary of the World Bank. The quotations received from various manufacturers on the basis of a global tender were discussed in detail in four meetings of the Evaluation Committee under the chairmanship of the Director General of the I.C.A.R. The construction of a new building to house the Computer System was almost completed and arrangements were being made for providing central air-conditioning and for furnishing the building. Four Electronic Computer Operators and three Assistant Electronic Computer Operators joined the Centre during the year. This strengthened the staff position of the Centre.

Shri S.S. Pillai, Statistician-cum-Associate Professor who was in charge of the Computer Centre visited Budapest (Hungary) from 12th October, 1974 to 16th December, 1974 to attend the "International Training Course for Senior Applications Programmers" held under the auspices of the United Nations Development Programme. He also visited the Food & Agriculture Organisation, Rome from 18th December to 21st December, 1974 and discussed various problems relating to implementation of AGRIS at the Computer Centre of the Institute. Shri S.K. Raheja, Senior Statistician (H.Y.V.) was in charge of the Centre during the absence of Shri Pillai,

8. ADVISORY SERVICE

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

Technical advice and guidance was also rendered to research workers and students of the various Research Institutes, Universities and other research organisations in planning their experimental investigations and statistical analysis of data as well as in 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.

Crop Sciences.

(a) Technical advice and guidance was given to a number of research workers under the All-India Coordinated Agronomic Rcsearch Project and to students from various Agricultural Universities working on problems relating to agricultural field experiments.

(b) Technical advice was given to Officers of the C.P.R.I., Simla and the C.R.R.I., Cuttack in regard to statistical analysis of the data collected by them.

(c) Teehnical advice and assistance was given for planning of experiments and statistical analysis of data for a number of I.C.A.R. Co-ordinated Projects such as the Soil Test Crop Response Correlation Scheme and the All-India Agronomic Experiments Research Project.

(d) Technical advice was given for planning of "Operation Research Projects on Rice" undertaken by the I.C.A.R. with the help of the Ford Foundation.

Animal Sciences.

(a) Technical advice was given to the Project Coordinator at the N.D.R.I., Karnal in analysis and interpretation of data on bio-chemical polymorphism in cattle.

(b) Technical advice was given to the Professor, Punjabrao Krishi Vidyapeeth, Akola in computerisation and analysis of data pertaining to studies on gynaecology of Berari buffaloes.

(c) Technical advice was given to the Director, C.S.&W.R.I., Avikanagar (Rajasthan) in regard to computerisation and subsequent analysis of data collected under the All-India Co-ordinated Research Project on Sheep for Mutton and Wool.

(d) Technical advice was given to the Statistician of the Directorate of Animal Husbandry, Tamil Nadu in regard to the methods of statistical analysis of data, interpretation of results and preparation of reports of the following I.C.A.R. schemes :—

(1) Development of mutton breeds of sheep, Kattuppakkam.

(2) Improvement of sheep and wool on regional basis, Kamarajsagar.

(3) Selective breeding of Asil breed of poultry, Chettinad.

(e) Technical guidance was given to the Statistical Officer, Directorate of Animal Husbandry, Government of Madhya Pradesh for conduct of the survey on availability and cost of production of milk in the Jabalpur area and analysis of the data collected.

(f) Technical advice was given to (1) the Sheep Breeding Station, Kaveli (Andhra Pradesh), (2) the Agricultural Institute, Anand (Gujarat) and (3) the Indian Veterinary Research Institute, Izatnagar (.U.P) in regard to the procedures of statistical analysis of the data collected by them.

(g) Technical guidance was also given to the Punjab Agricultural University, Ludhiana in regard to the design of nutritional experiments on pigs.

Sample Survey Investigations.

(a) Technical advice was given to the Statisticians in charge of the Scheme "Sample surveys for assessment of the High Yielding Varieties Programme" in

regard to the conduct of these surveys in the Departments of Agriculture/Statistics of the various States.

(b) Technical guidance was given to the Directorate of Marketing & Inspection, Ministry of Agriculture, in regard to their survey for estimating marketable surplus of rice and wheat and post-harvest crop losses.

(c) Technical advice was given to the Joint Director of Agriculture (Statistics), U.P. from time to time in regard to the design of the sample survey for estimating the extent of cultivation, yield rates and production of apple and other temperate fruits in the hilly region of Uttar Pradesh and the interpretation of the data collected in the survey.

(d) As requested by the Government of Jammu & Kashmir, technical advice was given to their Consultant Engineers in planning a survey in raw material availability for setting up an Indo-Bulgarian joint project on fruit processing complex in the State.

(e) Technical guidance was given to a technical team from Zambia in regard to surveys on marketing of fruits.

(f) Technical advice was given to the Field Officer, Directorate of Animal Husbandry, Rajasthan in regard to estimation of meat production.

(g) Technical advice was given to the Indian Grain Storage Institute, Ministry of Agriculture, in regard to sampling methodology for carrying out a survey on "Improved Food Storage in the Villages in Andhra Pradesh" in collaboration with the Institute of Development Studies, London.

Data Processing.

(a) Technical guidance was given to Shri Gurnani, Senior Research Analyst of the Reorganisation Section of the I.C.A.R. in processing their data on the uniformity of pay scales and qualifications in respect of the staff working in the various research institutes under the administrative control of the I.C.A.R.

(b) Technical guidance was also given to Shri Kurian of the Directorate of Marketing & Inspection, Ministry of Agriculture in pre-processing of their data for the study of post-harvest losses of food grains.

9. OTHER ACTIVITIES

9.1 Planning Unit

The function of this Unit is to chalk out the programme of research work of the Institute, to work out the budgetary requirements therefor, and to initiate action for implementation of the related technical items of work.

During the year under report, the programme of research work of the Institute for the year 1975-76 was drawn up and the budgetary requirements thereof were worked out. Action was also initiated to start the field work of the projects in the various States under the following co-ordinated programmes :

(i) Developing measurement techniques and estimation methodology relating to crops,

(ii) Developing statistical methodology in animal husbandry,

(iii) Evolving sample survey methodology relating to agriculture and animal husbandry, and

(iv) Sample surveys for methodological investigations into the High Yielding Varieties Programme.

The details of the Fifth Plan Scheme of Strengthening of the Institute of Agricultural Research Statistics were worked out for consideration by the Expenditure Finance Committee.

The Unit was under the charge of Sh. M. Rajagopalan, Statistician-cum-Associate Professor.

9.2 Director's Cell

The functions of the Cell are (i) to collect requisite material from the different Divisions of the Institute and to prepare notes, reports etc. for various purposes, (ii) to convene meetings of the Senior Officers of the Institute and of the various technical committees and sub-committees of the Institute from time to time, to prepare the minutes of these meetings and to take necessary follow-up action, etc., (iii) to organise annual conferences of agricultural research statisticians and to

prepare and distribute the proceedings thereof, and (iv) to dispose of such other work as may be assigned by the Director in the course of the day to day working of the Institute.

During the year under report, the Cell collected the requisite material from the various Divisions of the Institute and prepared the consolidated material in respect of this Institute for the following reports, publications, etc.

(i) The Annual Report of the Institute for the year 1973,

(ii) The Quarterly Reports of the Institute falling due during 1974,

(iii) The Annual General Meeting of the I.C.A.R.,

(iv) The Annual Report of the I.C.A.R. for the year 1974-75,

(v) The Report of the D.A.R.E. for the Budget Session of the Parliament,

(vi) "Sample Surveys of Current Interest in India", a C.S.O. publication,

(vii) "Statistical System in India", a C.S.O. publication,

(viii) "Statistical Newsletter", a quarterly publication of the C.S.O.,

(ix) "The National Survey of Scientific and Technological Activities" conducted by the National Committee on Science and Technology (Department of Science and Technology),

(x) Report for the Fifth Session of the Far East Commission on Agricultural Statistics held in Malayasia in July, 1974,

(xi) "Sample Surveys in ESCAP region," a publication of the ESCAP,

etc., etc.

Also, monthly meetings of the Senior Officers of the Institute as well as meetings of the various technical Committees and Sub-Committees of the Institute were convened by the Cell. The number of such meetings held during the year under report was more than forty. Proceedings of all these meetings were prepared and circulated. Necessary follow-up action was also taken on these proceedings as also on the minutes of the meetings of the Staff Research Council of the Institute held from time to time (vide Section 1.2).

Besides, the First Annual Conference of the Agricultural Research Statisticians was organised at the Institute from the 25th to the 28th of April, 1974 (vide Section 12) and the proceedings thereof were prepared and distributed.

In addition to the above, other miscellaneous items of technical work assigned by the Director during the year under report such as giving comments on the papers/documents received by him, were also attended to.

Shri R.K. Khosla, as Officer-in-Charge, Shri B.N. Mehta and Shri M.L. Sahni worked in the Director's Cell during the year under report.

9.3 Field Unit

Collection of field data of the field schemes sponsored by the Institute either by its own field staff or by the field staff of the concerned State Departments has been one of the important activities of the Institute. The objective of employing its own field staff is to collect reliable data through intensive supervision of field work by the Field Officers and the supervisory field staff in collaboration with the project leaders concerned of the Institute as well as to study the feasibility of data collection with maximum precision through such means.

As the volume of the work of collection of field data increased through the years, the strength of the Field Unit has risen from one Inspector and five Enumerators in the year 1952-53, when the Unit was set up, to two Field Officers (at the Headquarters), one Assistant Field Officer, two Inspectors, six Supervisors, and thirty Enumerators in 1974.

During the year under report, the Field Officers played an important role of giving technical guidance and advice to the field staff in regard to collection of data, and planning and organisation of field work of the surveys undertaken by the Institute through the State Govt. Departments. Many training programmes were conducted in different States for this purpose. With a view to improving the quality of field data, rationalised intensive supervision of the field work was carried out. Guidance was also rendered in regard to problems faced by the field staff in the conduct of surveys. Progressive assessment and inspection of field work of agricultural and animal husbandry surveys mentioned below were carried out by the Field Officers during the year.

1. Estimation of birth and death rates in bovines in the Punjab.
2. Pilot investigation for developing an integrated technique for estimation of livestock products in Andhra Pradesh.
3. Pilot scheme for the study of yield and cultivation practices of vegetable crops in Bangalore district of Karnataka State.

4. Pilot surveys for estimating the cost of cultivation of apple and its marketing practices in hilly areas of U.P.

5. Scheme for pilot studies on pre-harvest forecasting of yield of different crops in different districts of U.P., Orissa, A.P. and Punjab.

The surveys which were carried out through the field staff of the Institute during the year under report were :—

1. Repeat survey of impact of Milk Supply Schemes on rural economy in milk-shed area of Mehsana district of Gujarat.

2. Employment and income effect of the New Agricultural Strategy in Aligarh district (U.P.).

3. Sample survey for evolving a technique for estimation of crop losses in storage in Aligarh district (U.P.).

4. Pilot sample survey for evolving a technique for estimation of production of cultivated fodders in Meerut district (U.P.).

10. PARTICIPATION IN INTER-ORGANISATIONAL SEMINARS, WORKSHOPS, ETC.

During the year under report, Officers of the Institute participated in several inter-organisational seminars, workshops, etc. The names of the Officers who participated and the particulars of the seminars, workshops, etc. in which they participated are given below.

(i) *Seminar on IBM Systems 370 and 360/44 Software held at the Computer Centre of the University of Delhi in January, 1974.*

Shri S.N. Mathur and Shri K.V. Sathe.

(ii) *Seminar on "Transfer of Modern Technology" held at the U.P. Institute of Agricultural Sciences, Kanpur in January, 1974.*

Dr. D. Singh.

(iii) *Seventh Annual Workshop of the All-India Co-ordinated Agronomic Research Project held at the Rajendra Agricultural University, Ranchi in March, 1974.*

Dr. D. Singh, Sh. K.S. Krishnan and Sh. S.R. Bapat.

(iv) *Eleventh All-India Dairy Industry Conference held at Jaipur in March, 1974.*

Shri B. Marutiram and Shri J.P. Jain.

(v) *First Annual Conference of Agricultural Research Statisticians and the 27th Annual Conference of the Indian Society of Agricultural Statistics held at the Institute of Agricultural Research Statistics, New Delhi in April, 1974.*

Almost all the Officers of the Institute.

(vi) *Thirteenth Annual Workshop of Wheat Research Workers held at the Punjab Agricultural University, Ludhiana in September, 1974.*

Shri K.S. Krishnan.

(vii) *Symposium on "Problems of increasing potato production in the plains and hills of India" held at the C.P.R.I., Simla on the occasion of its Silver Jubilee anniversary in September, 1974.*

Dr. D. Singh.

(viii) *Seminar on "Current Researches in Animal Breeding" held at the National Dairy Research Institute, Karnal in October, 1974.*

Dr. P. Narain.

(ix) *Seminar on "Data Base of Indian Economy (Demographic Data)" held at the Indian Statistical Institute, New Delhi in December, 1974.*

Shri T. Jacob.

(x) *FAI, FAO Seminar on "Optimising agricultural production under limited availability of fertilizers" held at New Delhi in December. 1974.*

Dr. D. Singh and Shri S.K. Raheja.

(xi) *International Symposium on "Recent Trends of Research in Statistics" held at the Indian Statistical Institute, Calcutta in December, 1974.*

Dr. D. Singh and Shri A.K. Srivastava.

(xii) *34th Annual Conference of the Indian Society of Agricultural Economics held at the Punjab-rao Krishi Vidyapeeth, Akola in December, 1974.*

Dr. R.K. Pandey.

(xiii) *28th Annual Conference of the Indian Society of Agricultural Statistics held at the Haryana Agricultural University, Hissar from 31st December, 1974 to 2nd January, 1975.*

Dr. D. Singh, Dr. P. Narain, Shri K.C. Raut, Dr. B.B.P.S. Goel, Dr. R.K. Pandey, Shri S.C. Rai, Shri R. Singh and Shri Padam Singh.

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

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

(i) *Workshop of Dry Land Project held at Hyderabad in February, 1974.*

MAHAPATRA, I.C., KRISHNAN, K.S., BAPAT, S.R. AND SINGH, MAHENDRA. Results of research on dry land.

(ii) *Seventh Annual Workshop of the All-India Co-ordinated Agronomic Research Project held at the Rajendra Agricultural University, Ranchi in March, 1974.*

MAHAPATRA, I.C., GOSWAMI, N.N., KRISHNAN, K.S., *et al.* Annua Report of the All-India Co ordinated Agronomic Research Project for the year 1972-73.

(iii) *First Annual Conference of Agricultural Research Statisticians held at the Institute of Agricultural Research Statistics, New Delhi in April. 1974.*

1. KRISHNAN, K.S. Recent trends in the designing and analysis of agricultural field experiments.
2. MARUTIRAM, B. Design and analysis of experiments in animal sciences research.
3. NARAIN, P. Statistical techniques in animal breeding.
4. NARAIN, P. Teaching of Statistics in Agricultural Institutes and Universities.
5. PILLAI, S.S. The Computer in agricultural research.
6. RAHEJA, S.K. Computer aided teaching and training.
7. SINGH, D. Applied research in sample survey techniques.

(iv) *27th Annual Conference of the Indian Society of Agricultural Statistics held at the Institute of Agricultural Research Statistics, New Delhi in April, 1974.*

1. AMDEKAR, S.J. AND RAHEJA, S.K. Study of low response of high yielding varieties of rice and wheat to fertilizers under farmers' conditions.

2. BIYANI, S.H. An investigation on the maximum number of factors in confounded factorials.

3. BOHRA, R.K. Pre-harvest fore-cast of forage production in a pasture of dicanthium annulatum.

4. DEY, A. Some results on balanced designs.

5. GEORGE, K.C. AND NARAIN, P. Correlations between relatives in inbred populations.

6. GOEL, B.B.P.S. AND SINGH, D. On the formation of clusters.

7. GUPTA, V.K. Some empirical studies on comparing sample mean, ratio and regression estimators of mean of finite populations through Monte Carlo methods.

8. KUMAR, PRANESH AND AVADHANI, M.S. On the efficiency of the combined ratio estimator under a simple size stratification and its application to successive sampling on two occasions.

9. MARUTIRAM, B., NADKARNI, U.G., SOMAYAZULU, L.B.S. AND JAIN, T.B. Commercial poultry production in relation to capital.

10. MARUTIRAM, B. Some properties in estimation of true class effects in p x q classification with disproportionate cell frequencies.

11. MARUTIRAM, B. Analysis of covariance in two-way classification with disproportionate cell frequencies.

12 MURTY, V.V.R., MAINI, J.S., SINGH, K.B. AND BASSI, G.S. A study of quality of statistics of slaughter in registered slaughter houses and estimation of annual meat production through random sampling techniques.

13. NIGAM, A.K. On some balanced row-designs.

14. PILLAI, S.S. AND RAUT, K.C. Feeding animals in milk under village conditions for economic returns.

15. RAI, S.C. A model for rank analysis in triad comparisons.

16. RAUT, K.C. Nutritional status of milch buffaloes under village conditions.

17. RAUT, K.C. AND SINGH, SHIVTAR. Effect of preceding dry period on calving interval.

18. SADASIVAN, G. AND GEORGE, M.V. Some contributions to the theory of sampling in stages.

19. SADASIVAN, G. AND AGARWAL, R. Optimum points of stratification in multi-dimensional populations.

20. SADASIVAN, G. AND SRINATH, M. Some contributions to post cluster sampling.

21. SADASIVAN, G. AND ZACHARIAH, S. A new test for outlying observations.

22. SESHAGIRI, A., DAS, M.N. AND DEY, A. Some incomplete block designs for parallel line essays.

23. SETHUMADHAVI, R. AND RAJAGOPALAN, M. Use of pps with 3-P sampling procedures.

24. SHARMA, SUKHDEV. On a class of probability sampling schemes.

25. SINGH, PADAM AND SINGH, R. A sampling scheme with varying probability without replacement.

26. SINGH, R. On inclusion of some units in the sample with certainty.

27. SRIVASTAVA, V.C. AND DEY, A. On a method of construction of balanced ternary designs.

(v) *Thirteenth Annual Workshop of Wheat Research Workers held at the Punjab Agricultural University, Ludhiana in September, 1974.*

MAHAPATRA, I.C., BAPAT, S.R. AND SINGH, MAHENDRA. Wheat yields in relation to fertilizer requirements in dry land on cultivators' fields.

(vi) *Workshop of Potato Research Workers held at Simla in September, 1974.*

SINGH, D., KRISHNAN, K.S. AND BHARGAVA, P.N. The effects of cultural factors on yield rates of potato.

(vii) *Seminar on "Current Researches in Animal Breeding" held at the N.D.R.I., Karnal in October, 1974.*

NARAIN, P. A new size index with multiple characters.

(viii) *FAO Seminar on "International Expert Consultation on the use of improved technology for food production in rainfed areas of Tropical Areas" held at Hyderabad in November, 1974.*

MAHAPATRA, I.C., BAPAT, S.R. AND SINGH, MAHENDRA. Use of technology by farmers in semi-arid tropics of India.

(ix) *International Symposium on "Recent trends of research in Statistics" held at the Indian Statistical Institute, Calcutta in December, 1974.*

NARAIN, P. The multi-dimensional conditioned diffusion equation with applications in genetics.

SINGH, D. AND SRIVASTAVA, A.K. Successive sampling and its application.

(x) *34th Annual Conference of the Indian Society of Agricultural Economics held at the Punjabrao Krishi Vidyapeeth, Akola in December, 1974.*

1. CHAWLA, J.S. AND PANDEY, R.K. Impact of commercial crops on farm income and investment—A case study in Sangrur District.

2. PANDEY, R.K. AND DIXIT, U.N. Inter-temporal analysis of productivity and wages of farm labour in Ferozepur District.

(xi) *28th Annual Conference of the Indian Society of Agricultural Statistics held at the Haryana Agricultural University, Hissar from 31st December, 1974 to 2nd January, 1975.*

1. BHAGAN, SRINAVAN AND MANWANI, A.H. Monte Carlo studies for comparing sampling mean ratio and regression estimator in sample surveys.

2. GEORGE, K.C. AND NARAIN, P. I.T.O. method for determining correlation between relatives in random mating population involving multiple alleles.

3. GOEL, B.B.P.S. AND SINGH, D. Efficiency of cluster sampling; subclusters of CAS system.

4. GOPALAN, R., MARUTIRAM, B. AND SRIVASTAVA, A.K. Comparative performance of Rambouillet x local in Jammu & Kashmir.

5. GUPTA, S.C. AND RAI, S.C. Rank analysis in paired comparisons.

6. JACOB, T. AND MARUTIRAM, B. Productivity of feed with respect to egg production under commercial management conditions.

7. KAISTHA, A.C., BANERJEE, A.K. AND RAI, S.C. Trends in yield rates of maize in India during the first three Five Year Plans.

8. KAISTHA, A.C. Impact of the first three Five Year Plans on the yield rates of various food crops in the State of Bihar.

9. MANWANI, A.H. AND SINGH, K.B. Studies in systematic sampling for estimating the production of guava.

10. RAI, S.C. AND GUPTA, S.C. On a model for rank analysis.

11. RAUT, K.C. AND SINGH, SHIVTAR. Some information on mortality among milch animals under village conditions.

12. SETHI, A.S. AND GARG, J.N. A procedure for estimating pepper production.

13. SINGH, BHAGAT AND MANWANI, A.H. Methodological problems for estimating the cost of cultivation of apples.

14. SINGH, BHAGAT AND SINGH, JAGMOHAN. Basic unit of measurement in the cost of cultivation of apples—Area or a tree.

15. SINGH, PADAM. On sampling with varying probabilities.

16. SINGH, R. AND SINGH, H.P. Statistical studies on some economical traits of Indian buffaloes.

17. SINGH, SHIVTAR AND RUSTOGI, R.L. Calf rearing in rural areas.

18. SRINATH, M. AND SRIVASTAVA, A.K. On estimation of multiple characters.

19. TYAGI, K.K. AND RAI, S.C. Impact of tube-well irrigation on agriculture in Meerut district.

(xii) *Symposium on "Recent developments in statistical genetics in relation to plant and animal breeding" held at Hissar in December, 1974. (during the 28th Annual Conference of the Indian Society of Agricultural Statistics).*

NARAIN, P. On theory of limits to artificial selection and average time taken to attain them.

(xiii) *Symposium on "Planning agricultural development under constraints in India" held at Hissar in December, 1974 (during the 28th Annual Conference of the Indian Society of Agricultural Statistics).*

PANDEY, R.K., NIGAM, A.K., MITTAL, M.G. AND SINGH, D. Maximisation of crop response under resource constraints.

12. FIRST ANNUAL CONFERENCE OF AGRICULTURAL RESEARCH STATISTICIANS.

As mentioned in the earlier reports for the years 1971, 1972 and 1973, an Achievement Audit Committee was set up by the I.C.A.R. in May, 1971 to examine the working of the Institute. In its report based on an assessment of the research work, staffing pattern, etc. of the Institute during the period 1966-71, the Committee *inter alia* recommended that the collaboration between the research statisticians of the Institute and those employed in the other Research Institutes of the I.C.A.R., Agricultural Universities and State Departments of Agriculture and Animal Husbandry should be greatly improved upon. The Committee suggested that periodical meetings and conferences, at least once in each year, might be held for the purpose. It was in pursuance of this recommendation that the First Annual Conference of Agricultural Research Statisticians was organised at the Institute from 25th to 28th of April, 1974 with a view to providing opportunities to agricultural research statisticians to exchange ideas among themselves. The Conference was organised jointly with the 27th Annual Conference of the Indian Society of Agricultural Statistics. In all, 153 delegates comprising scientists, experts, statisticians and research workers in the field of agricultural statistics drawn from all over India and belonging to various official and non-official organisations in the country, participated in the Conference.

The inaugural session was held on 25th April, 1974 under the chairmanship of Dr. M.S. Swaminathan, Director General, I.C.A.R. Shri A.P. Shinde, Union Minister of State for Agriculture delivered the inaugural address. The six technical sessions that followed were presided over by experts in the field of agricultural statistics. The first session on "Design and Analysis of Experiments" was presided over by Dr. P.N. Saxena; the second on "Sample Survey Techniques", by Prof. A.R. Kamat; the third on "Use of Computer in Agricultural and Animal Sciences Research", by Sh. V.R. Rao; the fourth on "Statistical Techniques in Plant and Animal Breeding", by Shri V.N. Amble; the fifth on "Teaching of Statistics in Agricultural Institutes and Universities", by Dr. O.P. Srivastava; and the sixth on "Research Facilities", by Dr. D. Singh. The plenary session was held under the chairmanship of Dr. B.K. Soni, Deputy Director General, I.C.A.R.

There were altogether 14 technical papers contributed by Statisticians with specialisation in their respective fields in the above-mentioned technical sessions.

A number of recommendations for improving research and training in the field of agricultural statistics emerged from the discussions at the technical and the plenary sessions. The contributed papers, the inaugural address and a summary of the discussions at the technical and the plenary sessions along with the recommendations made at these sessions are given in a publication titled "First Annual Conference of Agricultural Research Statisticians (25th to 28th April, 1974)—Contributed Papers and Proceedings" brought out by the Institute during the year under report.

13. PUBLICATIONS

During the year under report, forty-three papers by the officers, members of staff and research students of the Institute were published in standard journals, etc. A list of these papers is given as Appendix V. Also, seventeen papers were accepted for publication in different journals during the year. A list of these papers is given as Appendix VI.

The technical reports, etc. mentioned below were published as I.A.R.S. publications during the year under report.

1. LEELAVATHI, C.R., BAPAT, S.R. AND SINGH, D. *On the yardsticks of additional production from the use of fertilisers under dry farming conditions.*

Estimates of yardsticks of additional production from fertilizer use under dry farming conditions based on the data of experiments conducted on cultivators' fields in 20 selected districts located in different States showed that application of one unit of nitrogen at a moderate level of 25 kg. N/ha. gave additional production ranging from 10 to 14 tonnes per tonne of nitrogen in the case of cereals while phosphorus increased the production by 12 to 17 tonnes per tonne of P_2O_5 and potassium by 3 to 6 tonnes per tonne of K_2O on equal nutrient bases. On gram, a moderate level of 15 kg N/ha or 30 kg. P_2O_5/ha increases the production per unit application of these nutrients by about 8 units. The average response to application of 20 kg. N/ha or 40 kg. P_2O_5/ha of groundnut were of the order of 5 to 6 units.

2. PILLAI, S.S. *The Computer in Agricultural Research.*

This paper gives an overview of the computer applications in the field of agriculture and animal husbandry research in India. Starting with the conventional method of statistical analysis of large scale survey data to electronic data processing, the Computer Centre has progressively used this modern tool for deeper and sophisticated statistical analysis. The use of computer in agricultural economics, soil survey studies, survey data analysis, plant breeding, genetics, and students' research has been elaborated.

3. PILLAI, S.S. *The Computer in Student's Research at the Institute of Agricultural Research Statistics.*

The installation of an electronic computer at I.A.R.S. has opened up vast opportunities to the student community doing research in agriculture and animal

husbandry. The students use computer in analysis of experimental data, obtaining lay-outs of experiments, analysis of survey data, evolving efficient designs and estimators, simulation studies in agricultural economics and genetics, and in analysis of data in animal husbandry research. The paper presents the fields in which the student community has used the computer facility to conduct deeper and sophisticated analysis of research data.

4. RAHEJA, S.K., GOEL, B.B.P.S., BANERJEE, A.K., MEHROTRA, P.C. AND RUSTOGI, V.S. *Annual Report of Sample Surveys for Assessment of High Yielding Varieties Programme for 1971-72; Volume-I– Results of yield estimation surveys.*

5. SINGH, D., GOEL, B.B.P.S., GARG, J.N. AND SUBBARAO, D.V. *Monograph on sample survey techniques for estimation of egg production.*

This Monograph summarizes the sampling techniques adopted in the pilot sample survey for estimation of egg production and study of poultry practices conducted by the Institute and gives the details of the methodology developed from these pilot studies. The main results of all the surveys conducted by the Institute as well as some of those conducted by the States have been included

The average egg production for non-exotic hens per year varied from 66 eggs per hen per year in Gujarat to 135 per hen per year in Karnataka. In the hilly State of Himachal Pradesh also it was quite low, viz., 68 eggs per hen per year. In other States, the production varied from 93 eggs per hen per year in Kerala to 123 eggs per hen per year in Andhra Pradesh and Tamil Nadu.

Total egg production in the country from poultry during the year 1966 was estimated at 4698 million of which 3676 million (78.2 per cent) was from non-exotic hens and the remaining from other birds, viz., exotic fowls, ducks, turkeys and geese, etc., which account for about 22.5 per cent of total layers in the country during the year 1966.

The per capita availability of eggs during the year 1966 was the highest in Kerala State (19 eggs) followed by Karnataka (17 eggs) and Tamil Nadu (15 eggs). The per capita availability was the lowest in the States of Haryana, Gujarat, Rajasthan and Uttar Pradesh where only two eggs per capita were available during the year. The per capita availability in Himachal Pradesh, Bihar, Madhya Pradesh and Punjab was also quite low where 3 to 5 eggs per head per year were available. In the States of Andhra Pradesh and West Bengal the per capita availability in the year was 10 and 11 eggs respectively and thus the availability in these areas was comparatively higher than the corresponding all India figure of 8 eggs per head.

6. SINGH, H.P., SINGH, PADAM AND JHA, M.P. *Pre-harvest forecasting of yield of jute (1970-71 to 1973-74)—A consolidated report.*

7. *Compendia of the National Index of Agricultural Field Experiments for North Eastern Region, West Bengal, Kerala, and Tamil Nadu, 1960-65.*

8. *The First Annual Conference of Agricultural Research Statisticians (25th to 28th April, 1974)—Contributed papers and proceedings.*

The following monographs, etc. were finalized/under print for publication.

1. BHARGAVA, P.N., NARAIN, P. AND SAKSENA, ASHA. A monograph on the study of crop weather relationship.

2. RAHEJA, S.K., GOEL, B.B.P.S., BANERJEE, A.K., MEHROTRA, P.C. AND RUSTOGI, V.S. Annual Report of Sample Surveys for Assessment of High Yielding Varieties Programme for 1971-72: Volume II—Results of A.A.E. Enquiry.

3. RAUT, K.C., SINGH, D. AND SINGH, SHIVTAR. Estimation of availability and cost of production of milk (Krishna Delta Area, Andhra Pradesh).

4. SINGH, D., BHARGAVA, P.N., KHOSLA, R.K. AND SAKSENA, ASHA. A monograph on the study of size and shape of plots for field experiments on vegetable and perennial crops.

5. Compendia of the National Index of Agricultural Field Experiments for Karnataka, Andhra Pradesh, Maharashtra and Madhya Pradesh, 1960-65.

14. SUMMARY OF THE REPORT

14.1 Statistical Research in Crop Sciences.

14.1.1 Statistical analysis of data relating to complex experiments conducted at Model Agronomic Research Centres under the All India Coordinated Agronomic Research Project.

Statistical analysis of data of about 600 experiments conducted during the year 1973-74 at 45 Model Agronomic Centres as per the technical programme decided at the Annual Workshop of the Project was carried out during the year under report. In long term experiments, combined analysis over years was also carried out for the centres where 3-year cycles were completed.

In the production potential experiments for developing cropping patterns suitable for the regions, suitable high intensity crop sequences including cereals and pulses were identified at 15 centres where grain yields of over 10 tonnes/ha. were obtained. The highest annual yield of 18 tonnes/ha. was obtained at Mangalore with rice-rice-rice rotation. Also, in an experiment to develop an intensive farming system for small holders, the scope for high profits from small holdings of size one hectare was established at a number of centres. The net income from one hectare holding was assessed as Rs. 9089 at Pantnagar, Rs. 7140 at Navsari and between Rs. 3000 and Rs. 6000 at six other centres. Inter-cropping with legumes such as green gram, black gram, cowpea, soyabean and groundnut generally increased the yield of the principal *arhar* crop at five centres, while at Akola, inter-cropping with green gram in cotton was more profitable as compared to pure stand of cotton by about 38 per cent.

Significant direct as well as residual responses to farmyard manure were established through long term experiments conducted in a number of centres. At Ludhiana, application of F.Y.M. at 15 tonnes/ha in kharif season benefited not only the maize crop grown in that season but also the ensuing wheat crop, which increased the annual grain yield by about 25 q/ha. In an experiment designed to screen pre-release varieties for their fertilizer responsiveness, significant interaction of varieties and nitrogen application was established at a number of centres. For instance, at Maruteru, at moderate levels of nitrogen (60 kg. N/ha.), Pankaj gave the highest yield in kharif, while RP-4-14 did so during rabi.

Maintenance of the field free from weeds resulted in higher yields (14 to 18 q/ha) of Bala variety of rice-drill sown and grown under unirrigated conditions. At Kalyani and Chiplima, the responses to hand weeding 3-6 weeks after sowing were respectively 65 and 58 per cent of those to weed-free check. Among the test herbicides, the best response was obtained to the application of Tok-E-25 at 3 kg ai/ha applied in split dose 10 and 20 days after germination (at Kalyani) and applied in single dose 7 days after germination (at Chiplima). In an experiment on transplanted unirrigated rice conducted at Chiplima, best performance was obtained with Machete granule at 1.0 kg ai/ha applied 8 days after transplanting. At Bhubaneswar, a higher dose of 1.5 kg ai/ha gave the best response of about 21 q/ha.

14.1.2 Statistical analysis of data of simple experiments conducted on cultivators' fields under the All-India Co-ordinated Agronomic Research Project.

Data of about 7,630 simple experiments conducted on cultivators' fields during the year 1973-74 in 56 districts spread over different soil and agro-climatic regions of the country as per the technical programme decided at the Annual Workshop of the Project were statistically analysed during the year under report. For such experiments as had completed three years, combined analysis over years was also carried out.

It was seen that, under irrigated conditions, the response of kharif rice to $N_{80}P_{60}K_{60}$ exceeded 15 q/ha in 10 districts, namely, Kangra, Midnapore, Jammu, Mysore, Champaran, Bilaspur, Banda, Karimnagar, Bulsar and Goa—the response exceeded even 20 q/ha in the first two districts. In case of rabi rice, the response exceeded 15 q/ha in four districts, namely, Mysore, Goa, Balasore and Midnapore. A high response of 22.8 q/ha was obtained in Mysore. Moderate to good response of rice to potassium at the higher level of 90 kg K_2O/ha when applied over adequate levels of N and P was obtained in some districts of Karnataka, Andhra Pradesh, Tripura, Orissa, West Bengal, Goa, Pondicherry and Bihar. In case of high yielding varieties of wheat, an average response of 15 q/ha to $N_{80}P_{60}K_{60}$ was obtained in 7 districts, namely, Jammu, Fatehpur, Bulandshahr, Sehore, Rohtak, Delhi and Patna.

Under rainfed/dry conditions, the response to $N_{60}P_{40}K_{30}$ exceeded 10 q/ha for rice in Rewa, Mayurbhanj, Dhenkanal, and Ramanathapuram, for wheat in Rewa and Hoshiarpur, for jowar in Kurnool, Dharwar and Jhalawar and for maize in Gaya and Hoshiarpur. Significant response of about 2 q/ha to potassium

at 30 kg K_2O/ha was obtained for rice, wheat, jowar and bajra in quite a few districts.

14.1.3 Analysis of data relating to irrigation experiments.

During the year under report, data pertaining to 400 experiments on irrigation, irrigation-cum-manuring, irrigation-cum-varietal, irrigation-cum-cultural practices, etc. for the period 1960-61 to 1971-72 in respect of wheat crop were analysed and the results in regard to the various irrigation factors influencing the yield were summarised variety group-wise and soil type-wise.

It was seen that, in medium soils, tall aesytivum varieties gave significant responses (2.5 and 2.3 q/ha respectively) for the first and the second irrigations, while in case of both double and triple dwarf varieties, substantial increases in the yield rates were obtained for every rise in the frequency of irrigation upto five. The response to the first irrigation was the highest (6.4 q/ha) for double dwarf gene varieties. In heavy soils, the highest response (3.3 q/ha) for the first irrigation was observed for durum tall varieties.

To obtain good yield rates, at least two irrigations, one at crown root initiation stage and the other at flowering stage, were essential in case of triple gene varieties in light soils, while, in medium soils, aesytivum tall varieties needed three irrigations, one each at tillering, jointing, and heading stages. Appropriate stages of three irrigations for single dwarf varieties were crown root initiation, tillering and flowering. Double dwarf gene varieties needed five irrigations, one each at the stages of crown root initiation, tillering, flowering, milk and dough for maximum yield, while in case of triple dwarf gene varieties, good yield rates were obtained with four irrigations one each at crown root initiation, late tillering, jointing and flowering stages.

Irrigation at 20 per cent soil moisture was adequate for aesytivum tall varieties grown in medium soils, while, in heavy soils, irrigation at 30 per cent soil moisture gave the highest yield. For dwarf varieties (single and double gene) grown in medium soils, irrigation at soil moisture varying from 40 to 50 per cent was needed. In heavy soils, irrigation even to the extent of 75 per cent soil moisture level was found to be useful.

14.1.4 Evaluation of yard-sticks of additional production from the use of various developmental measures.

Data of nearly 3000 experiments on cultivators' fields on cereals, gram and groundnut during the years 1969-72 were collected and analysed during the year

under report. The yardsticks of additional production from the use of fertilizers under dry farming conditions were evaluated at 25 and 50 kg N/ha, 25 kg P_2O_5/ha and 25 kg. K_2O/ha for cereals, 15 and 30 kg N/ha, 30 and 60 kg P_2O_5/ha and 30 kg K_2O/ha for gram and 20 and 40 kg N/ha, 40 and 80 kg P_2O_5/ha and 40 kg K_2O/ha for groundnut.

The estimates of yardsticks of additional production for Bala variety of rice in Hazaribagh and Mayurbhanj districts were 13-17 tonnes/tonne of nitrogen at 25 kg. N/ha and 11-17 tonnes/tonne of nitrogen at 50 kg. N/ha, while in Jabalpur district these were 17 units at the higher dose for both Bala and locally improved tall varieties and 20 units at the lower dose for the latter. Application of phosphorus to rice at 25 kg. P_2O_5/ha resulted in additional production of 25-28 tonnes/tonne of P_2O_5 in Jabalpur and Mayurbhanj districts. While Bala gave additional production of 6-7 tonnes/tonne of K_2O, the locally improved tall varieties showed variation between 3 to 11 units in the different districts.

The yardsticks of additional prodution for Kalyana Sona variety of wheat in Ambala and Gaya districts varied between 9 to 11 tonnes/tonne of nitrogen at the lower dose and were 11 units at the higher dose. Estimates for the locally improved varieties in Hoshiarpur district were as high as 21 units and 17 units respectively for the two doses, while in the remaining districts these varied between 7 to 11 units. The additional production from the use of phosphorus was about 20 tonnes/tonne of P_2O_5 for both Kalyana Sona and the locally improved tall varieties in Ambala district and between 13 to 15 nnits for Kalyana Sona in Gaya and for the locally improved tall varieties of wheat in Gwalior, Jaipur and Hoshiarpur districts- While Kalyana Sona gave additional production of about 4 tonnes/tonne of K_2O, the locally improved tall varieties showed variation between 1 to 6 units in the different districts.

The yardsticks of additional productional of jowar, maize and bajra for the three nutrients showed considerable variation from district to district for the different varieties.

Higher yardsticks of additional production, i.e., 10-13 tonnes/tonne of nitrogen, were obtained for G-2 variety of gram in Gwalior as compared to 5-6 units for the local variety in Panch Mahal and Allahabad districts. Additional production for these varieties per tonne of P_2O_5 was between 4 to 9 tonnes, while it was 1 to 6 tonnes per tonne of K_2O.

The yardsticks of additional production for AK-12-24 variety of groundnut were higher, i.e. 6-11 tonnes/tonne of nitrogen, 6-13 tonnes/tonne of P_2O_5 and

about 4 tonnes/tonne of K_2O in Koraput and Mayurbhanj districts as compared to 6-8 tonnes/tonne of nitrogen, 4-6 tonnes/tonne of P_2O_5 and 2 tonnes/tonne of K_2O for the local variety in Bijapur district. Those for TMV varieties were low in Kurnool and Ramanathapurm districts.

14.1.5 National Index of Agricultural Field Experiments

During the year under report, data of about 2800 experiments conducted since 1961 were received from the regional staff posted in different centres in the country. Analysis of about 980 experiments and of 380 groups of experiments conducted during the period 1960-65 was undertaken during the year. The compendia volumes for the third series for the period 1960-65 in respect of Gujarat, Rajasthan, Orissa, Eastern Region, Kerala and Tamil Nadu were received from the press and printing was practically completed for Mysore, West Bengal, Andhra Pradesh and Madhya Pradesh. The printing of the experimental data for Maharashtra and the processing of the experimental data for Bihar and Uttar Pradesh were in progress. Also, Volume II of the Index of Agricultural Field Experiments was printed, while the material for Volume III of the Index was being prepared.

14.1.6 Crop weather relationship studies

The objective of the project was to study the effect of rainfall on crop production and the behaviour of rainfall. Data on daily rainfall for Jalgaon district for the period 1946-71 were collected from the Meteorological Department, Poona for the study.

It was seen that there was high variation in the monthly rainfall for the months of June and September, while it was low for the months of July and August. As the period was reduced to 20 days, the variation increased for each of the intervals. The distribution of rainfall for the months of July and August could be described by a normal curve while the distribution for the months of June and September was normalised by the application of a suitable logarithmic transformation. In respect of the periods of 20 days, it was seen that the distribution for the period Ist June to 20th June followed a normal distribution after transformation of the data on logarithmic scale, while for the remaining periods, the distribution was either normal or could be normalised by transforming the data to the square root scale. The study of the pattern and behaviour of rainfall through a stochastic model was continued during the year. Preliminary results showed that the weather of a particular day is independent of the weather of the previous day.

14.1.7 Pilot studies on pre-harvest forecasting of crop yield—Jute, Cotton, Paddy and Wheat.

A combined analysis of the data on jute collected from Bihar and West Bengal during the years 1970-74 was carried out and a consolidated report was prepared. It was seen that multiple correlation coefficients were generally significant. The contribution to the amount of variation in yield explained by the regression equation was found to range from 30 to 50 per cent in different periods and years. The partial regression coefficients of fibre yield with the plant population were found significant in all cases, while significance with height of the plant was observed in about 75% of the cases and with the basal diameter, only in rare cases. It was seen that 80 to 90 per cent of the total variation due to regression was explained by the plant population. Plant height increased the contribution, while basal diameter did not appear to have much contribution in the regression analysis. It was also seen that there was no appreciable gain by transforming data under different models. The suitable time for pre-harvest forecasting of jute yield based on biometrical characters appeared to be about 2 months before harvest of the crop or when the crop is about 2-3 months old.

Analysis of the data on cotton collected from Jalgaon and Baroda centres revealed that the biometrical characters influencing the yield are plant population and number of bolls per plant. The addition of the first picking yield in the regression equation improved the forecast considerably.

Statistical analysis of the data on paddy and wheat showed that the characters contributing to most of the variation in yield explained by the regression equation are the plant population and the number of tillers per plant. The suitable time for forecasting appeared to be about 2 to 3 months of sowing/transplanting.

14.2 Statistical research in animal sciences.

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

It was mentioned in the Annual Report for the year 1973 that analysis of the data received from the Regional Poultry Farm, Bhopal under the Co-ordinated Poultry Breeding Programme of the Government of Madhya Pradesh in respect of the foundation stock and the first generation of birds of selected parents showed that, on account of a decrease in heritability of rate of lay due to selection, the average rate of lay in the first generation was higher than that of parental generation by about 7%.

During the year under report, the data on the performance of the progenies obtained on selecting the birds on the basis of an index for rate of lay computed for the second generation were received and analysed critically. The selection scores of the birds were calculated separately for males as well as for females and were sent to the Farm for selecting the birds for propagating the third generation.

An analysis of the data collected during the laying periods of the year 1971-72 was also conducted with a view to studying the distribution of scores of birds based on different selection indices. Selection scores were worked out for each bird, using three methods of selection, viz., (a) selection on the basis of an index with optimum weights attached to the individual's performance and its full-sib family average, (b) selection on the basis of an index with optimum weights attached to the individual's performance and its half-sib family average and (c) selection on the basis of an index with optimum weights attached to individual's performance, full-sib family average and half-sib family average. For each of the three cases, suitable frequency distribution was fitted. For the scores based on the methods (a) and (b), Pearsonian Type I was found to be the proper distribution, whereas for the scores based on the method (c), normal distribution was found to be the appropriate one. The distribution of selection scores appeared to tend to normality as the information from more than two sources was combined. The variability for the scores was also found to increase when information from both the half-sib as well as full-sib families was combined with the individual's performance. It appeared that the selection based on the method (c) could be better exploited than that based on either of the methods (a) or (b).

14.2.2 Measurement of genetic improvement due to scientific breeding in cattle and buffaloes.

The data on the cross-bred cattle of nine Military Dairy Farms for the period 1934-55 consisting mostly of the crosses (i) Sahiwal x Friesian, (ii) Sindhi x Friesian and (iii) Sahiwal x Ayrshire x Friesian were analysed, using Harvey's technique of analysis of non-orthogonal data. It was observed that effects of farms and grades were highly significant in respect of several characters.

Further analysis of the data was in progress.

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

The objective of the project was to study the efficiency of selection on the basis of part time production and to estimate heritability of important characters

such as annual egg. production, age at maturity, weight at maturity, etc. as well as to explore the possibilities of estimating genetic correlations between these characters.

Some results of the analysis of the data collected at the Trivendrum Centre in Kerala under the Scheme for Improvement of Poultry through Family Selection were reported in the Annual Report for the year 1972, while results of investigations into the comparative efficiency of a new selection index developed for improvement of poultry and the problem of optimum structure of poultry breeding population when selection was based on that index were given in the Annual Report for the year 1973.

During the year under report, the data collected on White Leghorn under the above-mentioned Scheme at the Katpadi Centre in Tamil Nadu were scrutinised. Heritabilities and genetic correlations were estimated by intra-sire regression of progeny on dam as well as by the method of sib analysis Relationship between part time production and total production was studied, using regression technique. The correlation between part time production and total production was estimated to be of the order + 0.4.

Further analysis of the data was in progress.

14.2.4 Study of comparative performance of different grades of cross-bred cattle under village conditions.

Results of a preliminary analysis of the data obtained from the Vishakhapatnam Centre in Andhra Pradesh were reported in the Annual Report for 1973. The data for the study made during the year under report were obtained from the Centres at Chalakudy and Neyyattinkara in Kerala State. The data pertained to the period 1955-1974.

A perliminary analysis of the data showed that the cross-bred animals gave a significantly higher yield and had a longer lactation length than the local animals in all the lactations. Among the different grades of cross-bred cattle, 3/4 Jersey animals gave a significantly higher lactation yield in their first lactation than half-bred animals, while differences in respect of lactation length were not significant. The proportion of abnormal calvings was significantly different among local and cross-bred animals, while it was of the same order among the various grades of cross-bred animals. In general, the mortality rate was comparatively higher among local cattle than in half-bred animals in all the categories.

Further analysis of the data was in progress.

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

The field work of the survey in Dhulia region of Maharashtra was begun in December, 1969. After the completion of detailed enquiry in February, 1972, collection of data for building up an appropriate index of cost of production of milk was initiated in the area in March, 1972 and was completed in February, 1974.

It was found that the over-all daily production of milk in the area was 298 tonnes, of which as much as 76 per cent was accounted for by buffalo milk. The average daily milk yield of a buffalo in milk was about 3 5 kg. as compared to only 1 kg. of a cow in milk. In commercial milk producer households, the cost per kilogram of buffalo milk was about Rs. 1.30, when family labour was included and Rs. 1.25, when it was excluded. The average maintenance cost of a milch buffalo was about Rs. 2.30 per day including family labour and Rs. 2.15 when it was excluded. The corresponding maintenance costs for a milch cow were Rs. 1.25 and Rs. 1.10 respectively. Feed was the major component of cost accounting for 80% of the gross cost.

The analysis of the data collected to build up an appropriate index of cost of production of milk remained in progress.

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

During the year under report, the data collected in the bench-mark survey conducted in the milk-shed areas of Dudhsagar Dairy, Mehsana (Gujarat) during 1967-68 were processed further for the study. It was found that the average daily milk yield per cow in milk was 2.1 kg. in the supplying area and 2.2 kg. in the non-supplying area. The corresponding averages for a buffalo in milk were 4.4 kg. and 3.8 kg. respectively. On an average, 200 tonnes of milk was produced per day, of which as much as 95% was contributed by buffaloes.

The average production cost of the two rabi food crops, viz., wheat and barley, ranged from Rs. 26 to Rs. 45 per quintal and that of the two kharif food crops, viz., *jowar* and *bajra*, from Rs. 16 to Rs. 27 per quintal. The average production cost for the two fodder crops, viz., *rizka* and *jowar*, ranged from Rs. 7 to Rs. 8 and from Rs. 4 to Rs. 5 per quintal respectively. The average cost of production of each crop was appreciably less than the market rate except in the case of *rizka*, where the two were more or less of the same order.

A milch cow was fed, on an average, 3.3 kg. of greens, 3.4 kg. of dry matter and 200 gms. of concentrates per day while a milch buffalo was given 9.0 kg. of greens, 8.1 kg. of dry matter and 980 gms. of concentrates per day. The cost of production of one kilogram of cow milk was about 80 paise in the supplying area and twice as much in the non-supplying area, when feed cost was evaluated on the basis of both market rates and cost of production rates. The corresponding figures for buffalo milk were 70 paise and 100 paise respectively. The prevailing market rates for sale of milk were 70 p/kg to 79 p/kg for cow milk and 78 p/kg to 95 p/kg for buffalo milk.

On an average, a family consisted of seven persons, four adults and the others below 14 years of age. One out of two persons in a family was a worker. Non-milk producer families had, however, a lesser proportion of workers. In commercial milk producer households, 50 to 57 per cent of the workers were engaged in crop production, 30 to 37 per cent in milk production and the remaining in other vocations. The pattern of employment in private milk producer households was also the same with 55 to 64 per cent engaged in crop production and 25 to 34 per cent in milk production. On the other hand, in non-milk producer households, as many as 72 to 82 per cent of the workers had field work as their main occupation while about 5 to 8 per cent were engaged in each of the other three vocations, viz., trade, artisan work or skilled work. The average annual gross income of a commercial milk producer family was of the order of Rs. 7,600 in the supplying area and Rs. 6,500 in the non-supplying area. The corresponding estimates for a private milk producer family were Rs. 6,300 and Rs. 6,000 respectively, while those for a non-milk producer family were Rs. 1,600 and Rs. 1,700 respectively.

14.2.7 National Index of Animal Experiments.

During the year under report, data on 60 experiments on Animal Nutrition conducted at the National Dairy Research Institute, Karnal as well as data pertaining to general experimental conditions under which experiments on Animal Nutrition are conducted at the U.P. College of Veterinary Science and Animal Husbandry, Mathura were collected. Also, data pertaining to 120 experiments on Animal Nutrition conducted at this College were analysed and the results were compiled in the prescribed format.

In addition to the above studies, the data being collected for pilot studies for estimation of birth and death rates in bovines for preparation of life tables were scrutinized and processed. The field work of the repeat sample survey to study

the impact of milk supply schemes on rural economy in the milk-shed areas of the Dudhsagar Dairy, Mehsana (Gujarat) was completed in October, 1974, while about 90% of the data collected in the repeat survey conducted in the milk collection areas of the Delhi Milk Scheme during 1972-73 was transferred to punch cards by the end of the year under report. As regards the study of cost of poultry and egg production, statistical analysis of the data collected from about 130 farms in the Dasuya and Tanda regions of Hoshiarpur District of Punjab was completed, while the analysis of the data collected in the survey in Delhi and its surrounding areas was continued. Also, a project on design and analysis of experiments for studies on bovine semen metabolism was taken up during the year. Besides, preliminary work such as finalization of schedules and preparation of a hand-book of instructions for the field staff was completed in connection with a survey to study the impact of milk supply schemes on rural economy in the milk collection areas of the Madhavaram Milk Supply Scheme, Madras and the Greater Calcutta Milk Scheme, Calcutta with a view to develop a suitable assessment technique to evaluate the impact of urban milk supply schemes on rural economy in milk collection areas.

14.3 Sample Survey Investigations.

14.3.1 Sample surveys for assessment of the High Yielding Varieties Programme.

During the year under report, Volume II of the Annual Report of the Scheme for the year 1971-72 embodying the results of A.A.E. enquiry giving the area under the high yielding varieties of the five programme crops and the extent of adoption of the package of associated practices by cultivators was prepared. A brief summary of the results is given below.

(*a*) *Kharif, 1971-72*

The proportion of the area under the high yielding varieties of rice to the total area under rice was worked out for 36 districts in 11 States. It was found to be more than 55 per cent in Amritsar, Patiala, Gurdaspur and Ferozepur districts of Punjab and Cuttack district of Orissa, while it ranged between 20 to 42 per cent in 9 other districts and between 5 to 20 per cent in 16 other districts. In the remaining 6 districts, it was less than 5 per cent.

In case of the maize crop, the corresponding proportion was estimated for 21 districts covering 7 States. In Belgaum and Bijapur districts of Karnataka, about 80 per cent of the total area under maize was under HYV. In Amritsar and

Jullundur (Punjab), Faizabad and Kanpur (U.P.), Muzzaffarpur and Monghyr (Bihar) and Ambala (Haryana), the corresponding percentage ranged between 30 to 55, while in Basti and Gonda (U.P.), Chittorgarh (Rajasthan), Patiala (Punjab), Saharsa (Bihar) and Warrangal (A.P.), it ranged between 10 to 30. In the remaining districts, the area under HYV of maize was less than 10 per cent of the total area under the crop.

Out of the 13 districts covered for jowar in the States of Madhya Pradesh, Maharashtra, Karnataka and Rajasthan, it was seen that the area under HYV of jowar in Shimoga and Bellary (Karnataka), Mandsaur (M.P.) and Nagpur (Maharashtra) was about 67, 52, 37 and 34 per cent respectively of the area under the crop. In the districts of Wardha, Aurangabad, Bhir and Buldhana (Maharashtra), the corresponding percentage varied between 14 and 25; while in the remaining districts it varied from 7 to 10.

In case of bajra, the estimates were worked out for 18 districts in 8 States. It was observed that in Rajkot (Gujarat) and Nellore (A P.), about 75 and 59 per cent respectively of the total area under the crop was covered by HYV, while the corresponding percentage ranged from 25 to 46 in the districts of Kaira and Banaskantha (Gujarat), Hissar and Rohtak (Haryana), Coimbatore (T.N.) and Ferozepur and Sangrur (Punjab). In the remaining districts, this percentage was less than 25.

(*b*) *Rabi, 1971-72.*

The proportion of the area under the HYV of wheat to the total area under wheat was worked out for 35 districts in 9 States. It was more than 85 per cent in the districts of Jullundur, Patiala, and Amritsar (Punjab) and Faizabad (U.P.), while it ranged from 40 to 75 per cent in 16 other districts and from 13 to 39 per cent in the remaining 15 districts..

In case of rice, the corresponding proportion was estimated for 25 districts in the States of Andhra Pradesh, Kerala, Tamil Nadu, Karnataka, Orissa and West Bengal. It was 70 per cent or more in Kottayam and Trichur (Kerala), Guntur (A.P.) and Shimoga and Bellary (Karnataka) while it ranged between 40 to 67 per cent in the districts of East Godavri, Nellore and Chittoor (A.P.), Mallapuram and Ernakulam (Kerala), Coimbatore, Chingleput and Madurai (T.N.) and Mysore (Karnataka). In the remaining districts, it ranged between 6 and 37 per cent.

For the 6 districts covered for maize in the States of Andhra Pradesh and Karnataka, it was seen that the area under HYV of maize was 71 and 54 per cent

respectively of the total area under the crop in the districts of Bijapur and Mysore (Karnataka), while in the remaining 4 districts, the corresponding percentage ranged from 13 to 34.

The estimates for jowar were worked out for the district of Shimoga in Karnataka. Almost all of the area under the crop was under its HYV. In case of bajra, the corresponding estimates were made for 4 districts in Tamil Nadu and for the district of Bellary in Karnataka. About 78 per cent of the total area under bajra in Bellary was under its HYV while the percentage in the remaining 4 districts ranged between 8 and 36.

14.3.2 Pilot sample survey for evolving a technique for estimation of production of cultivated fodders.

During the year under report, the data collected during 1972-73 kharif and rabi in Meerut district of Uttar Pradesh were analysed. It was observed that the production of fodder crops could be estimated annually on the basis of crop cutting surveys as was being done for all principal crops.

14.3.3 Pilot sample survey for developing a sampling technique for estimation of production of fresh fruits in Tamil Nadu.

Statistical analysis of the data collected from all the districts of Tamil Nadu in the survey was carried out during the year under report and a report was under compilation. It was seen that the area under fresh fruits in the State during the agricultural year 1972-73 was 80.6 thousand hectares under regular orchards and 12.1 thousand hectares under stray plantation. While banana as well as mango accounted for nearly 44 per cent of the area each, citrus accounted for 5% only. The area under grapes was 800 hectares only. The number of banana plants, mango and citrus trees and grape vines was 75 million, 3 million, about 1.1 million and 1.4 million respectively. Young trees of fresh fruits other than banana constituted nearly 20% of the total number of trees in the State. The stray plantation was estimated at 6 million of which banana plants were 4.5 million, mango trees, 0.8 million and citrus trees, 0.5 million. The total number of orchards in the State was estimated at 261 thousand of which 156 thousand were of banana. Of the other orchards, 77 thousand had mango trees, 26 thousand, citrus fruit trees and 13 thousand, grape vines, while other fresh fruits were planted in as many as 23 thousand orchards. The average size of a banana orchard was 0 25 ha, and that of mango, 0 43 ha, while the average size of a grape vine-yard was extremely small, being only 0.06 ha.

The most important varieties of banana were Mauritius (38.3%), Hill plantain (22.1%), Povan (16.3%) and Rasthali (10.6%). Of the grafted varieties of mango, the most important ones were Neelam and Bangalore, each accounting for 35 per cent of the total number of mango trees of bearing age. The non-grafted local varieties accounted for 23 per cent. Among the citrus fruits, lime was the most important variety accounting for 44.5% of the total number of citrus trees of bearing age followed by sweet orange (27.4%) and other varieties put together (28%). The most important varieties of grapes were Muskat and Patchai-Draksha accounting for 55.4 per cent and 36.9 per cent respectively of the total number of bearing vines.

During 1972, on an average, a mango tree of bearing age yielded 283 fruits weighing 74 kg., while during 1973, it yielded 433 fruits weighing about 98 kg. The average yield (pooled for both the bearing seasons of 1972-73) per grape vine was 16.7 kg., the yield per hectare being 309 quintals. For citrus fruit, the pooled yield was found to vary considerably from variety to variety. Thus, while the average yield per lime tree was 243 fruits weighing 7.4 kg., that of a tree of sweet orange was 253 fruits weighing 20 kg.

The average distance between plants/trees was 2.26 meters in a banana orchard, 10.0 meters in a mango orchard and 5.1 meters in a citrus orchard. The percentage of orchards receiving irrigation was 96 for grapes, 86 for banana, 61 for citrus fruit and 24 for mango. The source of irrigation was mostly well. Fertilizer was applied to 71 per cent of banana, 23 per cent of grapes, 10 per cent of citrus fruit and 3 per cent of mango orchards. The most common fertilizer applied on mango was ammonium sulphate. On citrus fruit, ammonium sulphate, urea and other chemical mixtures were applied while the grape orchards mostly received urea. In the case of banana orchards, different fertilizers were applied in the form of mixtures. On an average, 3.3 kg. of ammonium sulphate was applied to a mango tree, 3.0 kg. of urea to a citrus fruit tree and 0.9 kg. of urea to a grapes vine pit containing 2-3 vines. The average rate of application of different fertilizers to banana varied between 0.2 to 0.5 kg. per plant.

It was seen that during the peak harvest season, the orchardist received, on an average, Rs. 3.60 to Rs. 6.00 per stalk of banana, Rs. 8 to Rs. 34 per 100 fruits of mango and Rs. 5.15 to Rs. 6.50 per 100 limes. The maximum price per 100 mango fruits varied between Rs. 10 and Rs. 50 and the minimum price between Rs. 5 and Rs. 18. The minimum price of Bangalore Blue variety of grapes was Rs. 125 a quintal and the maximum price Rs. 200 a quintal. Patchai-Draksha variety fetched Rs. 50 to Rs. 105 per quintal during the different seasons.

14.3.4 Methodology for estimation of milk production and other related studies in Northern Region of India.

Two sample surveys—one in the Northern region comprising Punjab, Haryana and Himachal Pradesh and the other in Andhra Pradesh of the Southern region—were conducted under the main project "Pilot sample surveys for developing an integrated technique for estimation of principal livestock products and study of of attendant animal husbandry practices". The field work in the former Centre was completed in 1972. In the second centre, data on wool and meat as main products were collected during the year under report, while data on production of egg as the principal product had been collected earlier in the year 1973 as mentioned in the Annual Report for the year 1973. Statistical studies on the data pertaining to milk production collected in the survey during the years 1969-72 were continued during the year under report and the results were presented in a report.

It was seen that the total milk production in the Northern region was 4565 thousand tonnes in 1969-70, 4857 thousand tonnes in 1970-71 and 4953 thousand tonnes in 1971-72 of which buffalo milk accounted for 77.5 per cent, 79.3 per cent and 80 per cent in the three years respectively. In case of buffaloes, season-wise estimates of milk production varied considerably. Milk production in case of cows was the highest during the rainy season and the lowest during summer, while in the case of buffaloes, the highest milk production was during winter and the lowest during the summer season.

During the year 1969-70, the per capita per day availability of milk in the region was 486 gms. of which 377 gms. was from buffaloes and 109 gms. from cows. The per capita per day availability increased to 505 gms. during the year 1971-72.

The results clearly demonstrated the feasibility of using the sampling methodology adopted for the investigation.

14.3.5 Sample survey for estimation of milk production and study of bovine keeping practices-Madha Pradesh (1966-67).

The survey was conducted in Madhya Pradesh during the year 1966-67 by the Auimal Husbandry Department of the State under the technical guidance of the Institute and covered the entire State.

It was estimated that the State had 5.09 million milch cattle and 2.26 million milch buffaloes in the year of the survey. The total milk produetion was 1,031

thousand tonnes of which 406 thousand tonnes was from cows. The various breeds of milch cows were Malvi (6.1%), Hariana (3.1%), Nimari (0.8%), and Golao (0.1%) and the rest were non-descript. In case of milch buffaloes, Murrah formed 6.2 per cent, the rest being non-descript. The average daily milk yield per cow in milk was 0.51 kg. (with a standard error of 6.1%) while tne corresponding estimate for a buffalo in milk was 1.70 kg. (with a standard error of 6.6%).

14.3.6 Preparation of a monograph on sample survey techniques for estimation of egg production.

The objective of the project was to publish the results of the various pilot and large scale sample surveys on estimation of egg production and study of poultry practices conducted by the Institute in the various States of the country as well as the details of the techniques evolved and recommended to the State Animal Husbandry/Veterinary Departments for collection of similar statistics in the respective States.

During the year under report, the results of analysis of the data collected in the past were consolidated. The monograph was finalized and was under print.

14.3.7 Inter-censal estimates of livestock numbers.

During the year under report, a suitable stochastic model was built up, making use of livestock census data, for working out estimates of livestock numbers for inter-censal years for the country as a whole. Work on building up a suitable stochastic model for estimation of livestock numbers for inter-censal years for a State wass till in progress.

14.3.8 Estimates of feed fed to cattle and buffaloes.

Detailed data on a day's supply of feeds given to bovines were collected in the sample survey conducted by the Institnte in the country during the years 1960-70 for estimation of production of milk and study of bovine keeping practices. These data were utilized to work out average daily feed supply for the different categories of bovines for each season of the quinquennial census year 1966. Assuming the same average feed supply, estimates of total supply of green fodder, dry fodder and concentrates during the year 1972 were worked out.

It was observed that, on an average, a cow in milk received 8.6 kg. of roughage and 320 gms. of concentrates, a dry cow, 6.0 kg. of roughage and 260 gms. of concentrates, a working animal, 10.4 kg. of roughagc and 260 gm.. of concentrates and a young stock, 3.4 kg. of roughage and 130 gms. of concentrates

per day during the year 1966. The corresponding figures in the case of buffaloes were 13.4 kg. and 680 gms. for buffaloes in milk. 9.4 kg. and 230 gms. for a dry buffalo, 8.7 kg. and 360 gms. for a working buffalo and 4.8 kg. and 150 gms. for a young stock.

It was estimated that during the year 1972, 294.9 million tonnes of green fodder (excluding grazing), 345.9 million tonnes of dry fodder and 21.6 million tonnes of concentrates were given to the bovines in the country.

In addition to the above survey investigations, collection of additional data and critical analysis of the data already collected were still in progress in connection with the survey for estimation of cost of cultivation of apples and study of their marketing in the Himalayan region of Uttar Pradesh and the sample survey in Bangalore district of Karnataka for developing a technique for estimation of production of vegetables. The monograph on methodology for estimation of meat production was being finalized and the data collected from the entire district of Aligarh in Uttar Pradesh during the agricultural year 1973-74 for a study on employment and income effects of the new agricultural strategy as well as the data collected in a survey conducted in the same district for developing a sample survey technique for estimation of crop losses in storage were under critical study. Sample surveys for methodological investigations into the High Yielding Varieties Programme were initiated in 15 States. Besides, studies on extent and intensity of adoption of high yielding varieties of cereal crops by farmers of different holding size groups as well as on extent of adoption of associated improved practices in growing these high yielding varieties were taken up with the help of the data collected under the agronomic and agro-economic enquiry of the Scheme "Sample Surveys for Assessment of High Yielding Varieties Programme" during the autumn of the year 1972-73 in Ernakulam district of Kerala State. The data pertaining to the yield estimation survey conducted in Tamil Nadu during kharif, 1972-73 under this Scheme were taken up for a regression analysis of the factors influencing the yield rates of the high yielding varieties of rice.

14.4 Basic research in Statistics.

(a) *Sampling* :

The problem of estimation of multiple characters in sample surveys relating to finite populations was attempted. Different models in 3-p-sampling were suggested. Some Monte-Carlo studies were undertaken for comparing different methods of estimation. New pps sampling schemes were proposed and their efficiencies compared with the existing sampling schemes. Studies on non-response errors in

successive sampling were undertaken. Some new systematic sampling schemes were suggested where it was possible to estimate unbiasedly the variance of the mean.

(b) *Genetical Statistics* :

Studies on the parent-offspring and full-sib correlations separately under full-sib mating and parent-offspring mating systems, both for autosomal as well as sex-linked genes, were conducted. Relationship between retention of a cow in a herd and its milk yield in the first lactation was studied, and a method for estimating the heritability of survival was developed.

(c) *Designs of Experiments* :

Important contributions were made in the realm of change-over designs. Development of new designs for paired comparisons, namely, standard comparison pairs and symmetrical pairs, and designs for sensory evaluation were reported.

14.5 Publications :

Forty-three papers by the officers, members of staff and research students of the Institute were published in standard journals during the year under report, while seventeen papers were accepted for publication in different journals. Besides, two technical reports, two souvenir papers, two monographs, four compendia of the National Index of Agricultural Field Experiments and a book titled "The First Conference of Agricultural Research Statisticians (24th to 26th April, 1974)—Contributed papers and proceedings" were published as IARS publications during the year, while two technical reports, two monographs and four compendia of the National Index of Agricultural Field Experiments were finalised or were under print for publication.

APPENDIX I

List of Class I officers in position as on 31.12.1974

	Name	*Designation*
1.	Dr. D. Singh	Director
2.	Dr. Prem Narain	Senior Statistician (Genetics)
3.	Shri S.K. Raheja	Senior Statistician (Survey)
4.	Shri K.S. Krishnan	Senior Statistician (Agro)
5.	Shri S.C. Basu	Chief Administrative Officer
6.	Shri M.R. Garg	Administrative Officer
7.	Shri S.D. Bokil	Statistician-cum-Associate Professor.
8.	Shri S.S. Pillai	-do-
9.	Shri M.P. Jha	-do-
10.	Shri B. Marutiram	-do-
11.	Shri K.C. Raut	-do-
12.	Shri M. Rajagopalan	-do-
13.	Shri T. Jacob	-do-
14.	Shri H.P. Singh	-do-
15.	Dr. A.H. Manwani	-do-
16.	Dr. B.B.P.S. Goel	-do-
17.	Shri P.N. Bhargava	-do-
18.	Dr. Aloke Dey	-do-
19.	Dr. A.K. Nigam	-do-
20.	Shri J.P. Jain	-do-
21.	Dr. R.K. Pandey	Agricultural Economist
22.	Shri U.G. Nadkarni	Junior Statistician
23.	Miss C.R. Leelavathi	-do-
24.	Shri J.N. Garg	-do-
25.	Shri R. Gopalan	-do-
26.	Shri K.G. Aneja	-do-
27.	Shri A.K. Banerjee	-do-
28.	Shri S.R. Bapat	-do-
29.	Shri J.S. Maini	-do-
30.	Shri P.C. Mehrotra	-do-
31.	Shri M.G. Mittal	-do-
32.	Shri L.K. Garg	-do-

33.	Shri V.S. Rustogi	Junior Statistician
34.	Shri P.N. Soni	-do-
35.	Shri S.N. Mathur	-do-
36.	Shri R.K. Khosla	-do-
37.	Shri A.K. Srivastava	-do-
38.	Shri Padam Singh	-do-
39.	Shri Shivtar Singh	-do-
40.	Shri K.V. Sathe	-do-
41.	Shri D.V. Subbarao	-do-
42.	Shri A.C. Kaistha	Mechanical Tabulation Officer
43.	Shri S.C. Rai	Assistant Professor
44.	Shri Randhir Singh	-do-
45.	Shri R.C. Aggarwal	Field Officer
46.	Shri Rajendra Singh	-do-
47.	Shri V.N. Iyer	Junior Technical Officer

APPENDIX II

List of sanctioned posts as on 31.12.1974

Sl. No.	*Post*	*Scale of pay*	*No. of posts sanctioned*
		Class I	
1.	Director	2000-2500	1
2.	Joint Director	1800-2250	2
3.	Senior Professor	1500-2000	5
4.	Senior Statistician	1500-1800	6
5.	Chief Scientist (CC)	1500-1800	1
6.	Chief Administrative Officer	1300-1700	1
7.	Administrative Officer	1100-1600	1
8.	Statistician-cum-Associate Professor	1100-1600	19
9.	Agricultural Economist	1100-1600	1
10.	Programmer (CC)	1100-1600	6
11.	Junior Statistician	700-1300	24
12.	Assistant Professor	700-1300	2
13.	Mechanical Tabulation Officer	700-1300	1
14.	Junior Technical Officer	700-1300	1
15.	Field Officer	700-1300	2
		Class II	
1.	Accounts Officer	890-1200	1
2.	Assistant Field Officer	650-1250	1
3.	Section Officer	650-1200	2
4.	Statistical Investigator	550-900	39
5.	Electronic Computer Operator	550-900	8
6.	Programming Assistant	550-900	2
7.	Economic Investigator	550-900	1
		Class III	
1.	Superintendent	550-900	1
2.	Junior Accounts Officer	550-900	2

Sl. No.	*Post*	*Scale of pay*	*No. of posts sanctioned*
3.	Assistant	425-800	13
4.	Cashier	425-800 plus Rs. 40/-	1
5.	Personal Assistant	425-800	8
6.	Assistant Incharge	425-800 plus Rs. 40/-	1
7.	Junior Accountant	425-750	2
8.	Statistical Assistant	425-700	75
9	Technical Assistant	425-700	1
10.	Asstt. Electronic Computer Operator	425-700	6
11.	Caretaker	425-700	1
12.	Senior Storekeeper	425-700	1
13.	Senior Library Assistant (Gr. II)	425-700	1
14.	Inspector	425-700	2
15.	Senior Computer	425-600	61
16.	Supervisor	330-560	6
17.	Card Librarian	330-560	2
18.	Stenographer	330-560	12
19.	Upper Division Clerk	330-560	12
20.	Upper Division Clerk (Hostel)	330-560	1
21.	Punch Supervisor	330-480	8
22.	Machine Operator	260-400	4
23.	Key Punch Operator	260-400	75
24.	Enumerator	260-400	41
25.	Lower Divison Clerk	260-400	32
26.	Telephone Operator	260-400	2
27.	Staff Car Driver	260-400	1
28	Tubewell Operator	260-400	1
29.	Carpenter	260-350	1
30.	Jeep Driver	260-350	1
31.	Senior Gestetner Operator	260-350	1
32.	Library Attendant	225-308	1

Class IV

1.	Junior Gestetner Operator	210-270	1
2.	Daftry	200-250	6

Sl. No.	*Post*	*Scale of pay*	*No. of posts sanctioned*
3.	Laboratory Attendant	200-250	12
4.	Jamadar	200-250	1
5.	Chowkidar	196-232	8
6.	Farash	196-232	6
7.	Mali	196-232	5
8.	Beldar	196-232	2
9.	Peon	196-232	15
10.	Sweeper	196-232	10
11.	Khalasi	196-232	10

APPENDIX III

List of dissertations approved during the year 1974 for award of Ph. D. and M.Sc. Degrees and Diploma in Agricultural Statistics.

Ph. D. Degree.

1. GEORGE, K.C. On correlation between relatives in inbred populations.

A detailed study of the parent-offspring and full-sib correlations separately under full-sib mating and parent-offspring mating systems, both for autosomal as well as sex-linked genes has been conducted Two methods, viz; the I.T.O. method, employing stochastic matrices, as well as generation matrix methodology, have been studied. A general theory for obtaining the correlation between both the parents and k offspring under a given system of mating have been developed both for the autosomal as well as sex-linked genes. The various correlations have also been studied graphically. It has been found that in general, the I.T.O. method is not applicable to inbred populations. However, for autosomal genes and in the case of parent-offspring mating system (mating between a fixed sire and his daughter, grand daughter, great-grand daughter, etc.), the joint distribution of the parent-offspring relationship could be expressed in terms of T and F (suitably defined) matrices. In the case of sex-linked genes, the I.T.O. method succeeds in finding the joint distribution and correlation coefficient for brother-brother and father-son relationships, both for the full sib as well as parent-offspring mating systems.

2- MANWANI, A.H. Theory of estimation of multiple characters in sample survey.

The thesis deals with a unified treatment of estimation procedures for multiple characters in a finite population. The central idea underlying the thesis is that in a sample survey, statistician is faced with studying a given system and drawing inferences about various entities, characters or sub-characters which enter into this system. At the estimation stage, the statistician should utilize all the a priori knowledge on the inter-relationships among different characters including auxiliary and exogeneous variables entering into the system so as to work out the precise estimates.

Different estimation procedures for single character and multiple character problems have been studied. Derivation of estimators relevant to multiple

characters sample survey situation has been attempted. Various types of estimators based on Seemingly Unrelated Regression Equation (SURE), Two-Stage Least Squares (2-SLS), Three-Stage Least Squares (3-SLS) and Least Variance Ratio (LVR) principles have been derived. Application of these new estimation procedures to different practical sample survey situations which statistician is likely to come across in surveys in the field of agriculture, horticulture and animal husbandry have been illustrated.

The problem of stratification for more than one character has also been studied. The method of stratification given by Ghosh (1963) for stratifying sampling units for two characters has been extended to k characters.

Finally, a large number of actual survey data have been studied so as to compare the efficiency of ratio and regression methods of estimation in relation to sample mean estimator through Mente-Carlo method.

3. SESHAGIRI, A. Some contributions to design and analysis of bio-assays.

The present thesis deals with problems of construction analysis of incomplete block designs for use in bio-assays. Various designs have been proposed to suit different situations and the method of analysis explained. Designs for both parallel line assays and slope ratio assays have been considered and their efficiencies have been compared with the existing designs.

4. SHARMA, S.D. Contributions to sampling theory.

This thesis deals with certain aspects of the sampling theory. Several aspects of 3-P (Probability proportional to prediction) sampling have been considered. A new approach to 3-P sampling has been suggested and the advantages of this new approach demonstrated.

A sampling scheme known as 3 PWORT (3-P without replacement type) sampling which results in larger precision as compared to 3 P Sampling has been discussed.

Another sampling scheme known as "Three Pee Fixed Sample Size Scheme" has been suggested. This can be conveniently used in forest surveys and it ensures a sample of fixed size. This is an advantage over 3-P Scheme since when the size is variable, there is a possibility of selection of very few units or a very large number of units.

Finally, studies have been made to infer about a population characteristic or characteristics by making observations on the sample. The main result has been

that ratio and regression estimators are proper estimators to be used when a statistician is capable of choosing a model between his study population and auxiliary population.

5. SHARMA, V.K. Contribution to change-over designs.

This thesis relates to investigations on experimental designs in which treatments are applied to the experimental units in sequences over a number of periods.

In the present dissertation an attempt has been made to provide designs along with their analysis for investigations of the effects of the treatments where the residual effects of the treatments persist over two consecutive periods.

A new type of designs called change-over designs with complete balance for the first and second residual effects of the treatments has been introduced. These designs allow the estimation of direct effects and hence of all contrasts between direct effects with minimum variance by making the estimation of these effects orthogonal to all other effects. An appropriate method of analysis of these designs has also been given.

Suitable designs which allow the estimation and testing of periods x treatments interaction parameters besides the residual effects of the treatments have also been developed. The situations where the residual effects of the treatments are carried over to only one period after the periods of their application and also where the residual effects are carried over to two periods have been dealt with separately.

Diploma.

1. AGGARWAL, D.K. Some investigations for crop insurance scheme under Indian conditions.

An improved procedure for determining premium rates taking into account the seasonal variation in yield rates is obtained. Two models for reinsurance contracts are developed. These procedures are illustrated by utilising the yield data on high yielding and local varieties of crops in IADP districts. Frequencies of crop losses for different coefficients of variation of seasonal yields are also worked out.

2. AGARWAL, S.K. The application of sampling technique in the study of attitudes of farmers and their sons on education and farming in Aligarh District, U.P.

Immense progress in the field of agriculture and spread of education in the recent years, has generated the curiosity to know as to how the outlook of the

farming community towards agriculture is changing with the increase in education among them. One such study was conducted in the Aligarh district of U.P. which is also one of the districts covered under I.A.D.P. The approach of Snowball Sampling, originally suggested by Coleman and further developed by Goodman, was made use of in the study.

On the basis of study, it has been found that a majority of farmers and their sons were more inclined towards education than agriculture, which is an indication that there is a tendency among the farmers to deviate from agriculture. The study also revealed that in the case of education, the distance of villages from the nearest city influenced the opinions of the farmers. In entirely irrigated tracts they favoured farming. When the same type of study was carried out to study the attitude towards farming, it was observed that the distance of the village from the nearest city and irrigation facilities again played similar roles. When educational facilities were not available, they opined for farming.

3. MARUTIRAM, B. Analysis of covariance in two way classification with disproportionate cell frequencies - Estimation of true class effects.

The problem of estimation of true class effects and their variances has been investigated in the case of two-way classification with disproportionate cell frequencies under different constraints on class effects with and without concomitant variation. Alternate expressions have been given for estimation of true class effects and their variances for differing computational facilities. As in the orthogonal case, the estimates of linear contrasts of class effects are invariant of constraints on class effects in both the cases with and without concomitant variation.

4. MEHTA, S.K. Balanced and partially balanced n- ary block designs.

In this dissertation some methods of construction of partially balanced n ary designs have been suggested. It is shown that partially ternary designs can be constructed through PBIB designs so that the type and order of association scheme in the partially balanced ternary designs remain unchanged. Using properties of partially balanced ternary designs and linked block designs, some new methods of construction of certain series of Group Divisible and Triangular PBIB designs have been presented. A general method of construction of balanced n-ary designs with varying block sizes and varying replications has been discussed.

5. RAWAT, P.S. Some investigations on rotatable designs.

Second Order Rotatable Designs (SORD) were introduced by Box and Hunter (Ann. Math. Stat., 1957). Various methods of construction of these designs are

reported in the literature. All these different approaches of construction of these designs, however, can be looked upon as special cases of a general unified method. An attempt has been made to unify the theory of construction of SORD. It has been shown that for any given number of levels, a SORD can always be constructed by choosing an appropriate PB array. Conditions which must be satisfied by these arrays in order that they yield SORD have been derived. A method of construction of 4-Level SORD with blocks is also presented. This investigation has helped in bridging the gap which existed hitherto, namely, obtaining 4 - Level SORD with blocks. Some asymmetrical rotatable designs have also been obtained from already existing symmetrical rotatable designs with four and six levels. These designs have been obtained by applying orthogonal transformation on the design points of the symmetrical rotatable designs.

6. SHASTRI, S.S. A study on successive sampling procedure adopted in livestock survey.

Different procedures of estimating aunual milk production and changes in seasonal estimates are discussed when the design of the survey is one of successive sampling. In this design the survey is carried out over 9 successive seasons extending over 3 years. Some of the sampling units are matched over all the 9 seasons, some over only the corresponding seasons, and independent unmatched samples are taken only in the three seasons of the first year.

7. SINGH, M.G. A contribution to theory of sampling.

Several attempts have been made by many a researcher to provide a practicable Probability Proportional to Size (PPS) sampling design for selecting a sample of n distinct units and build up an optimum estimate. In this connection, however, another problem that has been attempted consists in examining the existence or otherwise of a uniformly minimum variance linear unbiased estimate in the class of all sampling designs. Basic to this problem lies the work of Horvitz and Thompson, who pointed out that under any sampling design there exist several types of linear estimates of the population total (or mean) and pinpointed three classes of linear estimates, often referred to as T_1, T_2 and T_3 type estimates. The T_2-class consists of only one unbiased estimator and it is generally referred to as the Horvitz and Thompson estimate.

It is felt, however, that most of the methods evolved for obtaining an optimum PPS sampling without replacement strategy are entirely not satisfactory. Often, they lack simplicity and algebraic expressions are complicated and unmanageable for even moderate size. But, in this scheme, those due to Lahiri, Midzuno and Sen (LMS) and Rao, Hartley and Cochran have wider applicability. Further, the ratio estimator under LMS Scheme is known to be unbiased for the

population total or mean. But the ratio estimate belongs to the T_3-class proposed by Horvitz and Thompson. So the important question arises as to the comparability of this estimate under the LMS Scheme with similar (T_3-type) estimate under any PPS Sampling without replacement procedure. This problem has been investigated in this thesis. Under suitable transformation of the ancillary data prior to the selection of the sample, the LMS ratio strategy is shown to be asymptotically the best in the class of all unbiased T_3-type PPS sampling without replacement strategies.

8. VIR, DHARAM. Improvement of family selection index through an auxiliary trait.

An index of selection is developed utilising the information on family relatives such as full-sibs and half-sibs and applying the correction for a secondary trait. Its efficiency is discussed in relation to (i) the individual selection, (ii) index for family selection developed by Rajagopalan and (iii) index for correction due to a secondary trait developed by Rendel. An illustration is given applying these procedures.

M.Sc. Degree.

1. BALACHANDRAN, G. Design for sensory evaluation.

In this dissertation some of the designs which can be used in food technology, standardisation, quality testing of cereals etc. have been developed. The designs developed can be used for conducting experiments involving paired comparisons of different types like complete pairs, symmetrical pairs and standard comparison pairs.

The method of paired comparisons is a well known method of ranking objects according to the response they produce on a set of subjects. Bose (1956) has developed linked paired comparison designs for testing agreement among the judges. The designs developed by him have a lot of symmetry and are similar to balanced incomplete block designs with an additional restriction. In the present work, similar designs for comparing the effects of a certain set of varieties rather than for testing the concordence among the judges have been developed. Some designs with good combinatorial properties have been obtained in this case. In the case of symmetrical pairs also, some solutions for parametric relations which lead to simple arrangements have been obtained. For the practitioners of sensory evaluation these arrangements will be useful. For standard comparison pairs also, similar arrangements have been obtained.

2. CHANDER, SUBHASH. Study on genetic variation in full-sib mating and phenotypic assortative mating.

The genetic variability in a population generated under continued full-sib mating and phenotypic assortative mating for different values of initial gene frequencies, dominance deviations and intensities of selection against recessive genotypes is worked out. It is concluded that, in general, in the absence of selection, in producing higher genetic variability phenotypic assortative mating is to be preferred over full-sib mating. However, in the presence of selection, full-sib mating is to be preferred.

3. DWIVEDI, V.K. Inverse sampling procedure.

This thesis deals with the use of inverse sampling for estimation of population total and stochastic model for estimation of recruitment-rate. Some alternative estimators of the population total have been developed along with biases and variances with their estimates. A numerical illustration is given and the existing relations between estimated biases and variances are also given.

4. GHAI, R.K. Some contribution on rainfall distribution and its behaviour.

In this dissertation an attempt has been made to examine the variability and behaviour of rainfall during different intervals of jowar crop season like 20 days, month and season based on daily rainfall data of Jalgaon district (Maharashtra State). The investigation has been made on the type of mathematical model which will describe the rainfall distribution of different intervals and the suitable transformation which could make the distribution normal, so that the various properties of rainfall behaviour could be studied. A study has been carried out to find the probability of excess ond deficient rainfall as compared to normal for various proportions. In addition, the limits within which rainfall may be expected to lie for 80 and 90 per cent confidence co-efficient have also been determined.

5. GUPTA, S. C. Planning and analysis of experiments involving rankings.

In this thesis, a mathematical model has been developed for analysis of experiments involving ranking in paired comparisons. It is postulated that the t treatments have true positive ratings $\pi_1\pi_2, \ldots \pi_t$ on a particular subjective continuum throughout the experiment. Further, it is assumed that when treatment i appears with treatment j in a block, the probability that treatment i obtains the top rating is taken to be $\pi_i^2 (\pi_i^2+\pi_j^2)$. The likelihood function is obtained and the maximum likelihood estimates of the treatment parameters are estimated. The model permits tests of hypothesis of general class and the estimation of treatment ratings. Two special tests are considered to test the null

hypothesis that true treatment ratings are equal. The methods of pooling and combining the results of several judges are also developed. The utility and application of the model are explained by a numerical example. A test has been proposed to test the appropriateness of the model.

6. KUMAR, ASHISH. Investigation on responses to fertilizer and estimation of optimum dose considering soil test values.

Different regression models to describe the relationship between crop yield, fertilizer levels and soil test values to make fertilizer recommendations are studied. The soil variables included in the regression analysis were pH, organic carbon, available P, available K and conductivity. Of the three models considered, in the first model only linear terms of all the five variables were included while in the second and third models, a square and a square rooot term of available P in addition to linear terms was respectively added. The two approaches considered were the multiple regression technique and the generalized yield function. The methods have been illustrated with the data on wheat obtained from the Simple Fertilizer Trials on cultivators' fields.

The results obtained by the two methods were more or less identical and the models using square and square root terms of available P were found to be better than the one with linear terms only. The usefulness of these techniques needs to be further established by including more soil and non-soil variables in the regression analysis, if computer facilities are available.

7. MURALI, R Comparative efficacies of different methods of stratification.

In large scale sample surveys, geographical stratification is generally adopted assuming homogeneity of the units within a stratum on grounds of administrative and other conveniences. However, in case this assumption does not hold, the estimates obtained through such stratification will have poor precision. For ensuring homogeneity of units within a stratum, other methods for stratification based on criteria like holding size, irrigation, level of fertilizer application, date of sowing, variety, etc. used so as to eliminate differences due to factors which influence the crop yield in different units may lead to higher precision.

This aspect was investigated and studied with the help of the data collected under the scheme "Sample Surveys for Assessment of High Yielding Varieties Programme" undertaken at I.A.R.S. during 1971-72 on major cereal crops, viz.,rice, wheat, maize, jowar and bajra in some of the important growing districts in the

country. The results showed that for the two crops, paddy and wheat, stratification based on 'date of sowing' was generally more efficient than other criteria. The 'level of fertilizer application' was also found to be a good criterion for stratification of units for these two crops. For the other three crops, maize, jowar and bajra, 'holding size' as a basis of stratification of units was found to be more efficient than other criteria.

8. SETHI, A. S. Procedurces for estimating the number of pepper standards and average yield per bearing standard.

In this dissertation four different estimates of number of pepper standards were considered and their relative efficiencies compared. These were (1) Simple unbiased estimate, (2) ratio estimate, (3) Hartley Ross estimate and (4) regression estimate. The regression estimate was found to be the best one for estimating the number of pepper standards as compared to other estimates. The bias in regression estimate was estimated to be negligible. Efficiency of stratification was discussed with regard to simple unbiased estimate and regression estimate and the gain in efficiency due to stratification was estimated to be 48% and 101% respectively. Further, three different estimates of average yield per bearing standard were suggested and their percentage standard errors compared. These were (i) Simple estimates ($\bar{y}_1$) (2) Ratio estimate ($\bar{y}_2$) and (3) Ratio-Ratio estimate ($\bar{y}_3$). It was shown that $\bar{y}_3$ is better than $\bar{y}_1$ or $\bar{y}_2$ and $\bar{y}_2$ is better than $\bar{y}_1$. These estimates were illustrated by using the data collected in a sample survey on pepper crop conducted by the I. A. R. S. in Kerala during the year 1966-67.

9. TYAGI, K. K. Assessment of impact of tube-well irrigation on agriculture.

A study has been made for assessing the performance of State tube-wells in the district of Meerut. The sampling design used for the study was stratified two-stage random sampling. Irrigation sub-divisions were taken as strata while tube-wells were the first stage unit of selection and cultivators whose fields were irrigated were the second stage unit of selection. Selection at each stage was made with equal probability. 40 tube-wells were selected from the district and for each selected tube-well 10 cultivators were selected for detailed enquiry.

A study on the area irrigated by tube-wells was made and it was found that a number of tube-wells were not used to their full capacity. The reasons for not utilising the tube-wells to their full capacity are also presented in the thesis alongwith some suggestions for improving the performance of tube-wells. The design was observed to be 22% more efficient as compared to simple random sampling.

10. VENKATESAN, R. Estimation of genetic parameters for certain economic characters in Kankrej herd of cattle at the Institute of Agriculture, Anand.

Co-efficients of heritabitity of and genetic correlations between first lactatior. milk production, first location period and first calving interval are worked out for Kankrej herd of cattle maintained at the Institute of Agriculture, Anand during 1944-65. Selection indices such as simple daughter average index, corrected daughter average index and discriminant function are also worked out for these characters and compared.

APPENDIX—IV

List of seminar talks delivered by members of staff and students of the Institute during the year 1974.

Sl. No.	*Name of Speaker*	*Title of Talk*
1.	Sh. U. K. Pandey	Application of Statistical Tools in Economic Analysis.
2.	Dr. A. Dey	On difference set solutions of Balanced n-ary Designs.
3.	Sh. B. Balarami Reddy	Estimation of Genetic Interaction effects and variances-qualitative inheritance.
4.	Dr. A. K. Nigam	Recent advances in experiments with mixtures.
5.	Sh. C. L. Gowda	Path Co-efficient Analysis in Plant Breeding.
6.	Sh. L. B. S. Somayazulu	Maximum Likelihood.
7.	Dr. R. K. Pandey	Estimation of Demand for Recreational Research.
8.	Sh. M. S. S. Reddy	Various methods of estimating heritability.
9.	Sh. A. R. Sawant	Genotype × Environment interaction.
10.	Sh. H. S. Gaur	Role of Population Dynamics Research in Nematode Control.
11.	Miss T. R. Singh	Some aspects of socio-methodology.
12.	Sh. K. S. Mangith	Determination of Genetic Diversities.
13.	Sh. V. K. Dwivedi	Post Cluster Sampling.
14.	Sh. Ashish Kumar	Non-Linear Estimates.
15.	Sh. R. Venkatesan	Efficiency of family selection.
16.	Sh. A. S. Sethi	Unbiased Ratio Estimation.
17.	Sh. Ikbal Singh	Irrigation Planning—A Linear Programme Methodology.

18.	Sh. G. R. Bhatia	The use of Markov Process in Market Share Studies.
19.	Sh. B. M. Sharma	Linear Programme in Farm Planning.
20.	Sh. R. G. Patil	Output-input ratio measurement in agriculture in selected two districts of Maharashtra.
21.	Sh. G. Balachandran	On Horvitz Thompson and Des Raj Estimators.
22.	Sh. Subhash Chander	Estimation of number of effective factors in the inheritance of quantitative characters.
23.	Sh. K. K. Tyagi	Bayes Decision Theory and its Application
24.	Sh. S. S. Gaur	Pooling of cross sections in time-series data in economic analysis.
25.	Sh. R. K. Ghai	A study of occurrence of rain-fall with the help of Markov Chain Model.
26.	Sh. D. K. Vij	On Ratio and Product Estimation.
27.	Sh. R. D. Godake	Error in variables in Linear Regression Model.
28.	Dr. A. H. Manwani	Principle of Least Squares Estimation in Sample Surveys—An Alternative to Unbiased Principle.
29.	Sh. Rupak Chakravarti	Orthogonal Arrays.
30.	Sh. H. C. Mathur	Line × Tester analysis for the estimation of combining ability in crop.
31.	Sh. K. S. Krishnan	Long term manurial experiments at Model Agronomic Centres.

APPENDIX—V

List of papers (with abstracts) published during the year 1974.

1. AMBLE, V. N., JACOB, T. and NIGAM, A. K. A method for the estimation of economic nutrient requirments for milk production. *Ind. J. Anim Sci. 44 (1), 1-3.*

The paper proposes a method for woking out the economic nutrient requirements for milk production from data of animal nutrition. A quadratic production function relating milk yield to nutrients intake was considered for the purpose. A method based on nutritional and economic aspects has been discussed and the method illustrated by an example.

2. BANERJEE, A. K. and MEHROTRA, P. C. Study of association of yield and some factors influencing it for high yielding varieties of rice in selected districts of Tamil Nadu. *Agri. Situ. Ind. 29 (11), 565-570.*

The data regarding high yielding varieties of rice cultivated in the four selected districts of Tamil Nadu, namely Chingleput, Coimbatore, Madurai and Tirunelveli during kharif 1970-71 were analysed. IR-8 was found to be the most popular high yielding variety of rice. The highest average yield of 35.3 q/ha. was achieved for this variety. The percentage increase in the average yield of high yielding varieties of rice over the average yield of local varieties was of the order of 40 to 65 per cent. The cultivators were generally not adopting the recommended dosages of chemical fertilizers to the full extent. There did not appear to be any specific association of either average yield or fertilizer use with the size of the holding. A number of farms growing high-yielding varieties obtained yield rates which were similar to or less than the mean yield of local varieties. The average yield generally showed an increasing trend with increased levels of nitrogen application. A fairly good number of cultivators were found to have adopted improved agricultural techniques. However, in oder to achieve better results, more extension efforts are needed. Use of seeds pre-treated with chemicals as also of plant protection chemicals was found to have gained popularity in all the four districts. About 5 to 25 per cent of the high yielding varieties fields were reported to have been damaged due to various causes. The results showed that had adequate measures been taken to minimise infestation and occurrence of diseases, the average yield could have been improved.

3. BHARGAVA, P. N., PRADHAN, ASHA, and DAS, M. N. nfluence of rainfall on crop production. *JNKVV* Res. Jour., *8* (1).

Rainfall and crop yield data was collected for Delhi (Wheat), Cuttack (Paddy), Indore (Wheat, Cotton and Groundnut), and Chinsurali (Paddy) centres to study the influence of rainfall on crop yield. Fisher's regression integral technique was adopted to analyse the data.

The study indicated that in case of wheat the variation in yield due to variation in rainfall was about 56 to 89 per cent. Additional rainfall for the crop grown under irrigated conditions (Delhi) was useful during flowering and seed formation period (December—1st week of February) while for rainfed crop (Indore) it was beneficial during the entire crop season.

About 75 per cent variation in paddy was explained by the variation in rainfall Additional rainfall during September and October was found to be beneficial to the crop.

90 per cent variation in cotton yield was found to be due to the variation in rainfall. But additional rainfall above normal was not found to be beneficial to the crop

In case of jowar and groundnut crops, 88 per cent and 70 per cent variation in yield respectively was explained by the variation in rainfall. Additional rainfall above normal during any time of the season was not beneficial for jowar crop. Additional rainfall during October and November was found to be beneficial for the groundnut crop.

4. BHATIA V. K. and NARAIN, P. Relationship between the retention of a sheep in the flock and its wool yield in the initial clip. *Ind. J. Anim. Sci. 43 (11), 996—1002.*

A study was conducted on the probability of retention of an ewe in the flock up to a particular order of a clip and its relationship with wool yield in the initial clip. The data for this were collected at the Sheep-Breeding Farm, Banihal-Reasi (Jammu & Kashmir) during 1952-66 under a scheme of the Indian Council of Agricultural Research for the improvement of sheep and wool by crossing the Kashmiri ewes with Rambouillet rams. The proportion of ewes retained to various orders of clips continued to decrease with the increase in the order of clips for both the indigenous and cross-bred ewes. The retention probability of 50% was observed at about the 11th clip in local type, but it was as early as 8th clip in the case of half-breds

and 5th clip in $\frac{3}{4}$ ths. The greasy fleece weight of the 2nd clip of ewes retained to various orders of clip showed an almost increasing trend with the increase in the order of clip. With almost 50% retention, the increase in the wool yield at the 2nd clip of those retained over the yield of their 2nd clip starters was about 2.1, 1.4 and 2.2% respectively, for the local type, half-breds and $\frac{3}{4}$ ths. For the local type and $\frac{3}{4}$ ths in the initial 4 clips, starting from the 2nd, the ewes were not pro. bably culled on the basis of their wool yields, the corresponding regression coefficients being negative. In these two types, beyond the 7th clip, the regression coefficients and the relative retention coefficients were positive and showed an increasing trend with the increase in the order of clip. In the case of half-bred ewes, although the regression coefficients were positive upto the 7 th clip and negative thereafter, no definite conclusion about the correlation between early and later yields could be drawn.

5. DAYANAND, MAHAPATRA I. C. and BAPAT, S. R. Efficiency of phosphatic fertilizers. *Indian Farming, 24 (1)*.

The analysis of the data of experiments conducted on wheat. taramira and barley in the villages of Shahadra and Kanjawalah blocks of the Union Territory of Delhi to compare the efficiency of different phospahtic fertilizers showed that triple superphosphate gave higher economic return as compared to single superphosphate.

6. DEY, A and MIDHA, C. K. On a class of PBIB designs. *Sankhya, B 36, 320-22.*

M. B. Rao (1966) defined a family of association schemes, called the Group Divisible family of association schemes. In this paper a simple method of construction of PBIB designs based on these schemes is given and as a corollary, a class of semi-regular group divisible designs are obtained.

7. DEY, A and SAHA, G. M. An inequality for tactical configurations. *Ann. Inst. Statist. Maths., 26, 171-73.*

Given a set E of v elements and given positive integers k, β ($\beta \leqslant k < v$) and α, a tactical configuration $C(\alpha, \beta, k, v)$ is defined to be a system of b subsets of E, having k elements each, such that every subset of E having β elements is contained in exactly α sets of the system.

In this paper, it has been proved that the inequality

$$b \geqslant 2^{\beta-2}(v-\beta+2)$$

holds for C (α, β, k, v) configuration whenever $v \geqslant k+\beta-1$. This inequality is more stringent than the one proposed by Raghavarao (1970).

8. DEY, A., MIDHA, C. K. AND TRIVEDI, H. T. On some methods of construction of rectangular and group divisible designs. *Jour. Ind. Soc. Agri., Stat. 26* (2), *14-18.*

Using orthogonal arrays and Hadamard matrices, two methods of construc tion of group divisible designs are discussed. A method of construction of rectangular PBIB designs is also discussed and as a consequence, a result regarding Family (A) BIB designs of Shrikhande (1962) is obtained.

9. GOEL, B. B. P. S., SINGH, K. B. AND SINGH, K. P. Availability and disposal of dung in India. *Ind. J. Anim. Sci., 43 (8), 671-76.*

Utilizing the data collected through sample surveys for estimation of milk production and study of bovine practices conducted by the Institute of Agricultural Research Statistics in a number of states in the country, the estimates of evacuation rates of dung per bovine and percentage utilization for compost, for dung-cakes and for other purposes were worked out.

The all-India dung production for 1966 was 344.5 million tonnes. The cost of the available soil nutrients, i.e., nitrogen, phosphoric acid and potash, from dung to the first crop is nearly Rs. 200 crores. A suggestion has been made for better utilization of dung, besides increasing the production of compost, to obtain substantial quantity of domestic fuel in the form of fuel-gas from dung—equivalent to 124,000 tonnes of charcoal or 194.5 million K. Watts of electricity.

10. GOPALAN, R. AND MARUTIRAM, B. Performance of Rampur Bushair x Polwarth Crosses. *Ind. J. Anim Sci., 44 (2), 65-69.*

Data on various wool quality characteristics, greasy-fleece weight and various vital characteristics covering a period of 6 years from 1962 were utilised to make a critical comparison of the performance of Rampur Bushair sheep and their crosses with Polwarth. Graded ewes were superior to Rampur Bushair ewes. Three-fourths Polwarth ewes were superior to half-breds in regard to fibre diameter. A policy of large-scale upgrading of local Rampur Bushair sheep with Polwarth up to 75% exotic blood for fine wool production appears safe for adoption under local conditions. However, it would be worthwhile to secure information regarding the performance of inter-breds of different exotic blood levels for evolving a new breed of fine wool sheep.

11. GUPTA, S. S., RAJAGOPALAN, M., MEHROTRA, P. C. and BANERJEE, A.K. Fertilizer application to HYV of wheat and resulting yield rates in Maharashtra State. *Agri. Situ. Ind. 28 (11), 761-65.*

A study to assess the yield performance of high yielding varieties and associated practices followed by the farmers during 1969-70 and 1970-71 was undertaken. The results showed that average yield of HYV of wheat was found to be significantly higher than the average yield of local varieties during both the years. The percentage of fields benefited by the application of N, P, K as also the rates of application of these fertilizers generally showed a fall during 1970-71 as compared to 1969-70. The average rates of N, P and K adoped were about 50, 60 and 35 per cent of the State recommended dosages. About 25% of the fields received all the three fertilizers. An increasing trend in the additional yield for HYV of wheat over the local varieties with increased dosages of nitrogen was observed which suggests that there is ample scope for adoption of HYV of wheat by farmers as availability and application of nitrogen do not seem to be the limiting factors. Damage to the standing crop was found to be more in 1969-70 compared to that in 1970-71. This could partly be ascribed to lower yield rates in 1969-70 compared to those in 1970-71. The major causes of crop loss were rats, cattle, weed infestation and attack of insect-pests and plant diseases. This points to the need for educating the farmers in the use of plant protection measures. The yield rates worked out for different holding size categories did not differ much.

12. KRISHNAN, K. S. Recent trends in the designing and analysis of agricultural field experiments. *Proc. of the First Annual Conference of the Agricultural Research Statisticians held at the I. A. R. S., New Delhi in April, 1974, 1-10.*

The diversification of agricultural research involving much new technology has paved the way in the designing and analysis of field experiments breaking new ground. The magnitude of experimentation at research stations has gone up by about three times during the past quarter of the century. Besides, experiments on cultivators' fields have also gained wide ground. The various coordinated projects undertaken under the stewardship of the I. C. A. R. have provided scope for giving new direction to the planning of field experiments.

The major emphasis in experiments at agricultural research stations is on multiple cropping in crop sequences. Appropriate designs for such experiments as also for long term experiments for studying residual and cumulative effects of fertilisers on crops have been identified. Designs for experiments on intercropping and mixed cropping have been developed and are being adopted in the experiments under the Coordinated Agronomic Research Project.

In experiments on cultivators' fields it has been possible to increase the number of plots demarcated within a field from three or four from the initial stage to as many as 12. Adoption of split plot designs in cultivators' fields with a village constituting a replication and a field as a main plot is under examination.

13. MAHAPATRA, I. C. BAPAT, S. R. and SINGH, MAHINDRA. Economics of fertiliser use. *Fertilizer Marketing News, Dec., 1974.*

The analysis of the data of fertilizer trials conducted on cultivators' fields under the All India Coordinated Agronomic Research Project showed that, based on the present price structure of fertilizers and the price of produce, especially for rice and wheat, it was in few districts that cost benefit ratio exceeding two, even at moderate level of fertilizer application such as N_{60} or N_{60} P_{30}, could be obtained. However, in Shahabad, Karnal, Burdwan, Thanjavur, Coimbatore, Chittor, Shimoga, Raipur and Raichur, cost benefit ratio ranged between one and two for kharif rice and in Shimoga, Sambalpur, Cuttack and Raichur for rabi rice. In case of wheat, CBR exceeded two in Shahabad, Karnal, Aligarh, Kanpur, Delhi and Hoshangabad and ranged between one and two in Varanasi, Burdwan, Monghyr and Ludhiana.

14. MAHAPATRA, I. C, GOSWAMI, N. N. and BAPAT, S. R. Lessons from simple fertiliser trials. *Indian Farming, 23 (12).*

The study of response data of trials conducted on cultivators' fields showed that for raising the yield of rice (unhusked) by 15 q/ha or more through fertilization, 180 g/ha NP level is required in districts such as Burdwan and West Godavari during kharif and in Raipur during rabi while sim lar yield increase can be obtained by application of 90 kg nutrient per hactare in Thanjavur and Shimoga. Similarly, to raise wheat yield by 15 q/ha or more in Mehsana, Jhansi, Bhavnagar, Pali and Nasik districts, a total nutrient supply of 240 kg/ha (N_{120} P_{60} K_{60}) is required while in Delhi, Aligarh, Ludhiana and Hoshangabad the yield increased by 15 q/ha or more even with application of 90 or 120 kg of nutrient (as NP) per hectare and with 150 kg nutrient/ha in Shahabad, Karnal, Kanpur and with 240 nutrient/ha in Varanasi and Burdwan.

15. MAHAPATRA, I. C., GOSWAMI, N. N. and BAPAT, S. R. Faslon Men Santulit Urwark Den. *Kheti, May, 1974.*

The data obtained from 1374 trials conducted in 18 districts on rice during kharif and from 729 trials conducted during rabi have conclusively shown that N_{120} P_{60} K_{60} followed by N_{120} P_{60} gave highest responses as compared to any other

lower combination of NP or single application of N or P. Similarly, results of 1864 trials in 14 districts with wheat showed that highest total production and response were obtained with N_{120} P_{60} K_{60} or N_{120} P_{60} followed by N_{120} P_{30}, N_{60} P_{60} or N_{60} P_{30} or N_{120},

16. MAHAPATRA, I. C., KRISHNAN, K. S., SINGH, MAHINDRA and JAIN, H. C. Strategy for fertilizer recommendation based on multiple crop sequences. *Fertilizer News, Dec., 1974.*

Experiments conducted under the All India Co-ordinated Agronomic Research Project from 1969-70 to 1973-74 on fertilizer use efficiency in multi-crop systems at 45 Model Agronomic Centres representing 15 major soil groups and 19 agro-climatic zones in India have indicated that in fixed single year two-crop (cereal) rotations generally high cumulative responses were observed due to the application of phosphate (30-60 kg P_2O_5/ha), patassium (30 kg K_2O/ha) and farmyard manure (15,000 kg/ha). Application of farmyard manure generally proved more beneficial when applied in wet season and phosphate in dry season. Intercropping with green gram, black gram, soyabean, onion and groundnut proved highly remunerative in wide-row crops like cotton and red gram as compared to pure crop stands and needed no extra fertilizers. There is a possibility to reduce fertilizer application upto 75 or 50 per cent of the recommended levels in high intensity crop rotations with nominal reduction in total output, provided other associated non-cash inputs are taken care of. Total annual grain yield upto 15 tonnes/ha or even more with three crop rotations and upto 10 tonnes/ha with 2 crop rotations could be obtained by providing adequate inputs and crop management. Bajra crop removed more nutrients than maize at comparative yield levels. Inclusion of pulse crop in the sequence increased the uptake of nitrogen in the succeeding cereal crop while it was lower in a cereal dominated rotation, i.e., rice-rice-rice or maize/jowar/bajra-wheat-maize/bajra (F). Cow-pea removed more nutrients than green gram. Generally, fodder crops removed more potassium than grain crops.

17. MALHOTRA, P. K., NARAIN, P. and MATI, K. L. Estimation of the genetic parameters for economic traits in chickens selected on the basis of an index for rate of lay. *Indian Poultry Review, 5 (16), 575–577.*

The effect of selecting sires on the basis of progeny performance tests (testing the significance of the difference between the performances of the dams and their daughters of a sire) on the estimates of genetic parameters has been studied. Both the methods of estimation, viz., intra-sire regression of daughter's performance on those of dams as well as the half-sib analysis were used.

It was found that the daughters of the sires contributing significantly to the genetic advance in the next generation, performed better than their dams by an amount which varied between half a per cent to fifty per cent for rate of lay and about 0.5 gms to 8 gms for average egg weight. The estimates of heritability for rate of lay were obtained as 0.12 and 0.26, of heritability of egg weight as 0.31 and 0.52 and of the genetic correlation between traits as 0.28 and—0.40 by intra-sire regression and half-sib analysis methods respectively.

18. MANWANI, A. H. and KAUL, B. L. Study on returns—Marketing of apples in Nainital region. *Economic Times, 4th November, 1974 issue.*

The study is devoted to comparing the economics of marketing apples of different varieties by the orchardists of Nainital hills of U. P. in three city markets of Haldwani, Lucknow and Bombay. The study has indicated that it is more profitable for the growers of the region to dispose of average grade of apple at Haldwani market and Delicious variety in Lucknow market. The average net price for one kg. of apple received by the grower in Haldwani market varied from Re. 1 to Rs. 1.30 depending upon the variety. In Lucknow and Bombay markets price range was 29 to 64 paise except for Delicious in Lucknow market. The average marketing charges which included commission, transport charges, etc. for selling one full case worked out to be Rs. 3.21, Rs. 4.50 and Rs. 16.57 respectively in Haldwani, Lucknow and Bombay markets.

19. MARUTIRAM, B. Design and analysis of experiments in animal sciences research. *Proc. of the First Annual Conference of Agricultural Research Statisticians held at the I. A. R. S., New Delhi in April, 1974, 11—20.*

In this article, various aspects and problems in the designing of experiments in the disciplines of animal nutrition and breeding in the light of the present status of experimentation are discussed. A quantitative assessment of the information obtainable from the experiments carried out fron 1945 to 1970 in the field of animal nutrition at one of the premier Institutes of the country was given alongwith an assessment of the extent of loss of information in connection with resource utilisation. The need for developing suitable experimental designs or plans, keeping in view the minimum testing facilities required, is emphasized.

20. MARUTIRAM, B., RAUT, K. C. AND JACOB, T. Methodological problems in statistical estimation of the indicators of progress of the I. C. D. Programme. *Jour. Ind. Soc. Agri. Stat, Sym. Vol., 1974.*

The I. C. D. P. has been initiated in milk-shed areas in different States in order to primarily effect a rapid increase in milk production. It is necessary to

ensure through a critical and objective assessment that the amount of expenditure incurred is being properly utilised and that the various phases of the programme of development are yielding a response commensurate with the efforts put in and the resources spent. The paper deals with the method of collection of relevant data for proper assessment and subsequent critical statistical analysis of data for drawing valid conclusions. Some of the important indicators of progress suggested are changes in number and composition of stock, average lactation yield of an animal, total milk production and utilization, cost of milk production, mortality and fertility rates, changes in cropping pattern, labour utilization, economic status of producers, etc. Keeping various aspects in view, an attempt has been made to suggest an integrated approach to the entire problem and the outline of a suitable plan is given.

21. NARAIN, P. Techniques for measuring genetic improvement in livestock breeding. *SABRAO Proc., Ind. Jour. Genet. & Plant Breeding, 34 A, 967—971.*

The genetic improvement in livestock can be brought about by either using appropriate selection programmes or resorting to cross-breeding with exotic animals or else a combination of both. The existing theory of quantitative genetics provides a prediction of the resulting genetic improvement on a short term basis under certain simplifying assumptions. In actual practice, however, these assumptions do not hold good and therefore the predictions are not appropriate. In view of this, techniques are required for separating accurately the environmental changes from the genetic ones with a view to measure the improvement brought about by resorting to alternative breeding programmes. In such livestock as poultry where generations can be replicated, experimental designs known as "Repeat Mating Designs" and "Random-Bred Control" can be used for measuring the genetic changes. But in large animals such as cattle, buffaloes, etc., one cannot use these designs. In such a case, one can make use of statistical techniques for separating genetic from environmental trends using the records maintained in a herd over several generations of selection. In the present days when facilities for deep freezing semen of bulls are being created, it may be possible to measure genetic changes by making use of fertile semen frozen over a period of, say, 15 years. With a bank of frozen semen from about 20 bulls, it would be possible to produce a population of cows whose mean gene frequencies do not change with the time and in which there would be no inbreeding for at least 20 generations. Another way of measuring genetic improvement is to evaluate the genetic changes in a population by the continued use of semen from a bull in un-related cows. Any genetic improvement in the population would then be seen as an increase with time of the difference between progeny of those bulls being used normally for artificial insemination and those for the reference bull. When the breeding programme involves

crossing with exotic animals, the measurement of genetic improvement means comparing the performance of the different grades of animals. However, since such a comparison can be made on the basis of each of the several economically important characters, it is desirable to use multi-variate techniques for combining the characters in an optimum way and using the resulting index for the purpose of comparison. In this paper some of the measurement techniques have been illustrated with the help of the results obtained in the case of cattle and sheep.

22. NARAIN, P. Teaching of Statistics in Agricultural Institutes and Universities. *Proc. of First Annual Conference of Agricultural Research Statisticians held at I.A.R.S., New Delhi in April, 1974, 116—124.*

Much of the modern developments in statistical methodology got simulation by the needs of research in agricultural and biological sciences. As a consequence, a branch of statistical science has emerged whose understanding requires not only the advanced techniques of mathematical statistics but also the basic knowledge of these applied fields. Such a branch has since acquired the name of agricultural statistics. This field is also basic to almost every branch of agricultural science. A worker engaged either in the field of agricultural research or in the field of agricultural development needs the tools of this discipline for planning his investigation, analysing the data and interpreting the results in the best possible manner. The training of agricultural scientists is therefore incomplete unless its curriculum includes some course in agricultural statistics. With the increasing number of agricultural universities in the country, the scope of teaching agricultural statistics has widened very much. In this paper, therefore, the requirements of those seeking education in this discipline, the levels at which they should be taught and the syllabi that it should contain have been discussed. In addition, the type of research in agricultural statistics which should be integrated with the teaching of this discipline has also been touched upon.

23. NARAIN, P. Statistical techniques in animal breeding. *Proc. of the First Annual Conference of Agricultural Research Statisticians held at I.A.R.S., New Delhi in April, 1974, 98—108.*

The statistical problem encountered in analysing the structure of animal populations arises in the estimation of genetic and environmental sources of variation in characters and of co-variation between pairs of characters with a certain precision. A basic problem is then to determine in advance the optimum number of individuals to be measured in each family such that the sampling variation of the estimation is minimised for fixed resources. When a selection experiment is required to be planned, it is necessary to devise a statistical technique for estimating

the breeding values for the given character so as to be able to pick up the genetically superior animals for producing the next generation. Optimisation problems involved in such a case are several. Designs of progeny testing maximising the genetic change for fixed resources or minimising the cost for fixed rate of genetic change, construction of selection indices, combining information from several sources, predicting the limits of response to selection and the average number of generations required to attain the limits are some of the problems. When the objective of the breeding programme is to improve several characters simultaneously, the optimum selection index is required to be constructed for determining the breeding values. The problem of the genotype vs. environmental interaction is also related. Statistical considerations are also involved in measuring the amount of genetic improvement actually brought about in a selection experiment as opposed to the expected genetic gains normally predicted at the time of planning the programme. In a cross-breeding programme with exotic animals it is required to develop methods for comparing different grades of animals so that the best one could be selected for stabilising the level of exotic inheritance. In this paper, the statistical problems mentioned above have been discussed with illustrations from the studies on the analysis of breeding data undertaken at the I.A.R.S.

24. NARAIN, P. The conditioned diffusion equation and its use in population genetics. *Jour. Roy. Statist. Soc., Lond., B 36* (*2*); *258—266.*

The forward and backward conditioned diffusion equations relative to the event of the process attaining absorption in one of the boundaries have been derived from the corresponding Kolmogorov differential equations. The backward conditioned diffusion equation has been used to derive the mean and variance of the length of time until absorption in one of the boundaries. The general results so obtained have been applied to the problem of random drift in population genetics, giving the means and variances of the distributions of time until fixation as well as of time until extinction of a particular gene in a finite population.

25. NARAIN, P. AND JAIN, J. P. Some aspects of a sampling design for measurement of responses in Intensive Cattle Development Programme. *Jour. Ind. Soc. Agri. Stat., Sym. Vol., 1974.*

Since the initiation of the Intensive Cattle Development Programme (ICPD) in 1964, several States have taken up the work of assessment and evaluation of this programme but in the absence of any recommended sampling design, there seems to be no uniformity in their approach as well as in the norms and definitions of the various parameters involved. This renders comparisons between different regions difficult and one cannot draw any general conclusions in regard to the suitability of

various development measures. The Institute of Agricultural Research Statistics has recently undertaken large scale surveys for developing a methodology to study the impact of milk supply schemes on rural economy in milk collection areas. Since most of the ICDP units are located in the milk-shed areas of the large dairy plants, it is desirable that the sampling design for the assessment work may take into account the findings of the above mentioned large scale sample surveys. An attempt has, therefore, been made in this paper to discuss the various aspects of the sampling design for the assessment of progress in ICDP Units, taking into account the experience gained from the surveys conducted at the I.A.R.S. In order to develop a uniform approach, the model scheme of the ICDP formulated by the Ministry of Agriculture has been taken as the base. However, since several ICDP units, after their establishment, have deviated from this model scheme, modifications in the sampling design, to the extent necessary, may be called for, depending upon the area, facilities available and other factors.

26. NIGAM, A. K. Variance functions for comparing mixture designs. *Ann. Inst. Statist. Maths. 26* (2), *325—329.*

In this paper we have considered certain variance-functions for comparing mixture designs. Three variance functions, namely, variances at the optimum, variances at any given point and the overall variances have been proposed for comparing the efficiency of mixture designs.

27. NIGAM, A. K. Some designs and models for mixture experiments for the sequential exploration of response surfaces. *Jour. Ind. Soc. Agri. Stat. 25* (*1*), *120—124.*

In this paper we have considerd some designs and models for the sequential exploration of response surfaces in mixture experiments. The case when certain crosses variables are persent has also been considered.

28. PANDEY, R. K. Capital investment in I. A. D. P. districts. *Eastern Economist, 16* (*21*).

Evidences suggest that agriculture in IADP districts is better organised and more productive than in those not included under the programme. The aims of this paper were to study the investment pattern of farmers and to analyse the factors affecting investment at various size groups of holding as well as for all farmers in the selected IADP districts. The variables included in the analysis were average investment per hectare, size of holdings, ratio of investment financed by the farmers' own sources, and gross income per hectare. Separate equations were estimated for marginal, small, medium and large cultivators. It was concluded.

that equity ratio and holding size were not important variables. Gross income per hectare was a very important variable in the analysis.

29. PANDEY, R. K. Domestic consumption of sugar in India. *Southern Economist, 13 (16), 9—10.*

With sugar prices rising to dizzy heights, the question as to how they are related to supply and income factors is important. The empirical model consisted of per capita domestic consumption of sugar in India, whole-sale price of sugar and consumers' income. The study shows that there is no well established relationship between prices and domestic consumption of sugar. Similarly, income effect is very mild, With the future increase in per capita income, the sugar consumption may not rise much. Price effect is insingnificant but positive. This implies that consumption may decline in future on account of price rise.

30. PILLAI, S. S. The computer in agricultural research. *Proc. of the First Annual Conference of Agricultural Research Statisticians held at the I. A. R. S. in April, 1974, 51—64*

This paper gives an overview of the computer applications in the field of agriculture and animal husbandry research in India. Starting with the conversion of conventional method of statistical analysis of large scale survey data to electronic data processing, the Computer Centre has progressively used this modern tool for deeper and sophisticated statistical analysis. Use of computer in agricultural economics, soil survey studies, survey data analysis, plant breeding, genetics, and students' research has been elaborated.

31. RAHEJA, S. K. Computer aided teaching and training. *Proc. of the First Annual Conference of Agricultural Research Statisticians held at the I. A. R. S., New Delhi in April, 1974, 91—97.*

With the development of more and more sophisticated computer and powerful yet simple computer languages, the electronic computer has become increasingly versatile in the recent years. In the field of education computer is increasingly used in teaching as well as training. Teaching is subject oriented while training is job oriented. Computer applications in teaching of statistics have so far been rather limited and there is great scope for exploiting computer as an effective aid for a faster and easier teaching of various courses in statistics. What needs to be emphasised is that merely adding of computer programming courses into the present system of teaching of statistics will be neither sufficient nor even desirable. To

achieve what we may call a Computerised Education System, the teaching methods and course work would have to be restructured by suitably integrating the statistical courses with computer training. Thus, use of simple laboratory exercises (designed specifically to avoid laborious and complex computations) as at present given to students using table calculator would be a waste of valuable computer time and it would be essential to modify these exercises to justify the use of computer as also to demonstrate its speed and accuracy.

In the field of training some of the well known techniques are Stimulus-Response-Reinforcement (producing a desired response from a given stimulus), Gestalt psychology i. e. learning by perception (showing parts and allowing the trainee to complete the whole), Rote-memory (like remembering arithmetic tables by heart), learning by sign principle (like use of mnemonic names), demonstration and use of visual aids, learning from success vs. failure (Skinner's principle). Added to this are the objectively formulated tests for assessment of performance and achievements both on-course and off-course. The latter can also serve as a 'feed back' source and can help in bringing about improvements in the training course as well as in the teaching methods.

32. RAHEJA, S. K. and TYAGI, B. N. Statistical analysis of replicated field trials on cultivators' fields. *Jour. Ind. Soc. Agri. Stat., 26 (1).*

Formulation of fertilizer recommendations for an area has to be based upon results of scientifically planned experiments in cultivators' fields so as to be directly applicable to cultivators' conditions. The experiments should be conducted for 3-4 years and the results pooled suitably. Planning and statistical analysis of experiments conducted at different places in a year have already been described by different workers. The method of statistical analysis when these experiments are repeated on different places over a number of years has been described in this paper. The procedure is illustrated with the help of data on simple fertilizer trials conducted in Muzzaffarpur (Bihar) in 1958-59 to 1960-61. Test of significance and computation of standard errors for differences in the mean yields in various treatments are also given.

33. RAI. S. C. Technological change in foodgrains production in India. *Food, Agri. Plant. Jour., 1974.*

In this study, an attempt has been made to estimate the cumulative effects of technological change in the production of foodgrains in India during the years 1942-43 to 1964-65. Crops considered for the purpose of estimating the technological change are rice, jowar, bajra, maize, ragi, wheat, barley, gram, small millets and kharif and rabi pulses.

The study revealed that for the purpose of the technological change, the total period may be divided into two parts : One from 1942-43 to 1950-51 where the technical progress has got a decreasing trend. An annual decrease of 2.2 per cent has been observed in the technical development in agriculture in the above period. During the second part of the period, i.e., from 1950-51 to 1964-65, the technological change is observed to have a rising trend. It has registered an annual increase of about 2.8 per cent over 1950-51 value.

34. RAI, S. C. A model for rank analysis. *Food, Agri. Plant. Jour., 1974.*

A model for analysing the data obtained from experiments involving ranking has been proposed. The model is developed by postulating $t\ (t\text{-}1)\ /2$ paired comparisons in which order of the ranking is taken to be consistent. The advantage of the model is that it allows all the treatments to be compared together at the same time. Maximum likelihood estimates of the parameters are obtained and the test procedures are developed. The medel provides a test for comparing the treatment main effects. The interaction between judges and treatments can also be detected and tested in the model. Some of the procedures developed in the model have been explained by a numerical example.

35. RAJAGOPALAN, M., GUPTA, S. S., MEHROTRA, P. C. AND BANERJEE, A. K. Fertilizer application to IR-8 in Tamil Nadu. *Chemical Era 9 (5), 14—16.*

In this paper an attempt has been made to study the extent of popularity and yield performance of IR-8 variety of rice during kharif and rabi 1969-70 in the 4 districts, namely, Chingleput, Coimbatore, Madurai and Tirunelveli of Tamil Nadu. The results indicated that IR-8 was the most popular high yielding variety of rice in all the 4 districts, during both the seasons. All the sample fields received nitrogenous fertilizers, the percentage of fields receiving phosphorus and potash varied between 75 and 97 and 58 and 91 respectively. Though the rates of application of chemical fertilizers did not differ much for kharif and rabi seasons, the yield rates were comparatively higher in kharif as compared to those in rabi season except in Chingleput where they were almost of the same order. The results showed that only about one fourth of the sampled fields received N, P, K, round about the recommended dosages. The results also indicated that the yield rate of IR-8 variety increased with increased dosages of N up to 200 kg/ha but thereafter it showed a falling trend. It could be surmised that it would not be profitable to increase the dosages of N beyond 200 kg/ha.

36. RAUT, K. C. AND SINGH, SHIVTAR. Factors influencing the price of bovine stock. *Ind. Jour. Agri. Eco , 29 (2).*

The price of an animal depends on both the quantitative and qualitative characters. The quantitative characters are level of milk production, age, order of lactation, stage of lactation and stage of pregnancy in the case of milch stock and age in the case of male ones. The factors of qualitative nature like condition of health, colour and other confirmation characteristics are purely subjective and cannot be measured. A study has been made to see how far the factors of quantitative nature can influence the pricing of an animal, utilising data collected from the surveys carried out by I.A.R.S. in Madras city, rural areas of Tamil Nadu, Krishna delta area of Andhra Pradesh, Dhulia region of Maharashtra State and Hissar district of Haryana. Results are given for milch cows and buffaloes as well as for bullocks.

37 SAHA, G. M. DEY, A. AND KULSHRESTHA, A. C. Circular designs—further results. *Jour. Ind. Soc. Agri. Stat., 26 (1), 87—92.*

In this paper the association scheme of the circular designs of Das (1960) is studied. Circular designs for mn treatments in n blocks of mk plots and k repli cations are shown to be PBIB designs with $(n+1)/2$ or $(n+2)/2$ associate classes according as n is odd or even. The duals of circular designs are also shown to be PBIB designs of $(n-1)/2$ or $n/2$ associate classes according as n is odd or even.

38. SINGH, D. Applied Research in Sample Survey Techniques. *Proc. of the First Annual Conference of Agricultural Research Statisticians held at the I.A.R.S., New Delhi in April, 1974, 21—50.*

Some problems involved in the application of sample survey techniques have been discussed in this paper. At the outset, the logical development of the sampling theory has been briefiy sketched. It is observed that basically, as the theory of sampling was developed to solve the practical problems, the major contributions in the theory have been made by the sampling practising statisticians. Some of the problems in survey research arising from the field of agriculture have been discussed with a particular reference to the variety of sample surveys conducted by the Institute of Agricultural Research Statistics. Brief reviews of different methods of selection, e. g., systematic sampling, cluster sampling, sub-sampling, varying probabilities and methods of estimation, e. g., ratio and regression methods and their applications to some actual problems have been discussed.

Complexities of the problems are multiplied in multi-subject surveys. However, in order to economise the collection of the data, most of the surveys are becoming

multi-purpose. Non-sampling errors constitute yet another topic which pose serious problems to the samplers. Some studies made in this direction, e. g., choice of size and shape of the plots, etc., have been discussed.

Planning of sample surveys is a potential area of research. Different aspects of efficient planning of a sample survey have been investigated and various practical considerations involved in different stages of the conduct of a survey have been critically discussed. In the end, some areas of research and problems of general nature which require the attention of research statisticians are presented.

39. SINGH, D. AND RAHEJA, S. K. Indian agriculture and requirements of credit. *"Agricultural credit in India—an appraisal" published by the Agricultural Fair Memorial Farmers Welfare Trust Society, New Delhi in 1974.*

The exent of availability and utilisation of loan was studied for rice and wheat in 7 districts each in important States. It was observed that the percentage of farmers taking loan was more in larger holding size classes. The main source of credit was cooperative agencies although the average amount advanced by this source was generally smaller than those by other agencies including Government. The average amount of loan taken was higher for medium and large cultivators. With regard to requirements of credit, it was found that the amount of loan taken was far short of that required for meeting the cost of material inputs both at the recommended level as well as the level actually adopted by farmers. The loan utilisation was not in any way related to the fertilizer use, being generally in proportion to the area under high yielding varieties of the crops. It would therefore be desirable to have a fresh look at the terms and conditions on which credit is at present being advanced to farmers and modify or revise them suitably so as to enable the small farmers to avail of this facility easily and effectively. It may also be worthwhile to give loans in kind, say, as seed or fertilizer, rather than in cash to ensure their utilisation for agricultural purposes.

40. SINGH, H. D., AUSTIN, A. AND PILLAI, S. S. A comparative study of the physical dough characteristics of improved wheat varieties under irrigated and rainfed conditions. *Agriculture and Agro-Industries Journal, March, 1974.*

Grains of 16 improved wheat varieties grown separately under irrigated and rainfed conditions were tested for physical characteristics of dough made from straight run flour with an alvograph. Highly significant varietal differences were found for all the dough characteristics. Lerma Rojo having the lowest values for stability, elasticity, strength, deformation work and P/G ratio, but highest values

for extensibility and swelling index was characterised with very weak, pliable and highly extensible dough properties. The crop raised under rainfed condition had shown higher values for all the characters. These were especially significant for stability, elasticity, strength and deformation work.

41. SINGH, R. D., SINGH, D. AND RAO, P. R. Estimation of agricultural acreage response relationship—some methodological issues. *Ind. Jour. Agri. Eco., 29 (1), 26-38.*

The paper is an attempt to examine empirically the following methodological issues :

(1) Whether the Nerlovian adjustment lag model can be better than the traditional model in all respects as claimed by Nerlove and others using this model,

(2) Which of the prices enters the farmers' expectations most vitally in their resource allocation decisions, and

(3) How can the effect of inter-regional characteristics be quantified and incorporated in the macro model to yield some meaningful result.

The study is based on data of Indian Virginia tobacco covering a period of 28 years, i. e., 1940-41 to 1967-68.

The study confirms that (1) the Nerlovian as well as traditional supply models can be equally efficient for estimating short run supply price elasticities, (2) the preference to Nerlovian adjustment lag model could be explained more in terms of its superiority with regard to the distinction that it makes between short run and long run elasticities, to the elimination or reduction of the incidence of serial correlation, and to its being able to present a more realistic supply situation by incorporating adjustment lag in the model; (3) the question of price specification that can be said to enter the expectation behaviour of farmers should not exclusively be decided on a priori assumption, and (4) aggregate or macro supply function must make adequate allowance for the inter-regional characteristics and their impact on the magnitudes of supply and variation therein.

42. SONI, P. N. Cropping pattern and crop intensity in various size classes of farmers in some I. A. D. P. districts. *Agri. Situ. Ind., 29 (7).*

The paper reports changes in cropping pattern and intensity of cropping in different size classes of farmers between the two periods 1962-65 and 1968-71, utilizing the data pertaining to cropped area in representative cultivator's holdings

selected under the Assessment Surveys conducted in the I. A. D. P. districts. Changes in cropping patterns in different districts were observed to be confined to specific areas, which tended to be fairly similar in respect of agro-climatic conditions. These included both irrigated and un-irrigated areas. The proportionate area under paddy in the districts indicated falling trend. This was more pronounced in large holdings as compared to that in small ones. The reduction in fallows during rabi season largely contributed to increase in crop intensity. The gain in crop intensity was observed to be positively associated with increase in holding size.

43. SRIVASTAVA, A. K. and SINGH, SHIVTAR. A note on two stage successive sampling. *Jour. Ind. Soc. Agri. Stat., 26 (1).*

In this paper, an estimation procedure has been discussed for two stage sampling design on several occasions where primary as well as secondary sampling units are partially retained.

APPENDIX VI

List of papers accepted for publication during the year 1974

1. BANERJEE, A.K., DEY, A. and SAHA, G.M. Main effect plans for 3^n factorials. *Ann. Instt. Stat. Maths.*

2. BHARGAVA, P. N., NARAIN, P. and PRADHAN, ASHA. A study on the recurrence of deficient rainfall in relation to rice crop. *JNKVV Res. Jour.*

3. BHARGAVA, P. N., RUSTOGI, V. S. and PANDEY, R. K. A study on marketable surplus of paddy in Shahabad district. *Economic Affairs.*

4. BHARGAVA, P. N. and SARDANA, M. G. Size and shape of plot for field experiment on apple crop. *Ind. Jour. of Horticulture.*

5. GARG, R. C. and PILLAI, S. S. Ratio-type estimation in double sampling for two stage designs. *Jour. Ind. Soc. Agri. Stat.*

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