ANNUAL REPORT
1973

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

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(I. C. A. R.)
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PREFACE

The Institute of Agricultural Research Statistics, New Delhi issues reports annually and the present report is for the year 1973. Efforts have been made to cover all the aspects of the functions and activities of the Institute during the year under report as far as possible.

I hope that this report would serve as useful reference for Agricultural Research Workers and other users. The Institute would welcome and appreciate any comments and suggestions for the improvement of similar reports in the future.

I am thankful to all the officers and staff of the Institute who have given unflinching cooperation in preparing and supplying the material required for this report. I take pleasure in acknowledging the untiring efforts of Sh. R.K. Khosla, Sh. B.N. Mehta and Sh. M.L. Sahni who were responsible for compiling and preparing the draft report and would like to place on record particularly the pains taken by Dr. P. Narain for final editing of this report.

D. Singh,
Director,
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New Delhi-110012

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INSTITUTE OF AGRICULTURAL RESEARCH STATISTICS

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ANNUAL REPORT FOR 1973.

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

The Institute made a modest beginning in 1930 as a statistical section of the Indian Council of Agricultural Research in pursuance of the recommendations of the Royal Commission of Agriculture. It was then manned by only one Statistician and a limited staff. The principal function of the Statistician was to assist the agricultural officers in the various provinces of the country in planning experiments, analysing the data and interpreting the results. He was also responsible for scrutiny of the technical programmes and progress reports of the research schemes of the Council.

The activities of the statistical section entered a new phase towards the end of 1943 when, at the instance of the Government of India, research was initiated

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

In 1945, the Council instituted regular post-graduate training courses for professional statisticians wishing to specialize in agricultural statistics and for research workers in the field of agriculture and animal husbandry who were desirous of acquiring knowledge of simple statistical methods required most often for use in their work. Although research and teaching was integrated, a small training unit consisting of whole-time professors, assistant professors and demonstrators was constituted for organising the various courses of study. The 'Statistical Wing' soon acquired international recognition as a training and research institution in the field of agricultural statistics and was made responsible for training foreign students and organising seminars for the Food and Agricultural Organisation of the United Nations.

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

In 1952, the services of two F.A.O. experts, Dr. Frank Yates, Chief Statistician, Rothamstead Experimental Station and Dr. D.J. Finney of Oxford University, were assigned to the Government of India to advise and assist the I.C.A.R. in reviewing its research and training activities. As a result of their recommendations, the activities of the 'Statistical Wing' were expanded in many directions. In August, 1955, it moved to its present campus at Pusa in the neighbourhood of the Indian Agricultural Research Institute for closer collaboration with that Institute. The campus provided adequate space not only for

office accoommodation for the technical and the ministerial staff but also for facilities of a library, class-rooms for the training classes, an auditorium and a hostel with the usual amenities including a play-ground for tne students admitted to the various courses of study. Also, in view of its important role as a training and research institution, the 'Statistical Wing' was designated as the 'Institute of Agricultural Research Statistics' in 1959. A mechanical data processing unit was also 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. The first and the second floors of the new building provided additional suitable office space for the expanding technical and ministerial staff of the Institute and a better accommodation for the co-operative canteen of the Institute that had been established in 1959. Also, there was now another more spacious auditorium in the third floor, which also served as a suitable venue for the cultural and other activities of the Recreation and Welfare Club of the Institute. All these facilities enabled the Institute to discharge its functions more efficiently.

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

1.1. Organisational structure of the Institute

The research and technical work of the Institute was re-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 Analysis.

The number of Class I Officers in position as on 31st December, 1973 was 45. A list of these officers is given as Appendix I. On the research and training side, the Director was assisted by 3 Senior Statisticians, 17 Statisticians-cum-Associate Professors, 1 Agricultural Economist, 16 Junior Statisticians, 1 Assistant

Professor, 1 Mechanical Tabulation Officer and 2 Field Officers and on the administrative side, by a Chief Administrative Officer, an Administrative Officer and an Assistant Administrative Officer.

The number of posts (including out-station posts) sanctioned as on 31st December, 1973 was 588 comprising 74 Class I, 52 Class II, 386 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 at the Indian Agricultural Research Institute, New Delhi-12 in May, 1966, a Staff Research Council was constituted at the Institute early in the year 1970. The objectives of the Research Council are to carefully choose the reseach programmes of the Institute, to decide on priorities, and to watch the progress of the various research schemes with a view to remove bottlenecks, 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 at the Institute during the year under report. Dr. A.K. Nigam continued as the Member-Secretary of the Research Council. Meetings of the Council were held on 10th, 11th and 12th of October, 1973. In addition, several sub-committee meetings of the Council were held from time to time. In these meetings, the progress of all the 37 research projects which were in operation or were proposed to be taken up during the year was discussed in detail.

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 the Hostel Annual Day on the 14th of July, 1973. Professor Sher Singh, Minister of State for Agriculture, Ministry of Agriculture, Government of India, was the Chief Guest.

1.4. Library

During the year under report, 256 new books and 200 other publications were added to the Library. There was, as usual, a constantly increasing number of queries about location of literature and for the short range reference service, which were duly attended to. About 13,500 persons visited the Library for borrowing or reading purposes and for consulting references. About 19,000 books 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 curtailed; it now remained open for 8 hours only from 9 A.M. to 5 P.M.

As usual, inter-library loan facilities were exchanged with other libraries in the country in general and with those in Delhi in particular. As in the past, reprints of the articles by the scientists of the Institute were sent to scientists in the country and abroad.

A catalogue of the theses available in the Library was prepared during the year under report. The arrangement in the catalogue is in "Dictionary order" and the arrangement of theses in the shelf is strictly according to specialised simple class number of the theses.

The Library was looked after by a Senior Library Assistant (Grade II) under the guidance and supervision of Dr. Prem Narain, Senior Statistician 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 the important projects undertaken by the Institute are presented in the form of graphs and charts. Besides, important publications by the officers and members of staff of the Institute are also displayed there. The Exhibition Room enables a visitor to the Institute to get at one place a comprehensive picture of the important research activities of the Institute.

During the year under report, a number of distinguished visitors to the Institute including Prof. Sher Singh, Minister of State for Agriculture, Govt. of India, Dr. M.S. Swaminathan, Director General, I.C.A.R. and Dr. B.K. Soni, Deputy Director General (AS), I.C.A.R. were taken round the Exhibition Room.

1.6. Fellowships

The courses of study for which fellowships are awarded by the Institute, the values of the fellowships, and the periods for which the same are tenable are givev 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, 37 fellowships were awarded as detailed below :

(*i*)	Ph.D. I Year	2
	II Year	2
	III Year	1
(*ii*)	Diploma	8
(*iii*)	M.Sc. I Year	7
	II Year	10
(*iv*)	P.S.C.	7

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 Experiments Scheme of the I.C.A.R. and with the Soil Science and Agricultural Chemistry Division of that Institute in the planning and designing of experiments under the Soil Test Crop Response Scheme.

(*b*) The scheme for estimating the cost of production of apples and studying their marketing practices in the Himalayan Region of Uttar Pradesh (vide Section 4.2) was, as mentioned in the report for the year 1972, undertaken by the Institute in active collaboration with the Directorate of Marketing and Inspection, Government of India, the Department 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 multi-level planning basis.

(*c*) The Institute also continued its collaboration with the Directorate of Economics & Statistics, Ministry of Agriculture upto July, 1973 in the analysis and interpretation of the data collected through assessment sample surveys for the evaluation of the Intensive Agricultural District Programme spread over 18 districts in the country.

1.8 Advanced Training

(*a*) Shri S.N. Mathur, Junior Statistician was deputed to attend a training course in PL/I computer programming language for the IBM-360 and IBM-370 series of computers held at the IBM Education Centre, Delhi from 26th March to 10th April, 1973.

(*b*) Shri K.V. Sathe, Statistical Investigator was deputed to attend a training course in linear programming imparted by the Delhi Chapter of the Computer Society of India from 24th to 28th September, 1973.

1.9 Visitors

During the year under report, two eminent statisticians, Dr. B.V. Sukhatme, Professor of Statistics, Iowa State University, U.S.A. and Dr. N.C. Giri, Professor of Statistics, Montreal University, Canada visited the Institute and delivered lectures on topics of current research. A number of other distinguished visitors including Prof. Sher Singh, Minister of State for Agriculture, Govt. of India, Dr. M.S. Swaminathan, Director General, I.C.A.R. and Dr. B.K. Soni, Dy. Director General (AS), I.C.A.R. also visited the Institute.

Shri S.C. Madan, Statistician, Department of Animal Husbandry, Govt. of Rajasthan, visited the Institute to discuss various problems in the statistical analysis of the data collected in the sample surveys on livestock products conducted in the State.

Besides, groups of I.S.E.S. and other trainees and officers of the Central Statistical Organisation and trainees of the Pusa Polytechnic visited the Institute at different times and for different periods during the year under report to attend the lectures and practicals specially arranged for them. Shri Pierre Louis, an F.A.O. trainee and Shri T.M. Srinivasan and Shri B. Gnanasundram of the Agricultural Economics Research Centre, Department of Economics, University of Madras visited the Institute to receive training on Unit Record Machines.

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/ Committees as indicated below :—

Name of Officer	*Name of Scientific Panel*
Dr. P. Narain	(*a*) Scientific Panel for Plant Breeding.
	(*b*) Scientific Panel for Fisheries Research.
Sh. B. Marutiram	(*a*) Scientific Panel for Animal Breeding.
	(*b*) Scientific Panel for Animal Pests and Diseases.
	(*c*) Scientific Panel for Animal Products Technology.

Sh. K.C. Raut	Scientific Panel for Dairy Science.
Sh. T. Jacob	Scientific Panel for Animal Nutrition and Physiology.
Dr. M.S. Avadhani	Scientific Panel for Agricultural Economics, Statistics and Marketing.
Dr. A.K. Nigam	Scientific Panel for Plant Physiology.
Sh. U.G. Nadkarni	Scientific Panel for Animal Products Technology.
Sh. L.K. Garg	Scientific Panel for Fisheries Research.

(*b*) During the year under report, the officers named below were members of the scientific associations, committees, panels, etc. mentioned against their names.

Name of Officer	*Name of Scientific Panel, Committee, etc.*
Dr. D. Singh	(*a*) International Statistical Institute, The Hague, Holland. (*b*) Indian Science Congress Association, Calcutta. (*c*) Indian Society of Agricultural Statistics, New Delhi. (*d*) Post-Graduate Faculty of the P.G. School, I.A.R.I., New Delhi. (*e*) Statistical Sectional Committee of the Indian Standards Institution, New Delhi.
Dr. M.N. Dass	(*a*) Indian Society of Agricultnral Statistics (Secretary). (*b*) Indian Association of Statistics, Bombay. (*c*) Calcutta Statistical Association. (*d*) Indian Science Congress Association. (*e*) Post-Graduate Faculty of the P.G. School, I.A.R.I., New Delhi.
Dr. P. Narain	(*a*) Indian Science Congress Association. (*b*) Indian Society of Agricultural Statistics (Also Editor of its Journal).

	(*c*) Indian Society of Plant Breeding and Genetics.
	(*d*) International Biometric Society, U.S A.
	(*e*) Society of Advancement of Breeding Research in Asia and Oceania (SABRAO), Japan.
	(*f*) Genetic Association of India.
	(*g*) Indian Association for Animal Production (Also, a member of the Editorial Board of its Journal).
	(*h*) General Council of the University of Edinburgh, U.K.
	(*i*) Post-Graduate Faculty of the P.G. School, I.A.R.I. New Delhi.
Shri S.K. Raheja	(*a*) Indian Society of Agricultural Statistics
	(*b*) Post-Graduate Faculty of the P.G. School, I.A.R.I., New Delhi.
	(*c*) Panel of Judges for All India Crop Competition Scheme of the Directorate of Extension, Ministry of Agriculture.
	(*d*) Expert Committee on Manures and Fertilizers, Ministry of Agriculture.
Sh. K.S. Krishnan	(*a*) Sampling and Analysis Sectional Committee of the Indian Standards Institution.
	(*b*) Censory Evaluation Sectional Committee of the Indian Standards Institution.
	(*c*) ICAR Panel on More Efficient Use of Fertilizers and Manures to Crops.
Sh. S.D. Bokil	(*a*) Indian Society of Agricultural Statistics.

	(*b*) Indian Society of Agricultural Economics, Bombay.
Sh. B. Marutiram	(*a*) Indian Society of Agricultural Statistics.
	(*b*) Indian Dairy Science Association.
	(*c*) Indian Association for Animal Production.
Shri K.C. Raut	(*a*) Indian Society of Agricultural Statistics.
	(*b*) Sensory (Organoleptic) Tests Sub-Committee of the Indian Standards Institution.
Shri A.H. Manwani	Study Team on Fruits and Vegetables Statistics constituted by the National Commission on Agriculture (Convenor).
Dr. B.B.P.S. Goel	(*a*) Indian Society of Agricultural Statistics.
	(*b*) Study Team on Livestock Statistics in the National Commission on Agriculture.
Dr. M.S. Avadhani	Indian Society of Agricultural Statistics (Life Member and Hony. Jt. Secretary).
Dr. Aloke Dey	(*a*) Indian Science Congress Association.
	(*b*) Indian Society of Agricultural Statistics.
Sh. J.N. Garg	Post Graduate Faculty of the P.G. School, I.A.R.I., New Delhi.
Sh. R. Gopalan	Indian Society of Agricultural Statistics.
Sh. J.S. Maini	Indian Society of Agricultural Statistics.
Sh. L.K. Garg	Indian Society of Agricultural Statistics.
Sh. V.S. Rustogi	Association of Scientific Workers of India, New Delhi.

Sh. S.N. Mathur	Delhi Chapter of the Computer Society of India.
Sh. R.K. Khosla	(*a*) Indian Society of Agricultural Statistics. (*b*) Rice Research Workers Association, Cuttack. (*c*) Association of Scientific Workers of India.
Sh. A.C. Kaistha	Indian Society of Agricultural Statistics (Life Member)
Sh. K.V. Sathe	Delhi Chapter of the Computer Society of India.

(*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. Governing Body, I.C.A.R.
5. Standing Finance Committee, I.C.A.R.
6. Scientific Panel on Agricultural Economics, Statistics and Marketing, I.C.A.R.
7. Standing Committee for Agricultural Economic, Statistical and Marketing Research, I.C.A.R.
8. Working Group on Agricultural Statistics, National Commission on Agriculture.
9. Working Group on classification of the country into suitable agro-climatic regions and their production potential, National Commission on Agriculture.
10. Technical Committee for studies on evaluation of special employment programmes, Department of Agriculture.
11. Committee on sample surveys in hilly districts of Uttar Pradesh, Planning Commission.
12. Working Group on crop weather relationship, Meteorological Department.

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

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

15. Committee on Improvement of Agricultural Statistics, National Sample Survey.

16. Expert Committe on Crop Surveys, West Bengal.

17. Expert Team for assessment of fertilizer requirements for achieving the agricultural production targets, Department of Agriculture.

18. Sub-Working Group on Agricultural Planning, Department of Economics and Statistics.

19 Standing Committee on Export of Manures and Fertilizers, Department of Agriculture.

20. Sub-Working Group on Agricultural Statistics, Department of Economics and Statistics.

21. Working Group on Crop Weather Relationship Studies of the National Commission on Agriculture, New Delhi.

22. Technical Advisory Commitee for Agro-climatic Studies of Drought of the Indian Meteorological Department Poona.

23. Study Group on Rainfall Reliability Analysis of the I.C.A.R., New Delhi.

24. The Computer Society of India.

1.11. Appointments, promotions, transfers etc.

Shri K.V. Sathe, Junior Statistician, reverted to the post of Statistical Investigator with effect from 1st August, 1973.

Dr. D. Singh, who was on deputation as Deputy Agricultural Census Commissioner in the Department of Agriculture, re-joined the Institute as Director on 31st October, 1973 and Dr. M.N. Das, who officiated as Director during his absence, reverted to the post of Senior Professor of Statistics.

In November, 1973 Dr. M.N. Das, Sr. Professor of Statistics proceeded on leave abroad on a research assigment in Canada.

Shri M.P. Jha who was on foreign assignment with the Food and Agriculture Organisation of the United Nations as Agricultural Statistician in Seoul, South Korea, resumed duty in the post of Statistician-cum-Associate Professor on 31st December, 1973.

1.12. Miscellaneous

(*a*) Dr. D. Singh who rejoined the Institute as Director on 31st October, 1973 continued to discharge the duties of his former post of Deputy Agricultural Census Commissioner in the Department of Agriculture, Krishi Bhavan, New Delhi.

(*b*) Dr. M.N. Das, Director paid a visit to the Central Inland Fisheries Research Institute, Barrackpore in February, 1973 to participate in a discussion on the cost-benefit ratio of the coordinated project on inland fisheries development. In August, 1973, he attended a meeting of the working group on "Utility of Gram Sevaks" held at the National Institute of Community Development, Hyderabad.

(*c*) Dr. Prem Narain, Senior Statistician, delivered a series of extension lectures on "Statistical genetics and breeding" for the benefit of the students in dairy cattle and production and poultry production, etc. at Punjabrao Krishi Vidyapeeth, Akola (Maharashtra) in March, 1973. In August, 1973, he delivered a lecture on "Statistical Research in Animal Sciences" for the benefit of the trainees at the Central Statistical Organisation, New Delhi. In October, 1973, he delivered an extra-mural lecture on "Some aspects of statistical genetics in relation to animal improvement" at the U.P. Institute of Agricultural Sciences, Kanpur and gave a seminar talk on "Use of auxiliary traits in increasing the efficiency of selective breeding" at the Animal Science Department of Punjab Agricultural University, Ludhiana.

Dr. Narain was the President of the Seminar Association of the Institute during the year under report.

(*d*) Shri S.K. Raheja and Shri K.S. Krishnan, Senior Statisticians delivered lectures to the I.S.S. Probationers at the Central Statistical Organisation, New Delhi.

(*e*) Shri K.C. Raut, Statistician-cum-Assoc. Professor delivered a lecture on "Cost of production of livestock products" at the Summer Institute organised at the Indian Grassland and Fodder Researeh Institute, Jhansi in September/October, 1973.

(*f*) Dr. B.B.P.S. Goel, Statistician-cum-Assoc. Professor, delivered lectures on "Official Statistics" at the University of Delhi, Delhi.

(*g*) Dr. M.S Avadhani, Statistician-cum-Assoc. Professor offered technical advice for measuring the accuracy of a planchet designed by Dr. (Smt.) Shobha Sriharan, Junior Entomologist, I.A.R.I., New Delhi to

to count the radio activity of living insects under natural conditions and also advised on laying out of experiments for obtaining the relationship between the distance from the the point of placement and the time taken for the manifestation of the effect of insecticides on grass leaf hoppers.

(*h*) Dr. A. Dey, Statistician-cum-Assoc. Professor, was elected a member of the Sectional Committee in the Section of Statistics of the Indian Science Congress for the year 1973-74.

(*i*) Shri A.K. Banerjee, Junior Statistician, delivered lectures on "Statistical methods adopted in studies on insect-host plant relationship" at the Summer Institute on "Insect Plant Relationship" held at the Division of Entomology. I.A.R.I., New Delhi from 7th May to 2nd June, 1973.

(*j*) Shri J.S. Maini, Junior Statistician, was awarded a prize of books worth Rs. 50/- for securing as high as 93% marks in the Sample Survey Theory Paper in the Professional Statistician's Certificate Course Examination, which he passed in the First Division.

(*k*) Shri S.N. Mathur, Junior Statistician, visited the Central Arid Zone Research Institute, Jodhpur in December, 1973 to advise the Range Management Specialist there for computerization of the data collected under the Range Management studies for a number of projects during the previous several years.

(*l*) Shri S.C. Rai, Assistant Professor, organised an educational tour for the benefit of the Ph. D. and Diploma students of the Institute.

(*m*) A Summer Institute on "Design and Analysis of Agricultural Experiments" was organised by the I.C.A.R. at the Institute from 7th May, 1973 to 9th June, 1973 for the benefit of college teachers and research workers engaged in application and/or research in Statistics. Dr. M.N. Das, Shri S.K. Raheja, Dr. A. Dey, Dr. A.K. Nigam, Shri A.K. Banerjee, Shri Padam Singh, Shri S.C. Rai and others delivered lectures to the participants.

(*n*) The Work Study Team of the I.C.A.R. examined the working of the administrative sections of the Institute during the year and its report was awaited.

(*o*) As mentioned in the reports for the years 1971 and 1972, an Achievement Audit Committee under the Chairmanship of Dr. K. Ramiah,

M.P. and with Dr. M.S. Swaminathan. Director, I.A.R.I., New Delhi, Dr. P.V. Sukhatme, Director, Statistics Division, F.A.O., Rome, Dr. C,R. Rao, Director, I.S.I. and Prof. V.M. Dandekar of the University of Poona, Poona as members was set up by the I.C.A.R. in May, 1971 to examine the working of the Institute. The report of the Committee was received in March, 1973 and its recommendataions were being eaxmined by the I.C.A.R.

(*p*) The construction work of a new building in the campus of the Institute to serve as the Computer Laboratory and Library was taken up by the Central Public Works Department in June. 1973.

2. STATISTICAL RESEARCH IN AGRICULTURAL SCIENCES

The programme of statistical research in Agricultural Sciences was continued during the year under report. The progress of work pertaining to the various items of research as per programme laid down is given below in brief. The names of the principal investigator and his associate or associates are given at the end of the description.

2.1. Designing of experiments and statistical analysis of data collected under the Coordinated Agronomic Experiments Project.

The objectives of the Co-ordinated Project are to organise on all India basis complex experiments at Model Agronomic Research Centres and simple experiments on cultivators' fields on various agronomic aspects such as multiple cropping, fertiliser use, weed control, etc. The experiments have to be carefully planned and layouts prepared suitably. The data collected from these experiments need thorough scrutiny and comprehensive statistical analysis. The results obtained in the successive years should be compared for consistency and for assessing the extent of seasonal variations.

During the year under report the scheme was in operation in 56 districts and at 45 Model Agronomic Centres. In the districts covered about 9,000 simple experiments in all were conducted on cultivators' fields. At Model Agronomic Centres about 600 complex experiments in all were conducted. The simple experiments on cultivators' fields provided data on :

(*i*) the response of high yielding crop varieties of cereals to nitrogen, phosphorus, potassium and zinc with a view to formulating fertiliser recommendations for different agro-climatic regions of the country under irrigated and assured rainfall conditions ;

(*ii*) the response of important cereal, legume and oilseed crops to fertilisers under dry farming conditions and

(*iii*) the inter-relationship between the soil test values and crop responses to fertilisers.

The complex experiments provided data on :

(*i*) the response of important cereals to nitrogen, phosphorus and potassium singly and in combination ;

(*ii*) the best method and time of fertiliser application ;

(*iii*) the relative efficiency of complex fertilizers ;

(*iv*) the residual and long term effects of fertilisers and manure ;

(*v*) the most suitable intensive crop rotation for maximum production and different agro-climatic regions ;

(*vi*) the critical periods of irrigation of dwarf, durum and aestivum wheats and

(*vii*) the effects of various herbicides for weed control in different cropping systems.

Inspite of adverse climatic conditions prevailing in 1972-73 annual grain production of over 10 tonnes/ha was achieved at 11 Model Agronomic Research Centres. The highest production of about 17 tonnes/ha per annum was achieved at Tirupati with rice-rice-rice rotation. The results of inter-cropping experiments at the research centres showed that the inter-row spacing in *arhar* crop could be advantageously utilised for growing moong or other pulses. At Ludhiana with maize-wheat rotation a high response of 19 q/ha of wheat was obtained to the application of 60 kg P_2O_5/ha, but the succeeding maize crop could satisfy its phosphorus requirements from the residual effect.

Fertiliser response on cultivators' fields to $N_{80}P_{60}K_{60}$ exceeded 20 q/ha for paddy in Jammu, Kangra and Midnapore and for wheat in Bulandshahr. Significant response of about 5 to 6 q/ha of paddy was obtained at Pura and Kathulia Farm with 25 kg/ha of zinc sulphate and of about 8 q/ha of *jowar* at Indore with 50 kg/ha of the same chemical. Experiments on cultivators' fields under dry land conditions indicated good response to combined application of nitrogen, phosphorus and potassium to paddy in Rewa, Ramanathapuram and Mayurbhunj, to wheat in Hoshiarpur and Ambala, to maize in Ambala and Panchmahals, to *jowar* in Jaipur and to groundnut in Dharwar. (K.S. KRISHNAN, C.R. LEELAVATHI, S.R. BAPAT, V.N. IYER, S.C. JAIN, SHANTI SWARUP AND Y.R. DESHMUKH).

2.2. National Index of Agricultural Field Experiments.

The objects of this project are (*a*) to collect and maintain at a central place the results of all agricultural field experiments conducted in the various

research stations spread over the country; (*b*) to summarise the results of such experiments over the years and publish their results in the form of compendia and (*c*) to prepare critical summaries of important topics of agricultural research.

During the year under report experimental data in respect of about 4,800 experiments conducted during the period 1966-71 were received from the regional staff posted in different States. Including the data reported in earlier years the number of experiments conducted during the years 1966-71 for which the data had been received from the regional staff upto the end of December 1973 was of the order of 14,500. Analysis of experimental data and summarisation of the results for the experiments conducted during the period 1960-65 were completed for the regions of Gujarat, Orissa, Rajasthan, Tamil Nadu, West Bengal, Assam, Kerala and Mysore. Experimental data in respect of 2360 experiments for the period 1966-71 collected during the year under report were also analysed. The data in respect of the remaining experiments reported were under scrutiny or punching. Material for Volume II of the Index of Agricultural Field Experiments in respect of the experiments reported to the Institute by the Regional Staff during the year 1972 was under preparation.

Compendia volumes of Part III series for the period 1960-65 were printed for the regions of Gujarat, Orissa and Rajasthan. Introductory material was also prepared for the regions of Gujarat, Orissa, Rajasthan and Tamil Nadu. Printing of the core experimental material had been completed in respect of Tamil Nadu, Assam, Kerala and West Bengal. (R.K. KHOSLA, K.S. KRISHNAN, P.N. BHARGAVA, P.N. SONI, P.P. RAO, M.P. SAKSENA AND B.L. CHOWDHRY).

2.3. Pilot studies on Pre-harvest Forecasting of Yield of Crops.

The objective of the project is to investigate whether pre-harvest estimates of crop yield can be obtained objectively on the basis of the bio-metrical observations such as plant density, plant height and basal diameter recorded at different intervals of time during the crop growth.

The survey work was conducted for four crops as given below :

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

Paddy : Sambalpur (Orissa) and West-Godawari (Andhra Pradesh).

Jute : 24-Parganas (West Bengal) and Purnea (Bihar).

Cotton : Jalgaon (Maharashtra) and Baroda (Gujarat).

In each district about 250 fields were selected by adopting the stratified multi-stage random sampling technique and the bio-metrical data were recorded at the interval of four weeks starting after one month of sowing of the crop.

Multiple regression analysis was carried out for identifying the nature of relationship between yield and different bio-metrical characters. The analysis was carried out under four different models, namely : (*i*) original scale; (*ii*) logarithmic scale; (*iii*) square root scale; and (*iv*) inverse scale. Suitability of models was judged on the basis of the amount of variation in the yield explained due to the multiple regression.

In the case of cotton crop analysis was carried out in three stages by taking the dependent variate as (i) the yield of the first picking; (ii) total yield of the first two pickings; and (iii) total yield of all the pickings. Correlation coefficient between total yield of all the pickings and the yield of first two pickings was found to be of high order (0·8 to 0·9). The regression analysis carried out by taking the yield of all the pickings and the yield of the first two pickings gave almost similar trend regarding the significance of the multiple correlation and regression co-efficients and the amount of variation explained due to the regression. Thus the yield of first two pickings could be used for developing the regression relationship for pre-harvest forecasting studies. The number of plants and the number of balls per plant contributed significantly to the amount of variation due to the regression.

The analysis of data relating to the jute crop revealed that the number of plants and mean height of the plants are mainly responsible in developing the regression relationship for forecasting studies.

The analysis of the data on wheat and paddy crops indicated that the number of plants and the number of tillers per plant contributed most of the variation in the yield explained by the regression. (H.P. SINGH, N.K. OHRI AND I.C. SETHI).

2.4. Crop Weather Relationship Studies

The objective of the project is to study the effect of the rainfall on crop production in Raipur District (Madhya Pradesh).

Daily rainfall data for 24 years from 1944 to 1967 and yield rates for paddy for the corresponding periods were utilised. Rainfall data were collected from Meteorological Department, Poona and yield data were obtained from the

Directorate of Agriculture, Madhya Pradesh. In order to study the various aspects of rainfall like pattern of the behaviour of wet and dry spells, distribution of rainfall during various months of the season, and symmetrical fluctuations of the rainfall, various statistical techniques were applied.

The results of the investigations had suggested that rainfall was one of the most important factors contributing towards increase in the yield rate of paddy. The distribution of rainfall for individual months was found to be suitably described by normal curve. The cyclical behaviour of the rainfall could be suitably described by the harmonic function and the periodicity of the cycle was found to be of the order of about 9 years.

(P. N. BHARGAVA, PREM NARAIN AND ASHA PRADHAN)

3. STATISTICAL RESEARCH IN ANIMAL SCIENCES

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

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

The objective of the project was to develop statistical techniques for estimating genetic improvement with the help of cross-bred data on cattle and sheep. The sheep breeding data spread over about 14 years (1952-66) and collected at Sheep Breeding Farm. Banihal Reasi, Kashmir in connection with the I.C.A.R. Scheme for improvement of wool by cross-breeding on regional basis, were used. The data regarding the cross-bred cows of different Military Dairy Farms for the period 1934-55 consisting mostly of crosses (i) Sahiwal x Friesian (ii) Red Sindhi x Friesian and (iii) Sahiwal x Ayrshire x Friesian were used to study the genetic diversity between different grades of animals.

The technique of discriminant functions was used to obtain a score for the quality of an animal on the basis of several characters. These scores were used to rank the various grades available for assessing their potential for genetic improvement. In the case of sheep, the discriminant function viz. $Y=7.57X_1-X_2-1.49X_3+2.08X_4$ was found to fit the data with maximum discriminating power where X_1 is greasy-fleece weight, X_2 is fibre-diameter, X_3 is fibre-length and X_4 is fleece density. It. was found that in the comparison involving exotic breeds, fleece weight and fibre-diameter were comparatively more important than the other characters whereas in the comparisons not involvlng the exotic breed, fibre-diameter happened to be the most important character contributing between 53 to 59% of the total difference in terms of the discriminant function. It was further observed that, on the basis of discriminant function, half-breds and three-fourths did not differ substantially and therefore the optimum level of exotic blood for stabilising a new breed of sheep could be taken as 50%. The analysis of data relating to cattle was in progress (PRRM NARAIN AND L.K. GARG.)

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

The objective of the project was to develop statistical methodology for developing efficient selection procedures in poultry breeding.

The project had arisen due to a collaboration of the I.A.R S. with the High Level Inservice Training (Poultry) Institute, Hessarghata (Bangalore) and Regional Poultry Farm, Bhopal, under the Co-ordinated Poultry Breeding Programme of the State Government of Madhya Pradesh. The selection of birds (based on an index for rate of lay) for propagating the next generatlon of birds at the Poultry Farm at Bhopal was carried out at this Institute with the help of electronic computer. The data sent by the Farm were analysed on a top priority basis and selection scores of the birds were sent back to the Farm in the shortest possible time. The data obtained under this programme were further analysed with a view to develop efficient selection procedures under this project.

Birds were selected on the basis of an index where appropriate weights were attached to full-sib family average, half-sib family average and individual records for rate of lay which is expressed as the total egg production up to 240 days of age divided by 241 minus the age at first egg. Since egg production is considerably affected by location, the data were adjusted for their effects within each sire group by the method of fitting constant. Adjusted data were analysed by the half-sib method to get an estimate of heritability of lay. Using the estimate so obtained, selection indices for pullets and cockrels were worked out.

The analysis of the data of the foundation stock and first generation of birds of selected parents showed that the average rate of lay n the first generation was higher than that of parental generation by about 7%. The heritability of rate of lay was found to decrease due to selection. Further analysis of data was in progress. (PREM NARAIN AND J.P. JAIN).

3.3. 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. Attempts would also be made to explore the possibilities of estimating genetic correlation between the various characters mentioned above.

The data collected under this Scheme at Trivandrum Centre on egg production, age at maturity, etc. were analysed and reported earlier. Investigations had been taken up for studying comparative efficiency of a new selection index for improvement of poultry. Also, the problem of optimum structure of poultry breeding population when selection was based on above index was investigated. The Seheme was also in operation at two more Centres, one in Andhra Pradesh and one in Tamil Nadu. The data from Tamil Nadu Centre had been secured and were being scrutinised before processing.

An index utilising information on dam in addition to that on sibs and individuals' own performance in case of females was developed for increasing the accuracy of estimates of breeding worth of individual when dam and sire families were small and heritability of a trait was low. Numerical values for the weighting co-efficients for the range of number of full-sibs and half-sibs normally encountered in large scale breeding programme had been obtained and a ready reckoner prepared for use by poultry breeders in the actual selection of birds. Inclusion of dams' record in addition to information on the sibs resulted in appreciable gain of 4 to 6 percent in case of females and 6 to 33 percent in case of males when dam and sire families were smaller and heritability of the trait was low. The problem of optimum structure of breeding population and selection of birds based on records of dam, half-sibs and full-sibs including own performance in case of females and for a fixed testing facility had been examined. The sizes of sire and dam families as also the proportion of males and females as selected in each generation, were seen to be almost the same for varying testing facility and heritability of the trait. For a given testing facility, the optimum combination of the parameters which define the breeding plan completely had been suggested.

(R. GOPALAN AND B. MARUTIRAM)

3.4 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 on the best grade suited to local conditions.

The data for this study were obtained from the centre at Vishakhapatnam (Andhra Pradesh) and comprised of observations on lactation yield and lactation length 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.. Ist April,1957 to 31st March, 1971.

The data on lactation yield and lactation length 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 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, half-bred animals gave significantly higher lactation yield and had a longer lactation length in their first lactation than 3/4th Jersey animals. 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. Futher analysis was in progress. (R. GOPALAN AND B. MARUTIRAM).

3.5. Study of cost of poultry and egg production.

The objective of the project was (a) to evolve a suitable methodology for estimation of cost of poultry and egg production under commerical management conditions; (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 taken up in the selected areas of Dasuya and Tanda in Punjab and in Delhi and the surrounding areas.

Keeping in view the objectives of the survey cost accounting approach was followed. Estimates of different components of cost, viz., feeds fed, labour put in management practices, investments, depreciation on assets aod equipment,

depreciation on adult birds and miscellaneous expenditure would be obtained separately for different categories of birds in rural and urban areas. These components of cost would be added up to get the gross cost of production of poultry and eggs. From these estimates the cost of production of table and hatching type eggs, cost of hatching day old chicks and cost of rearing day old chicks to the adult stage would be estimated. Data on income from items other than sale of birds and eggs would be utilised to obtain estimates of net cost of production. Price relatives of feed and other components of cost would be calculated to find indices of cost of production of eggs aud poultry.

The data on various items of cost collected under the survey in Punjab had been further processed to get the size-category-wise, season-wise and year-wise components of cost. These components varied over size categories and also over seasons. Preparation of complete report on the statistical analysis of the data was in progress. The data on preliminary enumeration of the survey conducted in Delhi State had been processed. The data on detailed inquiry were being processed. A study of the relationship of egg production with fixed and working capital was made by fitting functional forms of different types and it was found that in farms where ratio of fixed to working capital was less 1, quadratic accounted for 77% and where it was more than 1, it accounted for 56%. However, it accounted for only 67%when all data were pooled together.

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

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

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

The field work of the survey was to be carried out at two centres, viz, (i) Krishna-delta area in Andhra Pradesh and (ii) Dhulia region of Maharastra State. The field work in Krishna-delta area was taken up during 1967-68 and completed in July, 1969 The field work in Dhulia region was initiated in December, 1969. After the completion of detailed enquiry in February, 1972, the collection of data for building up an appropriate index of cost of production of milk was initiated in the area in March, 1972 and continued throughout the year under report. At each

centre, 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 fed 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 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.

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

During the period under report the data pertaining to Dhulia region, Maharashtra for the first year of enquiry was analysed and it was observed that the overall daily production of milk in the area was 298 tonnes, of which as much as 76 percent was accounted for by buffalo milk. The average daily milk yield was about 3.38 kg. per buffalo in milk and 1.77 kg for a milch buffalo. The corresponding figures for a cow in milk and milch one were 1.05 kg. and 0.49 kg. respectively. A buffalo in milk in commercial producer households was given on an average 4.2 kg. of greens, 9.0 kg of dry roughages and 2.5 kg of concentrates per day. A dry buffalo was given aboat 2.0 kg. of greens, 7.1 kg. of dry fodder and 335 gms of concentrates. A cow in milk was given on an average 2.4 kg. of green, 5.1 kg. of dry fodder and 545 gms of concentrates per day as against 1.3 kg. of greens, 4.5 of dry fodder and 300 gms of concentrates fed to a dry cow. The maintenance cost of a milch buffalo was estimated to be Rs. 2.42 per day including unpaid labour and Rs. 2.33 when the unpaid labour was excluded. The cost of production per kilogram of buffalo milk was estimated to be Rs. 1.37 including unpaid labour and Rs. 1.32 excluding it. The prevailing market rate of milk in the area during the first year was Rs. 1.25 per kg. The detailed analysis for the second year of the enquiry remained in progress.

(K. C. RAUT AND SHIVTAR SINGH)

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

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

The data of bench-mark survey in the milk-shed areas of Dudhsagar Dairy, Mehsana (Gujarat) collected during 1967-68 were processed for statistical analysis during the year under report. These pertained to milk production, its quality, quantity and composition of feed given to animals, changes in number of milch animals, breed composition of animals and their age composition, main and subsidiary occupations of householders, cropping pattern, cost of production of fodder and other crops, return from various crops, income from dairying, fodder production, etc.

After the completion of field work of the repeat survey in the rural milk collection areas of D.M.S in the month of July, 1973, the venue of the survey was shifted to milk-shed areas of Dudhsagar Dairy, Mehsana in Gujarat State. The field work in the second centre would continue till the end of October, 1974.

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.

The study on feeds fed to different categories of animals in the rural milk collection areas of Dudhsagar Dairy, Mehsana was completed during the period under report. The salient results were as follows:

In the commercial households in supplying area, a cow in milk was fed on an average 5.1 kg. of greens, 3.9 kg. of dry roughages and 0.4 kg. of concentrates per day and a buffalo in milk was given 10.3 kg. of greens, 8.6 kg. of dry roughages and 1.5 kg. of concentrates. The total quantum of feed given to a buffalo in milk per day was about two times that given to a cow. In the non-supplying area, a cow in milk was fed one and a half times more roughages than her counterpart in the supplying area, whereas the quantum of roughages fed to a buffalo did not differ materially in the two areas. The quantities of concentrates fed were almost equal in quantity in the two areas. A dry cow in supplying area was given 1.7 kg. of greens, 3.0 kg. of dry fodder, and no concentrates per day as

against 3.6 kg. of greens, 6.6 kg. of dry fodder and only 30 gms of concentrates in the non-supplying area. A dry buffalo, on the other hand, was fed about 7.1 kg. of greens, 8.1 kg of dry fodder and 115 gms of concentrates in both areas. The pattern of feeding in private households was quite similar to the one observed in commercial households except that comparatively more greens and less of cencentrates were given to buffaloes maintained in private households. From the season-wise comparisons, it was observed that in case of cows maximum feed was given during rainy season followed by winter and minimum in summer whereas in case of buffaloes the maximum feed was given during the summer and minimum in rainy season.

A part of the data collected earlier in the repeat survey in the rural milk collection areas of D.M.S. were scrutinised and coded for statistical analysis.

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

3.8. National Index of Animal Experiments.

The objective of the project was to prepare compendia of the results of experiments conducted on animals in the various research centres in the country to benefit the research workers and planners in the field of animal sciences.

Data on 22 experiments from Central Livestock Research-cum-Breeding Station, Haringhata, 19 experiments from Eastern Regional Station of National Dairy Research Institute, Kalyani and 22 experiments from Allahabad Agricultural Institute were collected. Data pertaining to 75 experiments from U.P. College of Veterinary Science and Animal Husbandry, Mathura, were analysed. The processing of the remaining data was in progress.

The techniques of analysis of variance and covariance and regression analysis were followed.

The compendium of the results of experiments conducted at I.V.R.I. on Animal Nutrition during 1945-72 was prepared and the copies of the same in approved format were circulated to various research organisations, Directors of the Research Institutes and State Directors of Animal Husbandry. The compendium contained the results of about 400 experiments which were broadly divided into 4 categories: (1) Feeding trials for growth, milk and wool production; (2) Feeding trials with subsidiary feeds; (3) Requirements studies; and (4) Nutritive value of feeds and fodders. The experiments related to cattle, buffalo, sheep, goat and pig. The statistical design adopted in these experiments was mostly completely randomised design except for about 20 experiments where 'Randomised block design' was used. (M.N. DAS, A. DEY. T. JACOB AND S.N. BAJPAI).

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

The objective of the survey was to evolve a methodology for the estimation of age-specific fertility and mortality rates among cattle and buffaloes and construction of life-tables for bovines.

Data on preliminary enumeration from the Vijayawada centre (Andhra Pradesh) were received. Detailed enquiry of the 30 households selected in each village, which was initiated in the year 1972, was continued from second visit onwards and was completed. Information on various items like breed, classification, age, sex, birth/disposal, etc. was collected through six visits, in all, of the selected households. During the year measures were taken to initiate the field work at the second centre, namely, Amritsar area of Punjab. On the basis of the village-wise cattle population data were collected from 150 villages which had been selected according to the approved sampling design, namely, stratified multi-stage random sampling. The field staff were given training for carrying out the preliminary survey and the field work was initiated in December, 1973.

The data received from Andhra Pradesh were being processed.

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

3.10. Standardisation of the procedure of sampling from fleeces for study of wool quality.

The objective of the project was to standardise the procedure of sampling for assessing wool qnality of a single fleece as well as that of fleeces from a group of sheep so as to provide a basis for all scientific studies on fleece quality.

Data on quality characters viz. fibre-diameter, crimps per cm., fibre length staple length, medullation percentage and fleece density of regional composite samples of ewes of Nilgiri, Nilgiri x Romney Marsh farm flocks and Nilgiri sheep of village flocks collected from Sheep Breeding Farm, Kamarajsagar, Ootacamund (TamilNadu) and of ewes of Chokla and Polworth x Rampur Bushair crosses collected from C.S.W.R.I., Avikanagar (Rajasthan) were utilised for the study.

After obtaining the estimates of averages and their standard errors for all quality characters as mentioned earlier, the data were utilised to estimate the number of sheep to be selected from groups of sheep of sizes ranging from 20 sheep to 500 sheep to estimate the mean with standard error of 1%, 2% and 5% of mean. This was done separately for regional sampling with 20 cuts per sheep and for composite sampling procedure with 2 sub-samples per sheep. Out of the three composite sampling methods one which had the least coefficient of variation was used for estimating sample sizes.

The statistical analysis of all the data collected for all breeds had been completed and report prepared. The salient features of the results were as follows: (i) The averages of quality characters obtained by weighting with regional wool yield did not differ from those obtained by weighting with number of cuts or number of fibres. (ii) Averages based on the samples obtained by composite sampling methods and overall averages obtained from regional samples did not differ significantly. (iii) The analysis of variance showed that methods of composite sampling did not differ significantly. (For estimation of sample sizes, the one with least coefficient of variation had been taken) (iv) Between sheep variation, region variation and sheep x region interaction were found to be significant in almost all the cases. (v) Sample sizes were estimated for all characters separately for each age group, of each breed by regional sampling method and composite sampling method. Tables for the number of sheep required to be selected according to regional sampling from (i) observed flock sizes but with different number of cuts per sheep i.e. from 6, 12, 18 and 24 and from (ii) different flock sizes ranging from 20 to 500 and with 2) cuts per sheep had been prepared. Similar tables were also prepared for composite sampling methods.

Tables giving these sample sizes would be of ready use for selecting number of sheep from flocks of known strength to estimate quality characters means with standard error at 1%, 2% and 5% of the mean. On the whole, it was observed from the present study that composite sampling might be adopted when the regional means and variation are not required for grading of wool.

(B. Marutiram U.G. Nadkarni and T.B. Jain)

4. SAMPLE SURVEY INVESTIGATIONS

Sample survey investigations are undertaken by the Institute with a view to evolving suitable sample survey techniques and demonstrating their feasibility in 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 programme laid down are briefly described in the following paragraphs. The names of the principal investigator and his associate(s) are given at the end of each sub-section.

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

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

Two pilot sample surveys were proposed under the project, one in the northern region comprising Punjab, Haryana and Himachal Pradesh and the other in Andhra Predesh in the southern region. The field work in the first Centre was successfully completed during the year 1972, while in southern region, data on egg production as the principal product were collected during the year under report. Statistical studies were carried out on the data collected in the northern region.

The sampling design adopted in the pilot investigations was such that the primary units in the sample consisted of matched and unmatched units. Critical study of the data on milk yield collected during the years 1969-70, 1970-71 aud 1971-72 in northern region was continued during the year. The studies pertained to estimation of changes in milk production and other related characters from season to season and year to year, and coefficient of correlation between levels of production in different seasons etc. The results of the analysis were being finalized.

(J.N. GARG, V.V.R. MURTY, J.S. MAINI AND K.B. SINGH)

4.2. Pilot sawple survey for determining cost of cultivatioon and study of marketing of apples in Himalayan region of U.P.

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 datarelating 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 determining 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. One round of the survey (harvesting season of apple) starting from October, 1972 to September, 1973 was completed and it was possible to collect about 70 percent of the data proposed to be collected on different items. The data collected under the survey related to cost of cultivation of apple in hilly areas and were collected by ad hoc field staff. The data on the arrivals of apples and their prices during different periods were also to be collected from 13 city markets 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 the 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 inter-crops grown in the young orchards during the first six years of plantation was also cosidered.

(*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 & 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 on the orchard.*

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

The marketing data for the seven markets from where the data were received, were analysed and the report presented to the Planning Commission. The analysis of the cost data was in progress. It was found that very few cultivators maintain farm accounts giving information relating to inputs and outputs. It was, therefore, necessary to resort to cost accounting method to collect reliable data on these aspects. Whole time field staff was employed who collected the information by cost accounting method. From 13 important markets information regarding arrivals and prices of fruits in these markets was collected from wholesalers by Marketing Assistants. The data collected on cost of cultivation and marketing were being processed. Three of the six main objectives of the present survey listed above viz (i), (iii) and (iv) were achieved. Some data on marketing of apples had been analysed and a preliminary report was prepared. (A.H. MANWANI, B.L. KAUL BHAGAT SINGH M.S. BATRA, JAGMOHAN SINGH & S.K. MAHAJAN)

4.3. 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 period under report, data for the first and second rounds of the survey (which was completed in September, 1973) were scrutinised and analysis of the same was in progress. Technical programme and list of villages selected for the third

round of the survey were finalised and the field work of the survey 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 area under vegetables, (ii) yield data collected from crop-cutting plots of major vegetables grown in the region, viz. cabbage, tomato, brinjal, beans, lady's finger bhindi, cucumber and root crops like potato, carrot, 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 units of sampling, fields growing vegetables as secondary units of sampling. Crop-cutting expriments were conducted for studying the production and average yield of important vegetable crops.

Analysis of the data collected under the survey was in progress.

(S. S. NARULA, A. K. SRIVASTAVA & SATYAPAL)

4.4. 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 oganisational 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 fruit trees according to variety, both in terms of weight and count of fruits (mango, banana, citrus fruits and grapes) 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. The field work of the survey was completed in July, 1973. Analysis of the data collected in the survey was in progress. 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 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 namely, (a) for the esimation of extent of cultivation, the design was of two stage sampling with taluks covered under the survey as primary units and villages as secondary units, (b) for the study of yield of the selected fruit crops 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.

Analysis of the data collected under the survey was in progress.

(S. S. NARULA A. K. SRIVASTAVA & K. R. RAJAGOPALACHAR)

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

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

During the year under report the data pertaining to crop cutting experiments and A. A. E. enquiry for 1972-73 were partly received from all the States. Detailed report embodying the results of crop cutting experiments giving yield rates of high yielding and local varieties with corresponding rates of application of fertilizers conducted during 1971-72 in various States was prepared. The data of A.A.E. enquiry for 1970-71 giving the area under the five programme crops and extent of adoption of associated package of practices were also analysed and a detailed report prepared.

A brief summary of the salient results is given below :—

(*i*) KHARIF, 1971-72

During the season, four crops viz., rice, maize, jowar and bajra were covered under the survey. The crop-wise coverage in the different States was as follows :

RICE :

Andhra Pradesh (9 districts), Assam (2 districts), Bihar (9 districts), Haryana (1 district), Karnataka (3 districts), Madhya Pradesh (1 district), Tamil Nadu (4 districts), Maharashtra (2 districts), Orissa (2 districts), Punjab (4 districts), Rajasthan (1 district) and Uttar Pradesh (15 districts).

MAIZE :

Andhra Pradesh (3 districts), Bihar (8 districts), Haryana (1 district), Karnataka (2 districts), Punjab (3 districts), Rajasthan (2 districts) and Uttar Pradesh (14 districts).

JOWAR :

Karnataka (4 districts), Madhya Pradesh (1 district), Maharashtra (14 districts) and Rajasthan (1 district).

BAJRA :

Andhra Pradesh (3 districts), Gujarat (3 districts), Haryana (2 districts), Karnataka (1 district), Maharashtra (7 districts), Punjab (2 districts), Rajasthan (1 district) and Tamil Nadu (3 districts).

The salient results are given below, cropwise :

RICE :

The surveys on rice were conducted in 53 districts covering 12 States of the country. It was seen that IR-8 variety was grown by a majority of the farmers. The other varieties tried in various districts were Jaya, Mashori, Jagannath, Co-29, Co-25, Hamsa, Manila IR-49, IR-20, IR-5, ADT-27, Manohar Sali, TN-1, T-3, Tainan-3, Safri-17, R-24, TK-25, Padma, NSJ-200 and CH-4. The highest average yield of 40.3 Q/ha was recorded for Manila in Bellary district of Karnataka State while the lowest average yield of 10.5 Q/ha was for Jaya variety in Bahraich district of Uttar Pradesh and Saran district of Bihar. The yield rates of IR-8 variety generally varied in the range of 20 to 40 Q/ha except in a few districts of Bihar and U.P. where low yield was obtained. The rates of application of chemical fertilizers were the highest in Bellary district of Karnataka State and the lowest in Nagpur district of Maharastra and Kanpur district of Uttar Pradesh. The rates of application of N, P, K in all the districts were generally lower than the corresponding recommended rates.

MAIZE :

The results for this crop were available from 33 districts covering 7 States. The most commonly grown varieties of maize in these districts were Ganga Safed-2 and T-41 followed by Ganga-5. The other hybrids of maize grown were Ganga-3, Ganga 101, Deccan hybrid, Vijay and Jaunpuri White. The highest average yield of about 45 Q/ha was recorded for Deccan hybrid in the selected districts of Karnataka State. Due to unprecedented floods in a majority of the selected districts of Bihar State and some of the selected districts in the eastern region of Uttar Pradesh, the crop was either washed away or completely damaged. The yield rates of different HYV of maize in the selected districts of Punjab and Haryana were quite high ranging generally between 25 to 35 Q/ha. The rates of application of chemical fertilizers were generally lower than those recommended. The highest rates of application were observed in the districts of Karnataka State.

JOWAR :

The most commonly grown variety of hybrid jowar was CSH-1. The other variety tried was CSH-2. The highest average yield of 43.9 Q/ha. was observed for CSH-1 variety in Mysore district of Karnataka and the lowest average yield of 4.7 Q/ha. for CSH-1 variety in Aurangabad district of Maharashtra. The rates of application of N, P, K were the highest in the districts of Karnataka State.

BAJRA :

For this crop the surveys were conducted in 22 districts of 8 States. The high yielding varieties of bajra commonly grown were HB-1, HB-3 and HB-4. The highest average yield of 30.9 Q/ha. was obtained for HB-4 variety in Nellore district of Andhra Pradesh and the lowest average yield of 4.6 Q/ha. was for HB-3 variety in Parbhani and Bhir and for HB-1 in Sangli district of Maharashtra State. The rates of application of N, P, K were the highest in the districts of Andhra Pradesh.

(*ii*) RABI, 1971-72

During the season, all the five programme crops were covered. The cropwise coverage in the different States was as follows :

WHEAT :

Bihar (8 districts), Gujarat (3 districts), Haryana (3 districts), Karnataka (2 districts), Madhya Pradesh (2 districts), Maharashtra (15 districts), Punjab (6 districts), Rajasthan (3 districts), Uttar Pradesh (15 districts) and West Bengal (4 districts).

RICE :

Andhra Pradesh (9 districts), Karnataka (3 districts), Kerala (winter—3 districts), Kerala (summer—4 districts), Orissa (2 districts), Tamil Nadu (4 districts) and West Bengal (4 districts).

MAIZE :

Andhra Pradesh (3 districts) and Karnataka (3 districts).

JOWAR :

Maharashtra (1 district) and Karnataka (1 district).

BAJRA :

Tamil Nadu (4 districts) and Karnataka (1 district).

The salient results are given below :

WHEAT :

The most extensively grown high yielding variety of wheat in these districts was Sonalika followed by Kalyan Sona. Other varieties tried in the districts were N1-747-19, N1-917, HDM-1553, Safed Lerma, Sonora-64, Chotti Lerma, Lal Bahadur and UP-301. The highest average yield of 57.2 Q/ha was observed for U P. 301 variety in Morena district of Madhya Pradesh while the lowest average yield of 12.6 Q/ha was for N1-747-19 variety in Bhir district of Maharashtra State. The yield rates of different HYV of wheat in the districts of Punjab, Haryana and Uttar Pradesh were generally high compared to the yield rates in the districts of Mahrashtra, West Bengal and Bihar. The rates of application of N, P, K were the highest in Morena district of Madhya Pradesh.

RICE :

The most commonly grown variety of rice in these districts was IR-8 followed by IR-20 and Hamsa. The other HYV's of rice tried were TN-1, Jaya, Co-29, Annapoorna-28, Ratna, Kaveri, Mashori, Padma, Bala and Manila. The highest average yield of 44.7 Q/ha was for IR-8 in Mysore district of Karnataka State and the lowest average yield of 13.6 Q/ha was for Kaveri in Nellore district of Andhra Pradesh. The rates of application of chemical fertilizers were the highest in the districts of Karnataka State although in none of the districts covered the recommended levels of fertilizer were applied.

MAIZE :

The varieties Deccan hybrid and Ganga-5 were almost equally preferred by the cultivators followed by Ganga-3. The yield rates of different maize hybrids in the districts of Karnataka State were higher than those in the districts of Andhra Pradesh. The highest average yield of 66.9 Q/ha was observed for Ganga-5 variety in Mysore district. The rates of application of N, P, K were also the highest for this variety in this district.

JOWAR :

The commonly grown variety of hybrid jowar was CSH-1. The highest average yield of 29.4 Q/ha. was recorded for Ananta-1 variety in Shimoga district of Karnataka State. The yield rates as well as rates of application of chemical fertilizers were found to be higher in Shimoga as compared to those in Sholapur District.

BAJRA :

The commonly grown varieties of hybrid bajra were HB-4, HB-1 and HB-3. The highest average yield of 23.4 Q/ha was obtained for HB-1 variety in Coimbatore (Tamil Nadu) and the lowest average yield of 15.3 Q/ha was for HB-4 variety in Chingleput (Tamil Nadu). The rates of application of chemical fertilizers were generally of the same order in all the districts.

AGRONOMIC AND AGRO-ECONOMIC ENQUIRY

The estimates of area under high yielding varieties of rice, wheat, maize, jowar and bajra during 1970-71 are given below.

(*i*) KHARIF, 1970-71 :

RICE :

Estimates of area under high yielding varieties of rice were worked out for 33 districts from 8 States. In the districts of Krishna, Guntur, Nellore (Andhra Pradesh), Coimbatore and Madurai (Tamil Nadu), Amritsar and Gurdaspur (Punjab) and Basti (Uttar Pradesh) the estimated area varied from 32 to 52 thousand hectares. In Chittoor (Andhra Pradesh), Chingleput, Tirunelveli (Tamil Nadu), Shimoga (Karnataka), Ferozepur, Patiala (Punjab), Deoria and Basti (Uttar Pradesh) these estimates ranged between 14 to 26 thousand hectares. In the remaining districts the estimated area was below 10 thousand hectares. In Bulandshahr (Uttar Pradesh) and Amritsar (Punjab) nearly 50 percent of the total area under rice had been brought under HYV. In 10 districts the estimated

area ranged between 20 to 40 percent of the total area under the crop while in 11 districts less than 5 percent of the total area under rice was covered by HYV. From a comparison of the survey estimates of area with the corresponding figures reported by the State authorities, it was observed that the two sets of figures were in close agreement in the districts of Krishna (Andhra Pradesh), Mysore and Shimoga (Karnataka) and Ferozepur (Punjab). In the remaining districts there was no consistency between the two sets of figures.

MAIZE :

Estimates of area under high yielding varieties of maize crop were worked out for 21 districts spread over 6 States. In the districts of Karimnagar (Andhra Pradesh), Ambala (Haryana), Amritsar, Jullundur, Patiala (Punjab), Chittorgarh (Rajasthan), Saharanpur, Muzaffarnagar (Uttar Pradesh) and Belgaum (Karnataka) the estimated area varied between 4 to 18 thousand hectares. In the remaining districts except Bulandshahr (Uttar Pradesh) the estimated area was below 3 thousand hectares. In Bulandshahr district the estimated area worked out to 65.4 thousand hectares. The estimates of area showed that in Amritsar (Punjab), Belgaum (Karnataka) and Bulandshahr (Uttar Pradesh), nearly 40 to 60 percent of the total area under maize crop had been brought under HYV of maize. In Patiala (Punjab) and Muzaffarnagar (Uttar Pradesh) the corresponding percentage was of the order of 20. In 10 districts, the estimated area under HYV of maize accounted for about 6 to 14 percent while in the remaining 6 districts the estimated area was less than 5 percent of the total area under the crop in the district. Compared to the area reported to have been brought under HYV it was seen that only in 7 districts the estimated area and the area achieved were in agreement.

JOWAR :

Estimates of area under high yielding varietieso f jowar were worked out for the States of Maharashtra, Karnataka and Rajasthan covering in all 18 districts. In the districts of Akola, Amreli, Aurangabad and Buldhana (Maharashtra) and Bellary (Karnataka) the estimated area varied between 23 to 42 thousand hectares while in the districts of Bhir, Jalgaon, Nanded, Osmanabad, Parbhani, Sangli (Maharashtra) and Belgaum and Shimoga (Karnataka) the estimated area ranged between 11 to 20 thousand hectares. In the remaining districts the estimated area was below 9 thousand hectares. The estimates of area indicated that in Shimoga and Bellary (Karnataka) and Aurangabad (Maharashtra) about 50, 20 and 44 percent of the total area under jowar had been brought under HYV. On the other hand, in Nagpur and Wardha (Maharashtra) and Chittorgarh (Rajasthan) the estimated area worked out to be less than 5 percent of the total

area under the crop. In the remaining 12 districts the estimated area accounted for about 7 to 17 percent of the area under jowar crop. Only in 5 districts the estimated area was close to the reported area.

BAJRA :

Estimates of area under high yielding varieties of bajra were worked out for 20 districts spread over the States of Andhra Pradesh, Gujarat, Haryana, Maharashtra, Punjab, Rajasthan and Tamil Nadu. In the districts of Chittoor (Andhra Pradesh), Banaskantha (Gujarat), Parbhani (Maharashtra), Sangrur (Punjab) and Coimbatore (Tamil Nadu) the estimated area varied between 8 to 15 thousand hectares while in Kaira, Rajkot (Gujarat), Rohtak (Haryana), Bhir, Jalgaon (Maharashtra) and Ferozepur (Punjab) it ranged between 19 to 49 thousand hectares. In the districts of Hissar (Haryana), Ahmednagar and Aurangabad (Maharashtra) the estimated area was 138, 144 and 113 thousand hectares respectively. The estimates of area expressed as percentages of the total area under the crop showed that about 38 to 58 percent of the area under bajra had been brought under HYV in 8 districts while in 10 districts this percentage was less than 25. In the remaining 2 districts viz. Banaskantha (Gujarat) and Jaipur (Rajasthan) this percentage was less than 5. Compared to the area reported to have been brought under HYV of bajra by the State authorities it was seen that the two sets of figures were in agreement only in 4 districts.

(*ii*) *Rabi 1970-71*

WHEAT :

Estimates of area under high yielding varieties of wheat were worked out for 42 districts spread over the States of Gujarat, Haryana, Maharashtra, Karnataka, Punjab, Rajasthan and Uttar Pradesh. In the districts of Hissar (Haryana), Amritsar, Ferozepur, Jullundur, Patiala, Sangrur (Punjab), Muzaffarnagar, Meerut, Bulandshahr, Moradabad, Gorakhpur and Basti (Uttar Pradesh) the estimated area ranged between 100 to 172 thousand hectares while in the districts of Rohtak and Ambala (Haryana), Gurdaspur (Punjab), Saharanpur, Etawah, Kanpur, Deoria, Rae Bareli and Gonda (Uttar Pradesh) the estimated area ranged between 26 to 93 thousand hectares. In the remaining districts the estimated area was less than 22 thousand hectares. The estimated area under HYV of wheat expressed as a percentage of the total area under the crop showed that in Muzaffarnagar (Uttar Pradesh) the entire area had been brought under high yielding varieties while in five other districts viz. Etawah and Bulandshahr (Uttar Pradesh), Jullunder (Punjab) and Ambala and Hissar (Haryana) the

respective percentages varied between 80 to 90. In 11 districts, 50 to 70 percent of the total wheat area was estimated to have been sown with HYV while in another 11 districts, it was between about 20 to 35 percent. In 11 districts again, only about 5 to 10 percent of the total area under wheat was estimated to be under HYV of crop. The area under HYV of wheat was less than 5 percent of the total area under the crop in the districts of Satara and Wardha (Maharashtra) and Kota (Rajasthan). Compared to the area reported to have been brought under HYV of wheat it was seen that in 17 districts the two sets of figures viz. the estimated area and the reported area agreed fairly closely.

RICE :

Estimates of area under high yielding varieties of rice were worked out for 16 districts spread over the States of Andhra Pradesh, Karnataka and Tamil Nadu. In the districts of East Godavari, Guntur, Nellore and Chittoor (Andhra Pradesh), Chingleput and Madurai (Tamil Nadu) the estimated area ranged between 20 to 48 thousand hectares while in the districts of Krishna and Karimnagar (Andhra Pradesh), Coimbatore and Tirunelveli (Tamil Nadu) and Shimoga (Karnataka) the estimated area ranged between 5 to 14 thousand hectares. In the remaining districts the estimated area was less than 3 thousand hectares. These estimates expressed as percentage of the total area under rice showed that in the districts of Shimoga and Bellary (Karnataka) and East Godavari and Nellore (Andhra Pradesh) about 40 to 60 percent of area under rice was brought under HYV. In 9 districts area achieved under HYV of rice was estimated to be between 13 to 32 percent of the total area under the crop. In the remaining 3 districts viz. Anantapur, Guntur and Nizamabad (Andhra Pradesh) only 5 percent of the area under rice was covered by HYV. From a comparison of the estimated area with that reported to have been brought under HYV of rice by the State authorities it was observed that the two sets of figures were more or less of the same order in only 5 districts.

MAIZE :

The estimates of area under high yielding varieties of maize were worked out for 3 disticts of Andhra Pradesh and 2 districts of Karnataka. In the districts of Karimnagar and Warangal (Andhra Pradesh) the estimated area was 3 and 4 thousand hectares respectively. In the remaining districts it was less than 2 thousand hectares. The estimated area expressed as a percentage of the total area under the crop was about 94 percent in Mysore (Karnataka). In the remaining 4 districts less than 32 percent of area under maize was covered by hybrid varieties. In the districts of Warangal (Andhra Pradesh) and Mysore (Karnataka)

the two sets of figures viz. the estimated area and the reported area were in close agreement.

JOWAR :

Estimates of area under high yielding varieties of jowar were worked out for the districts of Bhir (Maharashtra) and Bellary and Shimoga (Karnataka). The estimated area in these districts worked out to 1.8, 3.6 and 2.6 thousand hectares respectively. In Shimoga (Karnataka) almost the entire jowar area was under HYV. Expressed as a percentage of the total jowar area, the area under high yielding varieties was 6 and 1 percent in Bellary (Karnataka) and Bhir (Maharashtra) respectively. The estimated area was consistent with that reported by the States except in Bellary district (Karnataka), where it was higher than that reported by the State.

BAJRA :

The estimates of area were worked out for 4 districts of Tamil Nadu. Except for Chingleput district, the estimated area in the various districts was of the order of 3 thousand hectares. The estimated area accounted for about 60 percent of the total area under bajra in Coimbatore while in the other 3 districts the estimated area varied between 6 to 36 percent of the total area. In none of the districts the estimated area compared favourably with that reported to have been brought under HYV of bajra by the State authorities.

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

4.6. Monograph on the methodology for estimation of poultry egg production and poultry practices.

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

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

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

The monograph was being finalized.

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

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

The objective of the project was to prepare a bulletin giving estimates of annual meat production and its per capita availability in different States and also for the country as a whole.

Pilot sample surveys for developing suitable sampling methodology for estimation of annual meat production in the States of Tamil Nadu and Haryana were conducted by the Institute during the years 1966-67. Data on the number of animals slaughtered privately viz., outside registered slaughter houses were also collected through the pilot sample surveys for estimation of milk production and study of bovine keeping practices conducted by the Institute in various other States during the Third and Fourth Five Year Plans. In addition, data on meat production were also collected in the scheme 'Pilot investigations for developing an integrated technique for estimation of major livestock products and study of attendant animal husbandry practices in Northern Region i.e., Punjab, Haryana and Himachal Pradesh'. The number of animals slaughtered privately had been estimated for the States of Punjab, Haryana, Himachal Pradesh, Maharashtra, Karnataka, Bihar and Andhra Pradesh whereas in the States of Punjab, Haryana and Himachal Pradesh, estimates of annual meat production had also been worked out for the years of the survey.

Meat production was estimated as a product of the number of animals slaughtered and the average meat production per animal. The estimates of the number of animals slaughtered consisted of two components i.e. the number of animals slaughtered in the registered slaughter houses for which a complete count was available and the number of animals slaughtered privately. The second component was estimated by using the data collected under the sample surveys. Similarly, the estimate of average meat production per animal as available from the surveys was utilised to estimate total meat production.

The total number of animals slaughtered in the Northern Region comprising Punjab, Haryana and Himachal Pradesh during the year 1971-72 was 7.63 lakh of which 89 per cent accounted for slaughter in registered slaughter houses. The estimate of annual meat production was 86.37 lakh tonnes and the per capita availability of meat worked out to 322 grammes per year. Final results would be worked out after receiving the necessary data from the States of U.P. M.P., Rajasthan and other areas.

(K.B. SINGH J.S. MAINI AND V.V.R. MURTY)

4.8. Preparation of a monograph on the methodology of 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 States and (*ii*) to give the exposition of the technique evolved for estimation of meat production in the country.

Detailed information on the number of animals slaughtered, yield of meat per animal, practices of disposal of meat produced was collected under the pilot surveys. Such information had been utilized to estimate the total number of animals slaughtered privately, average meat production per animal and total meat production, besides providing useful data on the prices, utilization of meat etc. During the year 1973, further critical study leading to the estimation of size of sample required for estimating the annual meat production was carried out.

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

(J.S. MAINI V.V.R. MURTY AND K.B. SINGH)

4.9. Intercensal estimates of livestock numbers.

The principal objective of the project was build up an appropriate stochastic model making use of the data from pilot sample survey on livestock products for working out estimates of livestock numbers in the intercensal years. The data collected in the Northern region had been analysed with a view to build up estimates of birth and death rates needed for setting up a birth and death model. Simultaneously, the existing literature on the study of similar problems on human and other populations was being examined.

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

4.10. Pilot sample surveys 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 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 rotation.

The data collected during the Rabi season of 1972-73 in Meerut district had been analysed while the data for Kharif season of 1973-74 were scrutinised.

Estimates of output of various fodder crops and their standard errors were calculated.

The feasibility of estimating production of fodder crops by conducting crop cutting experiments was demonstrated. (S.D. BOKIL AND ANANDA PRAKASH)

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

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.

The survey was initiated in September, 1973 and data were collected in respect of area, production, disposal, storage etc. of grains.

(S.D. BOKIL AND ANAND PRAKASH)

4.12. Employment and income effect of the New Agricultural Strategy in Aligarh district.

The objectives of this project were (*i*) to find out the effect of the new agricultural strategy on the income of various classes of farmers and (*ii*) to find out the employment effect of the above strategy on various groups of farmers.

This study was initiated in July, 1973. Actual field work started in the month of August, 1973. Data regarding employment and income from crop and animal husbandry enterprises were being collected from the selected farmers. Farmers had been stratified into small, medium and large categories. Agricultural labour households had also been selected for judging the impact of new technology on their employment and income status. Data were not analysed yet. The regression analysis as well as linear programming technique would be used to achieve the objectives mentioned above.

(R.K. PANDEY, M.G. MITTAL AND U.N DIXIT)

4.13. Availability of feed to cattle and buffaloes in India.

The objective of the project was to estimate per day per head availability of feeds along with their T.D.N. and D.C.P. values to cattle and buffaloes in different tracts of India.

Detailed data as a day's supply of feeds viz., green fodder, dry fodder and concentrates to animals were available in respect of large number of cattle and buffaloes through sample surveys conducted in the past by the Institute. Such data were available for a period of one year covering three seasons, viz , summer, rainy and winter for each of the tracts covered by the pilot surveys. These data were utilised to build up estimates of per head per day availability of feed in different tracts.

As mentioned above, the data on feeds had been utilised to work out estimates of per head per day availability of feeds to cattle and buffaloes in different tracts of India. For working out such estimates in respect of a particular classification of animals, say, cows in milk, the total quantity of a particular feed, say, green fodder, fed to the sample of animals had been first obtained and this total divided by the observed number of cows in milk including those not supplied with this particular feed. Such a procedure was adopted for different classifications of animals and different feeds in the various seasons.

The estimates of per head per day availability of feed were worked out for about 12 States in which pilot surveys were conducted. These tracts accounted for about 85 per cent of bovine population in the country.

(D.V.S. RAO, V.V.R. MURTY AND J.S. MAINI)

5. BASIC RESEARCH IN STATISTICS

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

(a) *Sampling*

An attempt to form clusters in the most optimum fashion utilizing the available information was made. The superiority of the suggested procedure over the existing one was also examined from efficiency as well as suitability point of view. Suitable estimation theory for sampling on successive occasions using a two stage sampling design with multi-auxiliary variables was developed. Studies on some aspects of non-response in two characters in a two stage design were also made.

(b) *Design of Experiments*

New methods of construction of 2 class G.D. designs using extended association schemes and by the use of two-symbol orthogonal arrays of strength two and Hadamard matrices were developed. Methods of contruction of PBIB designs based on Group Divisible family of association schemes and of Rectangular designs, using BIB designs were developed.

(c) *Genetical Statistics*

Some studies on estimation of genetic components of variation in economic traits of poultry were made utilizing the data of Regional Poultry Farm at Bhopal.

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 the Ph.D. degrees in Agricultural Statistics. These degrees are awarded by the Indian Agricultural Research Institute. All courses in Mathematics, Statistics, Computer Science, etc. for this group of students are offered at this Institute while courses in Agricultural Sciences are taught in 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 the Ph,D. students were held during the year under report.

A list of dissertations approved during the year under report for award of Ph.D. and 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 as well as for the M.Sc. and the Ph.D. Courses started in October, 1973. The number of students admitted to these courses were 11, 16, 13, 7 and 2 respectively.

A number of useful seminars/lectures were delivered by two eminent statisticians during the year under report. Their names and the titles of their talks are given below:—

1.	Dr, B.V. Sukhatme, Professor of Statistics, Iowa State University, U.S.A.	(i) Ratio method of estimation (ii) Use of preliminary test of significance for allocation in stratified sampling.
2.	Dr. N.C. Giri, Prof. of Statistics, Montreal University, Canada.	Multi-variate Analysis

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

1.	Sh. N.K. Vijay Kumar	Stability and adaptability parameters in plant breeding.
2.	Sh. Sukh Dev Sharma	Some recent developments in the estimation theory for sample surveys.
3.	Sh. Jose Samuel	Application of Statistics in Hydrology.
4.	Sh. K.C. George	The use of stochastic matrices in determining the correlation between relatives.
5.	Sh. H.T. Trivedi	Analysis of Incomplete Block Designs.
6.	Sh. A.H. Manwani	Some basic concepts in the theory of sample surveys for multiple characters.
7.	Dr. Aloke Dey	Some recent results in Incomplete Block Designs.
8.	Sh. P.K. Malhotra	Various methods of estimating effective number of factors in Quantitative Inheritance.
9.	Sh. Jugesh Chander	Non-sampling errors.
10.	Sh. S.J. Amdekar	Sampling with varying probabilities.
11.	Sh. C.K. Midha	Assessment of the high yielding varieties programme.
12.	Sh. R.P.S. Malik	A study on the non-response in two characters in two-stage design.
13.	Sh. S.H. Biyani	Error correcting code.

14.	Sh. M. Srinath	Decision Theory and its application to a problem in Agriculture.
15.	Sh. A. Seshagiri	Some methods of construction of confounded designs of asymmetrical factorial experiments.
16.	Sh. M.S. Batra	Estimation of genetic change in Indian herds of cattle.
17.	Sh. K.C. Raut	Some factors influencing the milk production of buffaloes.
18.	Sh. A.C. Kaistha	Coding method in data processing.
19.	Sh. V.K. Sharma	Change-over designs.
20.	Sh. Toto Sugito	Two-way stratification.
21.	Sh. N.B. Shete	Choosing appropriate statistical methods for extension education research.
22.	Sh. B.B.P.S. Goel	The formation of clusters.
23.	Sh. K.V. Ramaiah	Discriminant function in plant selection.
24.	Sh. V.K. Sharma	Use of statistics in farm management extension.
25.	Sh. S.K. Mehta	Balanced and partially balanced n-ary block designs.
26.	Sh, K.N. Agarwal	Analysis of rotational experiments.
27.	Sh. B.L. Choudhari	Asymmetrical Factorial Designs.
28.	Sh. Behari Lal	Estimation of recombination fraction for linked loci.
29.	Sh. V.R. Rao	Estimation of genetic parameters and their importance in plant breeding.
30.	Sh. S.S. Pillai	Compilation techniques.
31.	Sh. D.K. Agarwal	Some investigations for crop insurance scheme under Indian conditions.
32.	Sh. P.S.L. Srivastava	Environment interaction in relation to plant breeding.
33.	Sh. Hans Raj	Genetic variability relating to quality characters in forage sorghum and biometrical tools.

Lectures and practicals were arranged for the trainees of the Central Statistical Organisation and the Pusa Polytechnic, New Delhi during the year under report as indicated below :

Organisation	*Trainees*	*Period*
C.S.O.	Agricultural Supervisors	10.1.73 to 16.1.73
C.S.O.	Statistical Officers	6.2.73
C.S.O.	Statistical Officers	9.4.73 — 30.6.73
Pusa Polytechnic	Quality Improvement Programme	16.4.73 — 15.7.73
C.S.O.	Statistical Officers	22.6.73 — 8.7.73
C.S.O.	B. Stat. & M. Stat. Students	1.8.73
C.S.O.	Afghan trainee (UNDP)	19.7.73 — 10.8.73
C.S.O.	I.S.E.S. trainees	22.10.73

A Summer Institute in Design and Analysis of Experiments was organised from 7th May, 1973 to 9th June, 1973 for the benefit of college teachers and research workers engaged in application and research of statistics. 32 candidates from different parts of the country participated in the Summer Institute.

7. DATA PROCESSING

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

During the year under report, the computer was utilized for about 5,500 hours. Of the total utilized time, the Institute shared about 31% ; the Indian Agricultural Research Institute 22%, the Directorate of Economics and Statistics 10% and other agricultural Institutes and Universities 36%, while about 45 hours only (0.7%) were utilized by users like the National Physical Laboratory on payment basis.

About 150 M.Sc. and Ph.D. students and other agricultural research workers from the Research Institutes under the ICAR and Agricultural Universities were extended help in preparation of computer programmes and in doing the analysis of their research problems on the electronic computer. A training course in computer programming covering about 40 lectures and 60 hours of laboratory work was arranged for the nominees from ICAR Research Institutes and State Agricultural Departments from 22nd June, 1973 to 17th July, 1973.

The Mechanical Tabulation Unit carried out the work of punching sorting, listing and tabulation pertaining to the data of the various research schemes of the Institute and the different research problems of its students. Similar help was also rendered to the students and research workers of IARI, IVRI, NDRI and other Institutes under the ICAR, Agricultural and other

Universities and other agencies like the Timely Reporting Scheme of the Department of Agriculture, Government of Uttar Pradesh and the Directorate of Economics and Statistics, About 14.64 lakh cards were punched, about 3100 listings and about 200 tables were prepared and about 200 sortings were carried out during the year under report. Training in the use of punch card equipment was imparted to an FAO trainee and to two research workers deputed by the Agricultural Economics Centre of the Department of Economics, University of Madras.

The Centre helped the Post-Graduate School of the IARI in processing the data collected from the staff and the students on the various facilities provided by the School like teaching, medical aid, hostel accommodation, library, etc. The Centre also prepared the lay out of the analysis of the All India surveys conducted by the Agricultural Marketing Adviser to the Govt. of India by preparing card designs for punching data and finalising estimation procedures.

8. ADVISORY SERVICE

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

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

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

Agricultural Sciences

(*a*) Technical advice was given in respect of a number of schemes relating to crop sciences referred to by the I.C.A.R.

(*b*) Technical advice was rendered to the Central Potato Research Institute, Simla in statistical analysis of experiments on incidence of pests and diseases.

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

Animal Sciences

(*a*) Technical advice was given from time to time in regard to statistical analysis of data of a number of projects conducted by the I.V.R.I., Izatnagar.

(*b*) Technical advice was given to the Statisticians of the Directorates of Animal Husbandry of the respective States 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) Improvement of sheep and wool on regional basis, Bihar.

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

(3) Improvement of sheep and wool on regional basis, Rajasthan.

(4) Improvement of sheep and wool on regional basis, Tamil Nadu.

(5) Development of mutton breeds of sheep, Tamil Nadu.

(6) Selective breeding of Asil breeds of poultry, Tamil Nadu.

(*c*) Technical advice was rendered to the officers of the Department of Animal Husbandry, Government of Madhya Pradesh and of the Division of Agricultural Economics, Haryana Agricultural University, Hissar in undertaking surveys relating to Dairy and Livestock Economics.

(*d*) As requested by the Scientific Panel for Animal Nutrition of the I.C.A.R.. technical advice was given for the statistical analysis of data collected under the scheme on "Research in developing mutton breeds of sheep" carried out at Kavale, Andhra Pradesh.

(*e*) Technical advice was also given to research workers of the N.D.R.I,. Karnal, I.V.R.I,, Izatnagar and the Udaipur University, Udaipur in statistical analysis of data.

(*f*) Technical advice was rendered to the Regional Poultry Farm. Bhopal in regard to selection of birds on the basis of an index under the Coordinated Poultry Breeding Programme of the Govt. of Madhya Pradesh.

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 rendered from time to time to the Joint Director of Agriculture (Statistics). U.P. in the design of the sample survey on apple and other temperate fruits in the United Provinces and the interpretation of the data collected under the survey.

(*c*) Technical advice was also given to the Directorate of Marketing and Inspection, Ministry of Agriculture in connection with the survey on marketable surplus and post-harvest crop losses.

(*d*) Technical advice and guidance was accorded to the Statisticians of the Animal Husbandry Departments of the various States in regard to the statistical analysis of the data collected in the sample surveys on live-stock products conducted by them.

Data Processing

(*a*) Technical advice was given to the Range Management Specialist of the Central Arid Zone Research Institute, Jodhpur in computerization of the data collected under the Range Management Studies carried out during the previous several years.

(*b*) Technical advice was given to the Directorate of Marketing and Inspection, Ministry of Agriculture in regard to preparation of card designs for the analysis of their data of the survey on marketable surplus and post harvest crop losses.

9. 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 :—

1. *Sixth Annual Workshop of the All India Coordinated Agronomic Experiments Scheme held at Coimbatore in January, 1973.*
   Dr. M.N. Das, Miss C.R. Leelavathi, Sh. S.R. Bapat and Sh. M.G. Mittal.
2. *Sixtieth Session of the Indian Science Congress held at Chandigarh in January, 1973.*
   Dr. M.N. Das
3. *Conference of Animal Nutrition Rerearch Workers held at Jabalpur in February, 1973.*
   Shri T. Jacob
4. *Second Workshop on "All India Coordinated Research Project on Cattle" held at Jabalpur in February, 1973.*
   Dr. Prem Narain
5. *Eighth Annual Convention of Computor Society of India held at Vigyan Bhavan, New Delhi in February/March, 1973.*
   Sh. S.N. Mathur
6. *First Annual Conference of Indian Association for Animal Production held at Calcutta in April, 1973.*
   Dr. Prem Narain
7. *Third Workshop of "All India Coordinated Research Project on Poultry for Egg and Meat" held at I.V.R.I., Izatnagar in July, 1973.*
   Dr. Prem Narain
8. *Meeting of the Technical Committee of Direction for Improvement of Livestock Statistics held at New Delhi in August, 1973.*
   Shri. V.V.R. Murty
9. *Conference of the Statisticians of State Animal Husbandry Departments held at New Delhi in August, 1973.*
   Shri V.V.R. Murty

10. *Conference of State Statisticians in charge of Animal Husbandry and Dairying organised by the Ministry of Agriculture in New Delhi in August, 1973.*
Shr. K.C. Raut

11. *Sixth Annual Workshop of ICAR Coordinated Project "Measurement, Evaluation and Improvement of Soil Structure" held at Kharagpur in August, 1973.*
Dr. M.N. Das and Shri. S.K. Raheja

12. *Third Annual Workshop of the Scheme "Sample Surveys for Assessment of High Yielding Varieties Progromme" held at I.A.R.S. New Delhi in September, 1973.*

Almost all the officers of the Institute.

13. *Third Workshop of "All India Coordinated Research Project on Blood Group and Bio-Chemical Polymorphism" held I.V.R.I., Izatnagar in December, 1973.*
Dr. Prem Narain

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

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

1. *Second General Conference of S.A.B.R.A.O. held at I A.R.I., New Delhi in February, 1973.*
   NARAIN, P. Techniques for measuring genetic improvement in live-stock breeding.
2. *Sixth Annual Workshop of the ICAR Project "Measurement and Evaluation of Soil Structure" held at Kharagpur in August, 1973.*
   RAHEJA, S.K. Performance of high yielding varieties in cultivators' fields.
3. *Twelfth Wheat Workshop held in Delhi in September, 1973.*
   MAHAPATRA, I.C., GOSWAMY, N.N., LEELAVATHI, C.R., BAPAT S.R. and SINGH MAHENDRA. Wheat research in the Coordinated Agronomic Experiments Scheme
4. *Third Annual Workshop of the Scheme "Sample Sarveys for Assessment of High Yielding Varieties Programme" held at New Delhi in September, 1973.*
   RAHEJA, S.K. Comparative yield rates of high yielding varieties of cereals during 1970-71 and 1971-72.

11. PUBLICATIONS

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

The reports, etc. mentioned below were published as ICAR/IARS publications during the year under report.

1. Das, M.N., Amble, V.N., Marutiram, B., Jacob, T., Nadkarni U.G., Dey, A., Bajpai, S.N. and Jain, T.B. National Index of Animal Experiments.

2. Leelavathi, C.R., Bapat, S.R. and Das, M.N. Evaluation of yardsticks of additional production from the use of fertilizers on high yielding and locally improved tall varieties of cereals.

3. Marutiram,B. Aneja, K.G. and Arya, S.N. Investigations into suitability of sampling plan for milk recording in Key Village Blocks.

4. Pillai, S.S. Computer programmes for agricultural research.

5. Raut, K.C., Amble, V.N. and Singh, Shivtar. Economics of raising cattle and buffaloes.

12. SUMMARY OF THE REPORT

12.1. Statistical Research in Agricultural Sciences

12.1.1. Designing of experimental and statistical analysis of data collected under the All India Coordinated Agronomic Experiments Project.

During 1972-73, about 600 complex experiments were conducted at 45 Model Agronomic Centres. Inspite of adverse climatic conditions prevailing during the year, annual grain production of over 10 tonnes/ha was obtained at 11 Model Agronomic Research Centres, and 17 tonnes/ha per annum, the highest, with rice-rice-rice rotation at Tirupati. The results of inter-cropping experiments at the research centres showed that the inter-row spacing in arhar crop could be better utilized for growing moong or other pulses. At Ludhiana with maize-wheat rotation a high response of 19 q/ha of wheat was obtained to the application of 60 kg P_2O_5/ha, but the succeeding maize crop could satisfy its phosphorus requirements from the residual effect.

About 9,000 simple experiments were conducted in 56 districts on cultivator's fields. Response to $N_{80}P_{60}K_{60}$ exceeded 20 q/ha for paddy in Jammu, Kangra and Midnapur and for wheat in Bulandshahar. Significant response of about 5 to 6 q/ha of paddy was obtained at Pusa and Kathulia Farms with 25 kg/ha of Zinc Sulphate and of about 8 q/ha of Jowar at Indore with 50 kg/ha of the same chemical. Under dryland conditions, good response was observed to the combined application of N, P and K to paddy in Rewa, Ramnathapuram and Mayurbhunj, to wheat in Hoshiarpur and Ambala, to maiza in Ambala and Punchmahals, to jowar in Jaipur and to groundnut in Dharwar.

12.1.2. National Index of Agricultural Field Experiments.

During the calendar year 1973, data in respect of about 4,800 experiments conducted during the period 1966-71 in the country were received in the Institute and data of 2360 experiments were analysed. Analysis of experimental data and summarization of the results for the experiments conducted during the period 1960-65 were completed for 8 regions while compendia volumes of Part III Series for the period 1960-65 were printed for 3 regions. In addition, material for Volume II of the Index of Agricultural Field Experiments in respect of the experiments reported to the Institute during the year 1972 was being prepared.

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

During the year under report, the survey work was conducted on Jute,

Cotton, Wheat and Paddy crops. Multiple regression analysis was carried out for developing the suitable relationship between yield and different biometrical models, viz., (*i*) original scale, (*ii*) log scale, (*iii*) square root and (*iv*) inverse scale. The analysis of data on jute revealed that the number of plants and height of the plants are mainly responsible in developing the regression relrationship for forecasting studies while in the case of cotton the yield of the first two pickings could be used for developing the regression relationship for the pre-harvest forecasting studies. The number of plants and the number of balls per plant contributed significantly to the amount of variation due to the regression. Analysis of the data on paddy and wheat crops indicated that the number of plants and number of tillers per plant are the major contributors to the variation in the yield explained by the regression.

12.1.4. Crop weather relationship studies.

Daily rainfall data for 24 years from 1944 to 1967 collected from the Meteorological Department, Poona and yield data obtained from the Directorate of Agriculture, Poona for Raipur district were utilized for the study under report. It was investigated that rainfall was one of the most important factors contributing towards the increase in the yield of paddy. The distribution of rainfall for individual months was found to follow the normal curve and cyclical behaviour of the rainfall could be suitably described by the harmonic function and the periodicity of the cycle was found to be of the order of 9 years.

12.2 Statistical research in animal sciences.

12.2.1 Measurement of genetic improvement due ta cross-breeding in sheep and cattle.

The sheep breeding data collected at the Sheep Breeding Farm, Banihal—Reasi (Kashmir) for the period 1952-66 and the data pertaining to the crossbred cows of different Military Dairy Farms for the period 1934-55 were used for the study. The technique of discriminant functions was used to obtain a score for the quality of an animal on the basis of several characters and these scores were used to rank the various grades available for assessing their potential for genetic improvement.

In case of sheep, it was found that, in comparisons involving exotic breeds, fleece weight and fibre diameter were comparatively more important than the other characters whereas in comparisons not involving exotic beeds, fibre diameter happened to be the most important character. It was also observed that half-breds and three-fourths did not differ substantially and therefore the optimum level of exotic blood for stabilising a new breed could be taken as 50%.

The analysis of the data pertaining to cattle was in progress.

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

The data obtained from the Regional Poultry Farm, Bhopal under the Co-ordinated Poultry Breeding Programme of the Government of Madhya Pradesh were further analysed with a view to develop efficient selection procedures. The analysis of the data relating to the foundation stock and the first generation of birds of selected parents showed that the average rate of lay in the first generation was higher than that of parental generation by about 7%. The heritability of rate of lay decreased due to selection. Further analysis of the data was in progress.

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

Some results of the analysis of the data collected under the scheme for the improvement of poultry through family selection at the Centre in Kerala conducted 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. were given in the report for the year 1972. During the year under report, investigations were taken up for studying comparative efficiency of a new selection index for improvement of poultry. Also, the problem of optimum structure of poultry breeding population when selection was based on that index was investigated.

An index utilizing information on dam in addition to that on sibs and individuals' own performance in case of females was developed for increasing the accuracy of estimates of breeding worth of individuals when dam and sire families were small and heritability of a trait was low Numerical values for the weighting co-efficients for the range of the number of full-sibs and half sibs normally encountered in a large scale breeding programme were obtained and a ready reckoner was prepared for use by poultry breeders in the actual selection of birds. It was seen that inclusion of dam's records in addition to information on the sibs resulted in an appreciable gain of 4 to 6 per cent in case of females and 6 to 35 per cent, in case of males, when dam and sire families were small and heritability of the trait was low. The problem of optimum structure of breeding population and selection of birds based on records of dam, half-sibs and full-sibs including own performance in case of females and for a fixed testing facility was also examined. The sizes of

sire and dam families as also the proportion of males and females as selected in each generation were seen to be almost the same for varying testing facility and heritability of the trait. For a given testing facility, the optimum combination of the parameters which define the breeding plan completely was suggested.

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

The data for the study were obtained from the Centre at Vishakhapatnam (Andhra Pradesh). These pertained to the period 1957-71 and comprised of observations on lactation yield and lactation length of all completed lactations, abnormal calvings, and mortality in different age groups in respect of the local and the various grades of cross-bred animals.

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, half-bred animals gave significantly higher lactation yield and had a longer lactation length in their first lactation than three-fourth Jersey animals. The proportion of abnormal calvings was signficantly different among the local and the cross-bred animals while it was of the same order among the various grades of cross-bred animals.

Further analysis of the data was in progress.

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

The salient results pertaining to the project carried out in the Krishna Delta region of Andra Pradesh were given in the report for the year 1972.

During the year under report, the data pertaining to the Dhulia region of Maharashtra State for the first year of enquiry were analysed. It was seen 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 for a buffalo in milk was about 3.38 kg. and it was 1.77 kg. per milch buffalo. The corresponding figures for a cow in milk and for a milch cow were 1.05 kg. and 0.49 kg. respectively. A buffalo in a commercial producer household was, on an average, given 4.2 kg. of greens, 9.0 kg. of dry roughages and 2.5 kg. of concentrates per day, while a dry buffalo was given about 2.0 kg. of greens, 7.1 kg. of dry fodder and 335 grams of concentrates per day. The corresponding figures for a cow in milk were 2.4 kg. 5.1 kg. and 545 gms while for a dry cow these were 1.3 kg. 4.5 kg. and 300 gms. respectively. The maintenance cost of a milch

buffalo was estimated to be Rs. 2.42 per day when unpaid labour was included and Rs. 2.33 per day when it was excluded. The cost of production per kilogram of buffalo milk was Rs. 1.37 including unpaid labour and Rs. 1.32 when it was excluded. The prevailing market rate of milk in the area during the year was Rs. 1.25 per kilogram.

The detailed analysis of the data pertaining to the second year of enquiry was in progress.

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

The data collected in the bench-mark survey conducted in the milk shed areas of Dudhsagar Dairy in Mehsana (Gujarat) during 1967-68 were analysed for the study. The estimates of average daily milk yield per animal and of milk production in the areas were given in the report for the year 1972. The study on feeds fed to different categories of animals in the areas was completed during the year under report.

It was seen that in a commercial household in the supplying area, a cow in milk was fed on an average 5.1 kg. of greens, 3.9 kg. of dry roughages, and 0.4 kg. of concentrates per day while a buffalo in milk was given 10.3 kg. of greens, 8.6 kg. of dry roughages and 1.5 kg. of concentrates per day. The total quantum of feed given to a buffalo in milk per pay was about twice that given to a cow in milk. In the non-supplying area, a cow in milk was fed one and a half times more roughages than her counterpart in the supplying area, whereas the quantum of roughages fed to a buffalo in milk did not differ materially in the two areas. The quantities of concentrates fed were almost equal in the two areas. A dry cow in the supplying area was fed 1.7 kg. of greens, 3.0 kg. of dry fodder and no concentrates per day as against 3.6 kg. of greens, 6.6 kg. of dry fodder and 30 gms. of concentrates fed to her counterpart in the non-supplying area. A dry buffalo was fed 7.1 kg. of greens, 8.1 kg. of dry fodder and 115 gms. of concentrates in both the areas.

The pattern of feeding in private households was quite similar to that observed for commercial households except that buffaloes maintained in private households were fed more of greens and less of concentrates.

It was also observed that in case of cows, the maximum feed was given during the rainy season and minimum in summer, whereas in case of buffaloes the maximum feed was given during summer and the minimum during the rainy season.

12.2.7. National Index of Animal Experiments Scheme.

A compendium of the results of experiments conducted at I.V.R.I. on Animal Nutrition during the years 1945-72 was prepared and copies of the same in the approved format were circulated to Research Institutes, State Directorates of Animal Husbandry and other research organisations. The compendium contained the results of about 400 experiments which were broadly divided into four categories, viz., (1) Feeding trials for growth, milk and wool production, (2) Feeding trials with subsidiary feeds, (3) Requirements studies, and (4) Nutritive value of feeds and fodders. The experiments related to cattle, buffaloes, sheep, goats, and pigs. The statistical design adopted in these experiments was mostly 'C.R.D.' except for about 20 experiments where 'R.B.' was used.

Besides, data on 63 animal experiments were collected during the year while data pertaining to 75 experiments already collected were analysed. The processing of the remaining of the data collected was in progress.

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

Data on quality characters, viz., fibre diameter, crimps per cm, fibre length, medullation percentage and fleece density of regional and composite samples of ewes of Nilgiri, Nilgiri × Romney Marsh farm flocks and Nilgiri sheep of village flocks collected from the Sheep Breeding Farm, Kamrajsagar, Ootacamund (Tamil Nadu) and of ewes of Chokla and Polworth × Rampur Bushair crosses collected from the Central Sheep and Wool Research Institute, Avikanagar (Rajasthan) were utilized for the study. As already mentioned in the report for the year 1972, after the estimates of averages and their standard errors for all the above mentioned quality characters had been obtained, the data were utilized to estimate the number of sheep to be selected from groups of sheep of sizes ranging from 20 sheep to 500 sheep to estimate the mean with standard error of 1%, 2% and 5% of the mean.

On completion of the statistical analysis of all the data pertaining to all breeds during the year under report, it was seen that the averages of quality characters obtained by weighting with regional wool yield did not differ from those obtained by weighting with number of cuts or number of fibres, and that the averages based on the samples obtained by composite sampling methods and the over-all averages obtained from regional samples did not differ significantly. The analysis of variance showed that the methods of composite sampling did not differ significantly. For estimation of sample sizes, the one with least coefficient of variation was taken. Between sheep variation, region variation and sheep x region

interaction were found to be significant in almost all the cases. Sample sizes were estimated for all characters separately for each age group of each breed by the regional sampling method and the composite sampling method. Tables for the number of sheep required to be selected according to regional sampling from (*i*) observed flock sizes but with different number of cuts per sheep, i.e. from 6, 12, 18 and 24 and from (*ii*) different flock sizes ranging from 20 to 500 and with 20 cuts per sheep were prepared. Similar tables were also prepared for composite sampling methods. Tables giving these sample sizes would be of ready use for selecting a number of sheep from flocks of known strength to estimate quality characters means with standard error at 1%, 2% and 5% of the mean. On the whole, it was observed that composite sampling might be adopted when the regional means and variation are not required for grading of wool.

In addition to the above studies, investigations in connection with the pilot studies for estimation of birth and death rates in bovines for preparation of life tables were continued. The field work of the repeat sample survey to study the impact of milk supply schemes on rural economy was completed in the milk collection areas of the Delhi Milk Scheme in July, 1973 and it was thereafter begun in the milk-shed areas of the Dudhsagar Dairy of Mehsana (Gujarat) where it was to continue till the end of October, 1974. The scrutiny and coding of the data collected from the milk collection areas of D.M.S. was in progress. As regards the study of cost of poultry and egg production, preparation of a complete report on the statistical analysis of the data collected from the Dasuya and Tanda regions of Hoshiarpur District in the Punjab was in progress while the data collected in Delhi and its surrounding areas were being analysed.

12.3. Sample survey investigations.

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

The data on crop cutting experiments conducted during the year 1971-72 giving yield rates of high yielding and local varieties of rice, wheat, maiza, jowar and bajra with corresponding rates of application of fertilizers and the data of A.A.E. enquiry for the year 1970-71 giving the areas under the five programme crops, and extent of adoption of the associated package of practices were analysed during the year under report. The salient results obtained were as given below.

(*a*) *Yield Estimation Surveys*

(*i*) *Kharif 1971-72*

The high yielding varieties of rice cultivated were IR—8, Jaya, Mashori,

Jagannath, CO—29, CO—25, Hamsa, Manila, IR—49, IR—20, IR—5, ADT—27, Manohar Sali, TN—1, T—3, Tainan—3, Safri—17, R—24, TK—25, Padma, NSJ—200 and CH—4, of which IR—8 was the most popular. The highest average yield of 40.3 Q/ha was recorded for Manila in Bellary district of Karnataka, while the lowest average yield of 10.5 Q/ha was for Jaya in Bahraich district of Uttar Pradesh and Saran district of Bihar. The yield rates of IR—8 generally varied in the range of 20 to 40 Q/ha except in a few districts of Bihar and Uttar Pradesh, where a lower yield was recorded. The rates of application of chemical fertilizers were the highest in Bellary district of Karnatka and the lowest in Nagpur district of Maharastra and Kanpur district of Uttar Pradesh.

The most commonly grown varieties of maize were Ganga Safed—2 and T—41 followed by Ganga—5. The other hybrids of maize grown were Ganga —3, Ganga—101, Deccan Hybrid, Vijay and Jaunpuri White. The highest average yield of 45 Q/ha was recorded for Deccan Hybrid in Karnataka. The yield rates of the different high yielding varieties of maize in the selected districts of Punjab and Haryana were quite high ranging generally between 25 to 35 Q/ha. The highest rates of application of NPK were observed in the district of Karnataka.

The most commonly grown variety of hybrid jowar was CSH—1. The other variety tried was CSH—2. The highest average yield of CSH—1 was 43.9 Q/ha in Mysore district of Karnataka and the lowest, 4.7 Q/ha, in Aurangabad district of Maharashtra. The rates of application of NPK were the highest in the districts of Karnataka.

The high yielding varieties of bajra commonly grown were HB—1, HB—3 and HB—4. The highest average yield of 30.9 Q/ha was recorded for HB—4 in Nellore district of Andhra Pradesh and the lowest average yield of 4.6 Q/ha for HB—3 in Parbhani and Bhir districts and for HB—1 in Sangli district of Maharastra. The rates of application of NPK were the highest in the districts of Andhra Pradesh.

(*ii*) *Rabi 1971-72*

The most extensively grown high yielding variety of wheat was Sonalika followed by Kalyan Sona. The other varieties tried were N_1-747-19, N_1-917, HDM—1553, Safed Lerma, Sonora—64, Chotti Lerma, Lal Bahadur and UP—301. The highest average yield of 57.2 Q/ha was observed for UP—301 in Morena district of Madhya Pradesh while the lowest average yield of 12.6 Q/ha was for N_1-747-19 in Bhir district of Maharastra. The yield rates of the different high yielding varieties were generally higher in Punjab, Haryana and Uttar Pradesh than in Maharastra, West Bengal and Bihar. The rates of application of NPK were the highest in Morena district of Madhya Pradesh.

The most commonly grown variety of rice was IR—8 followed by IR—20 and Hamsa. The other high yielding varieties of rice tried were TN—1, Jaya CO—29, Annapoorna—28, Ratna, Kaveri, Mashori, Padma, Bala and Manila. The highest average yield of 44·7 Q/ha was obtained for IR—8 in Mysore district of Karnataka and the lowest average yield of 13·6 Q/ha, for Kaveri in Nellore district of Andhra Pradesh. The rates of application of chemical fertilizers were the higheest in the districts of Karnataka.

The popular varieties of maize were Deccan Hybrid and Ganga—5 followed by Ganga—3. The highest average yield of 66.9 Q/ha was observed for Ganga—5 in Mysore district of Karnataka, where the rates of application of NPK were also the highest. The yield rates of the different maize hybrids were higher in the districts of Karnataka than in the districts of Andhra Pradesh.

The commonly grown variety of hybrid jowar was CSH—1. The highest average yield of 29.4 Q/ha was recorded for Ananta—1 in Shimoga district of Karnataka. The yield rates as well as the rates of application of chemical fertilizers were higher in Shimoga district than in Sholapur district of Maharastra.

The popular varieties of hybrid bajra were HB—4, HB—1 and HB—3. The highest average yield of 23.4 Q/ha was obtained for HB—1 in Coimbatore district of Tamil Nadu and the lowest average yield of 15.3 Q/ha, for HB—4 in Chingleput district of this State. The rates of application of NPK were generally of the same order in all the districts.

(b) *Agronomic and agro—economic enquiry*

(*i*) *Kharif 1970-71*

The proportion of the area estimated to have been brought under high yielding varieties of rice to the total area under rice was nearly 50 per cent in Bulandshahr district of Uttar Pradesh and Amritsar district of Punjab, while it ranged between 20 to 40 per cent in 10 other districts and was less than 5 per cent in the remaining 11 districts.

In case of the maize crop, the corresponding proportion was nearly 40 to 60 per cent in Amritsar district of Punjab, Belgaum district of Karnataka and Bulandshahr district of Uttar Pradesh while it was of the order of 20 in Patiala district of Punjab and Muzaffarnagar district of Uttar Pradesh. It ranged between 6 to 14 per cent in 10 other districts while in the remaining 6 districts, it was less than 5 per cent.

The estimates of the area under the high yielding varieties of jowar indicated that about 50, 20 and 44 per cent respectively of the total area under jowar had been brought under the high yielding varieties in Shimoga, and Bellary districts of Karnataka and Aurangabad district of Maharastra. The corresponding percentage ranged between 7 and 17 for 12 other districts while it was less than 5 in the remaining 3 districts.

In case of bajra, it was observed that about 38 to 58 per cent of the area under the crop had been brought under the high yielding varieties in 8 districts, while this percentage was less than 25 in 10 other districts and less than 5 in the remaining 2 districts of Banaskhantha (Gujarat) and Jaipur (Rajasthan).

(*ii*) *Rabi 1970-71*

In Muzaffarnagar district of Uttar Pradesh, the entire area under wheat was grown with high yielding varieties, while in the districts of Etawah and Bulandshahr of U.P., Jullundhar of Punjab and Ambala and Hissar of Haryana, 80 to 90 per cent of the area under wheat had been brought under high yielding varieties. The corresponding percentage was 50 to 70 in 11 other districts, 20 to 35 in another 11 districts and 5 to 10 in yet another 11 districts. It was less than 5 in the remaining 3 districts, viz, Satara and Wardha of Maharastra and Kota of Rajasthan.

In case of rice, about 40 to 60 per cent of the area under the crop was grown with high yielding varieties in the districts of Shimoga and Bellary of Karnataka and East Godavri and Nellore of Andhra Pradesh. The corresponding percentage ranged between 13 and 32 in 9 other districis and was only 5 in the remaining 3 districts of Anantpur, Guntur and Nizamabad of Andhra Pradesh.

The estimates of the area under high yielding varieties of maize indicated that 94 per cent of the total area under maize had been grown with high yielding varieties in Mysore district of Karnataka, while this percentage was less than 32 in the remaining 4 districts.

In case of jowar, the corresponding percentage was 6 in Bellary district (Karnataka) and only 1 in Bhir district (Maharastra). However, almost the entire area under the crop in Shimoga district of Karnataka was grown with high yielding varieties.

The estimated percentage of area under H.Y.V. of bajra was about 60 in Coimbatore district while it varied from 6 to 36 in the other 3 districts of Tamil Nadu.

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

The objective of the project was to prepare a bulletin giving estimates of annual meat production and its per capita availability in the different States and also for the country as a whole. Final results of the project could be given only after necessary data were received from the States of Uttar Pradesh. Madhya Pradesh, Rajasthan and other areas, which were awaited.

In respect of the Northern Region comprising Puujab, Haryana and Himachal Pradesh, it was estimated that the total number of animals slaughtered in the region during the year 1971-72 was 7.63 lakh of which 89 per cent accounted for slaughter in registered slaughter houses. The estimate of annual meat production was 86.37 lakh tonnes and the per capita availability of meat worked out to be 322 grammes per year.

In addition to the above survey investigations, collection of additional data and critical analysis of the data already collected were in progress in connection with the 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 sample survey technique for estimation of production of vegetables, while statistical analysis of the data collected from all the districts of Tamil Nadu in the pilot sample survey for developing a sample survey technique for estimation of production of fresh fruit crops was in progress during the year. As regards the pilot sample surveys for evolving an integrated technique for estimation of annual output of principal livestock products, viz, milk, wool, eggs and meat, statistical studies on the data collected in the Northern region comprising Punjab, Haryana and Himachal Pradesh were carried out during the year, while data on production of egg as the principal product were collected in the Southern region. Studies for preparation of a monograph on methodology for estimation of meat production were continued, while a monograph on methodology for estimation of poultry egg production and poultry practices was being finalized after a further study to build up estimates of per capita availability of eggs and poultry meat in different parts of the country. Also, studies on availability of feeds to cattle and buffaloes in India and on methodology for estimation of inter-censal livestock numbers through surveys on livestock products as also on evolving a sample survey technique for estimation of cultivated fodders were continued during the year under report. Besides, field work in connection with a study on employment and income effects of the new agricultural strategy in the district of Aligarh in Uttar Pradesh was started in August, 1973 and the survey for developing a sample survey technique for estimation of crop losses in storage was initiated in that district in September, 1973.

12.4. Basic research in Statistics :

(*a*) *Sampling* : An attempt to form clusters in the most optimum fashion utilizing the available information was made. The superiority of the suggested procedure over the existing one was also examined from the point of view of efficiency and suitability. Suitable estimation theory for sampling on successive occasions using a two stage sampling design with multi-auxiliary variables was developed. Studies on some aspects of non-response in two characters in a two stage design were also made.

(*b*) *Design of Experiments* : New methods of construction of 2 class G.D. designs using extended association schemes and by the use of two-symbol orthogonal arrays of strength two and Hadamard matrices were developed. Methods of construction of PBIB designs based on Group Divisible family of association schemes and of Rectangular designs using BIB designs were developed.

(*c*) *Genetical Statistics* : Some studies on the estimation of genetic components of variation in economic traits of poultry were made utilizing the data of the Regional Poultry Farm at Bhopal.

12.5. Publications :

Forty-five papers by the officers, members of staff and research students of the Institute were published in standard journals during the year under report. Besides, three technical reports, a compendium entitled "National Index of Animal Experiments" and a book entitled "Computer Programmes for Agricultural Research" were published as ICAR publications. Also, twenty-three papers were accepted for publication in different standard jounals.

APPENDIX I

List of Class I Officers in position as on 31.12.1973.

Name	*Designation*
Research and Training Side	
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 Statistcian (Agro.)
5. Shri S.D. Bokil	Statistician-cum-Assoc. Professor
6. Shri V.V.R. Murty	Statistician-cum-Assoc. Professor
7. Shri S.S. Pillai	Statistician-cum-Assoc. Professor
8. Shri M.P. Jha	Statistician-cum-Assoc. Professor
9. Shri B. Marutiram	Statistician-cum-Assoc. Professor
10. Shri K.C. Raut	Statistician-cum-Assoc. Professor
11. Shri M. Rajagopalan	Statistician-cum-Assoc. Professor
12. Shri T. Jacob	Statistician-cum-Assoc. Professor
13. Shri S.S. Narula	Statistician-cum-Assoc. Professor
14. Shri H.P. Singh	Statistician-cum-Assoc. Professor
15. Shri A.H. Manwani	Statistician-cum-Assoc. Professor
16. Dr. B.B.P.S. Goel	Statistician-cum-Assoc. Professor
17. Shri P.N. Bhargava	Statistician-cum-Assoc. Professor
18. Dr. M.S. Avadhani	Statistician-cum-Assoc. Professor
19. Dr. Aloke Dey	Statistician-cum-Assoc. Professor
20. Dr. A.K. Nigam	Statistician-cum-Assoc. Professor
21. Shri J.P. Jain	Statistician-cum-Assoc. Professor
22. Dr. R.K. Pandey	Agricultural Economist
23. Shri U.G. Nadkarni	Junior Statistician
24. Miss C.R. Leelavathi	Junior Statistician
25. Shri J.N. Garg	Junior Statistician
26. Shri R. Gopalan	Junior Statistician
27. Shri A.K. Banerjee	Junior Statistician
28. Shri S.R. Bapat	Junior Statistician
29. Shri J.S. Maini	Junior Statistician
30. Shri P.C. Mehrotra	Junior Statistician
31. Shri M.G. Mittal	Junior Statistician

32.	Shri L.K. Garg	Junior Statistician
33.	Shri V.S. Rustogi	Junior Statistician
34.	Shri P.N. Soni	Junior Statistician
35.	Shri S.N. Mathur	Junior Statistician
36.	Shri R.K. Khosla	Junior Statistician
37.	Shri A.K. Srivastava	Junior Statistician
38.	Shri Padam Singh	Junior Statistician
39.	Shri A.C. Kaistha	Mechanical Tabulation Officer
40.	Shri S.C. Rai	Assistant Professor
41.	Shri R.C. Aggarwal	Field Officer
42.	Shri Rajendra Singh	Field Officer

Administrative Side

1.	Shri R.S. Saksena	Chief Administrative Officer
2.	Shri M.R. Garg	Administrative Officer
3.	Shri S.S. Grewal	Assistant Administrative Officer

APPENDIX II

List of sanctions posts as on 31.12.1973

Sl. No.	*Post*	*Scale of pay*	*No. of posts sanctioned*
		Class I	
1.	Director	Rs. 1600-2000*	1
2.	Joint Director	Rs. 1300-1800*	2
3.	Senior Professor	Rs. 1100-1600*	5
4.	Senior Statistician	Rs. 1100-1400*	6
5.	Chief Scientist (CC)	Rs. 1100-1400*	1
6.	Chief Administrative Officer	Rs. 1100-1400*	1
7.	Administrative Officer	Rs. 1100-1600	1
8.	Statistician-cum-Assoc. Professor	Rs. 1100-1600	19
9.	Agricultural Economist	Rs. 1100-1600	1
10.	Programmer (CC)	Rs. 1100-1600	6
11.	Junior Statistician	Rs. 700-1300	24
12.	Assistant Professor	Rs. 700-1300	2
13.	Mechanical Tabulation Officer	Rs. 700-1300	1
14.	Junior Technical Officer	Rs. 700-1300	1
15.	Field Officer	Rs. 700-1300	2
16.	Assistant Administrative Officer (CC)	Rs. 700-1300	1

(*Old scale of pay)

		Class II	
1.	Accounts Officer	Rs. 890-1200	1
2.	Assistant Field Officer	Rs. 650-1200	1
3.	Section Officer	Rs. 650-1200	3
4.	Statistical Investigator	Rs. 550-900	39
5.	Electronic Computer Operator	Rs. 550-900	6
6.	Jr. Accounts Officer	Rs. 550-900	2
		Class III	
1.	Assistant Incharge	Rs. 425-800 plus Rs. 40/-	1
2.	Assistant	Rs. 425-800	13

3.	Cashier	Rs.	425-800	1
		plus Rs.	40/-	
4.	Personal Assistant	Rs.	425-800	8
5.	Jr. Accountant	Rs.	425-750	2
6.	Statistical Assistant	Rs.	425-700	75
7.	Technical Assistant	Rs.	425-700	1
8.	Asstt. Electronic Computer Operator	Rs.	425-700	6
9.	Caretaker	Rs.	425-700	1
10.	Senior Storekeeper	Rs.	425-700	1
11.	Senior Library Asstt. (Gr. II)	Rs.	425-700	1
12.	Inspector	Rs.	425-700	4
13.	Supervisor	Rs.	330-560	11
14.	Senior Computer	Rs.	330-560	61
15.	Card Librarian	Rs.	330-560	2
16.	Stenographer	Rs.	330-560	12
17.	Upper Division Clerk	Rs.	330-560	12
18.	Upper Division Clerk (Hostel)	Rs.	330-560	1
19.	Punch Supervisor	Rs.	330-480	8
20.	Machine Operator	Rs.	260-400	4
21.	Enumerator	Rs.	260-400	46
22.	Key Punch Operator	Rs.	260-400	75
23.	Lower Division Clerk	Rs.	260-400	32
24.	Telephone Operator	Rs.	260-400	2
25.	Staff Car Driver	Rs.	260-400	1
26.	Tubewell Operator	Rs.	260-400	1
27.	Carpenter	Rs.	260-350	1
28.	Jeep Driver	Rs.	260-850	1
29.	Senior Gestetner Operator	Rs.	260-350	1
30.	Library Attendant	Rs.	225-308	1

Class IV

1.	Junior Gestetner Operator	Rs.	210-270	1
2.	Daftry	Rs.	200-250	6
3.	Laboratory Attendant	Rs.	200-250	12
4.	Jamadar	Rs.	200-250	1
5.	Chowkidar	Rs.	196-232	8
6.	Frash	Rs.	196-232	6
7.	Mali	Rs.	196-232	5
8.	Beldar	Rs.	196-232	2
9.	Peon	Rs.	196-232	15
10.	Sweeper	Rs.	196-232	10
11	Khalasi	Rs.	196-232	10

APPENDIX III

List of dissertations approved during the year 1973 for award of Ph.D. and M.Sc. Degrees and Diploma in Agricultural Statistics.

Ph.D. Degree

1. GOEL, B.B.P.S. Efficiency of certain systems of cluster sampling and its applications.
2. KATHURIA, O.P. On alternative replacement procedures in sampling on successive occasions and on use of multi-auxiliary information in such designs.

Diploma

1. MALIK, R.P.S. Some aspects of non-response in two characters in a two-stage design.
2. MIDHA, C.K. Contributions to incomplete block designs.
3. TRIVEDI, H.T. Some studies on partially balanced incomplete block designs.

M.Sc. Degree

1. AMDEKAR, S.J. Study of low response of high yielding varieties of rice and wheat to fertilizers under farmers' conditions.
2. BIYANI, S.H. On investigation of maximum number of factors in confounded factorials.
3. CHANDER, JUGESH, A statistical apprisal of the performance of high yielding varieties of wheat in West Bengal State.
4. MALHOTRA, P.K. Estimation of genetic components of variation in economic traits of poultry.
5. NITIPAWIRO, T.S. Procedures for estimation of average yield rates of high yielding varieties of crops.
6. SRINATH, M. Some contributions to post-cluster sampling.

APPENDIX IV

List of papers published or accepted for publication during the year 1973.

(*a*) *Papers published*

1. ANEJA, K.G. and MARUTIRAM, B. A sampling plan for measurement of changes in level of milk production in areas under development. *Ind. Jour Anim. Sci., Vol. 43, No. 12, 1973.*

2. AUSTIN, A., SINGH, H.D., HANSLAS, V.K. and PILLAI, S.S. Effect of variety and nitrogen fertilization on dough characters and baking properties of improved wheat varieties. *Agri. Agro.-Ind. Jour., Nov., 1972.*

3. AVADHANI, M.S. and SUKHATME, B.V. Controlled sampling with equal probabilities and without replacement. *Int. Stat. Rev., Vol. 41, No. 2, pp. 175-182.*

4. BHARGAVA, P.N., NARAIN, P., ANEJA, K.G. and PRADHAN, ASHA. A study of the occurrence of rainfall in Raipur District with the help of Markov Chain Model. *Jour. Ind. Soc. Agri. Stat., Vol. 25, No. 2, 1973, pp. 197-204.*

5. CAPEL, R.E. and PANDEY, R.K., Evaluating demand for deer hunting—A comparison of methods. *Canadian Journal of Agricultural Economics, November, 1973.*

6. CAPEL, R.E. and PANDEY, R.K. Demand estimation in planning for intensive resource management of deer and moose hunting in Manitoba. *Proc. of 38th North American Wildlife and Natural Resources Conference, Vol. 38, March, 1973.*

7. DEB, MAMATA and ARYA, SHASHI PRABHA. A note on almost continuous mappings in the sense of Frolik. *Math. Student 41 (1973).*

8. DEB, MAMATA and ARYA, SHASHI PRABHA. Some weaker forms of open mappings. *Math. Student 41(1973).*

9. DEY, A. and KULSHRESHTHA, A.C. Further second order rotatable designs. *Jour. Ind. Soc. Agri. Stat., Vol. 25, No. 2, 1973.*

10. GOPALAN, R and JACOB, T. Tables of orthogonal polynomials for unequally spaced values of the independent variate. *Jour. Ind. Soc. Agri. Stat., Vol. 25, No. 2.*

11. GOSWAMY, N.N., RAHEJA, S.K. and BAPAT, S.R. Fertilizer recommendations on cultivators' fields—soil fertility approach. *Fert. News, Vol. 18, March, 1973.*

12. GUPTA, S.B.L., PRASAD, R. and PANDEY, R.K. An economic evaluation of soil conservation measures in Varanasi District. *Ind. Jour. Agri. Econ., Vol. 28, 1973.*

13. GUPTA, S.S., BANERJEE, A.K., MEHRCTRA, P.C. and RAJAGOPALAN, M. A study on the high yielding varieties of rice in Andhra Pradesh. *Agri. Situ. Ind., Vol. 28, No. 1, April, 1973, pp. 17-21.*

14. JAIN, J.P. and RAUT, K.C. Milk production and its utilization in the milk shed areas of Delhi Milk Scheme. *Ind. Jour. Anim. Sci., Vol. 43, No. 9, 1973.*

15. KANWAR, J.S., DAS, M.N., SARDANA, M.G. and BAPAT, S.R. Economics of fertilizer use on rice in farmers' fields. *Fert. News, Vol. 18, Jan., 1973.*

16. KANWAR, J.S., DAS, M.N., SARDANA, M.G. and BAPAT, S.R. Are fertiliser applications to jowar, maize and bajra economical ? Fert. News, Vol. 18, July, 1973.

17. KHOSLA, R.K., SARDANA. M.G., SAKSENA, M.P. and SAHNI, M.L. Review of agricultural experimentation in India during 1965-70. *Ind. Jour. Agri. Sci., Vol. 43, No. 4, 1973.*

18. KHOSLA, R.K., SARDANA, M G., SAKSENA, M.P. and SAHNI, M.L. A review of agricultural experiments in India. *Jour. Ind. Soc. Agri. Stat., Vol. 25, No. 1, June, 1973.*

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