

ANNUAL REPORT

1971



INSTITUTE OF AGRICULTURAL RESEARCH STATISTICS

NEW DELHI-110012

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INSTITUTE OF AGRICULTURAL RESEARCH STATISTICS
(I.C.A.R.)
LIBRARY AVENUE: NEW DELHI-12.

ANNUAL REPORT FOR 1971.

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 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 occupying high positions in the universities and other research institutions of the U.S.A., Canada and some other countries.

- The Institute made a modest beginning in 1930 as a statistical section of the Indian Council of Agricultural Research. It was then manned with 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 and in analysing data and interpreting the results. He was also responsible for scrutiny of the technical programmes and progress reports of research schemes of the Council. The activities of the section entered a new phase towards the end of 1943 when, at the instance of the Government of India, research was initiated for developing objective and reliable methods of collecting yield statistics of principal food crops. This led to the development of the crop-cutting survey technique which has since been adopted by almost all the States in the country for estimating agricultural production. 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-organized into two units dealing with statistical applications to research in agriculture and animal husbandry and was headed by the Statistical Adviser to the Council.

In 1945, the Council instituted regular post-graduate training courses both for professional statisticians wishing to specialize in agricultural statistics and for agricultural and animal husbandry research workers desirous of acquiring knowledge of simple statistical methods required most often for use in their work. Although teaching and research 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 Institute soon acquired international recognition as a training and research institute 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 number. By the end of 1952, the crop-cutting surveys for the estimation of 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, 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 review the research and training activities of the 'Statistical Wing' and to advise on its development. On their advice, the activities of the 'Statistical Wing' were expanded in many directions.

The 'Statistical Wing' moved to the present campus in August, 1955. The campus provided not only adequate office space for the technical and the ministerial staff, but also facilities of a library, class rooms for training classes, an auditorium and a hostel with usual amenities including a play-ground for the students admitted to the various courses.

In view of its important role as a training and research organisation, the 'Statistical wing' was designated as the "Institute of Agricultural Research Statistics" in 1959. A mechanical data processing unit was also now added to the Institute. On the completion of construction of a new four-storeyed building in 1964, this unit was shifted to its ground floor and was expanded with the addition of an I.B.M. 1620 Model II electronic computer and other related equipments. The new building also provided suitable accommodation in the first floor for a co-operative canteen that had been established in 1959 and there was now another more spacious auditorium on the third floor, which also provided a suitable venue for the cultural and other activities of the Recreation and Welfare Club of the Institute. Also, a new three-storey wing of the hostel was constructed in 1970. All these facilities have enabled the Institute to discharge its functions more efficiently.

1.1 Organisational structure of the Institute

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

1. Statistical research in agricultural sciences;
2. Statistical research in animal sciences;
3. Sample survey investigations;
4. Basic research and training; and
5. Mechanical and electronic processing of data.

The number of Class I Officers in position as on 31st December, 1971 was 42. A list of these officers given in Appendix I. Also, a list of posts, technical and ministerial, sanctioned for the Institute as on 31st December, 1971 is given in Appendix II. The number of the sanctioned posts (including out-station posts) was 579, comprising 73 Class I, 52 Class II, 397 Class III and 57 Class IV posts.

On the research and training side, the Director was assisted by 3 Senior Statisticians, 15 Statisticians, 15 Junior Statisticians, 2 Assistant Professors of Statistics, One Mechanical Tabulation Officer, and 2 Field Officers. On the administrative side, the work was looked after by the Chief Administrative Officer, who was assisted by an Administrative Officer and an Assistant Administrative Officer.

The library of the Institute continued to be looked after by an Assistant Librarian.

1.2 Staff Research Council.

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

The Staff Research Council continued to function at the Institute during the year under report. Shri B.B.P.S. Goel took over as the Member-Secretary of the Research Council from Dr. Prem Narain. Meetings of the Research Council were held on 1st, 2nd, and 5th February, 1971, on 28th to 30th July, 1971 and on 2nd and 7th August, 1971. At these meetings, the progress of all the 35 research projects which were in operation or were proposed to be taken up during the year was thoroughly discussed.

1.3 Hostel.

The Institute has a well organised hostel inside the Campus. Of the two wings of the Hostel, the new wing was constructed in 1970 and was occupied in the beginning of the year under report. 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 on a cooperative basis by the students. The crockery, the utensils, etc. for the mess as also other furniture and fittings in the hostel are all provided by the Institute. There is also a doctor attached to the hostel and students are provided free medical aid, including free supply of essential medicines.

Besides, recreational facilities are also provided to the students. There is a Common Room furnished, inter alia, with a radio set, where all important magazines and news-papers are available. There are adequate facilities for games, both indoor and outdoor, for the students. Students organize sports and tournaments as well as a cultural programme on the occasion of the Hostel Annual Day celebrated each year in the month of April.

Dr. O.P. Gautam, Deputy Director General, I.C.A.R., was the chief guest at the Hostel Annual Day observed in April, 1971. It may also be mentioned that, after the Indo-Pakistan war broke out in December, 1971, the students of the Hostel collected funds, clothes and other material for the Jawans and their families and contributed about Rs.400/- to the National Defence Fund.

1.4 Library.

During the year under report, 220 new books and 500 other publications were added to the Library. There was a constantly increasing number of queries about references and location of literature, which were duly attended to. About 12,000 persons visited the Library for consultation, borrowing, reference or reading purposes. About 17,000 books and other publications 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 publications by borrowers was introduced in February, 1971. As usual, inter-library loan facilities were exchanged with other libraries in the country in general and with those in Delhi in particular.

Reprints of the articles by the officers of the Institute were sent to scientists in the country and abroad. A quarterly indexed bulletin of new additions to the library was introduced during the year under report as a new feature of the library. A catalogue of the "Serials" holdings of the Library was also prepared during the year under report.

1.5 Exhibition Room

In order that a visitor to the Institute may get at one place a comprehensive picture of the important research activities of the Institute, an Exhibition Room has been set up in its premises, where results from 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 the staff of the Institute are also displayed.

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

1.6 Fellowships.

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

	<u>COURSE</u>	<u>VALUE</u>	<u>PERIOD</u>
(i)	Ph.D.	Rs.250 p.m.	2 years (The period may be extended in special cases)
(ii)	Diploma	Rs.250 p.m.	1 year
(iii)	M.Sc. 1 year	Rs.150 p.m.	1 year
	II year	Rs.200 p.m.	1 year
(iv)	P.S.C.	Rs.200 p.m.	1 year

During the year under report, 39 fellowships were awarded and 30 fellowships were continued as detailed below:-

	<u>Awarded</u>	<u>Continued</u>
(i)	Ph.D. I year	1
	II year	1
	III year	-
(ii)	Diploma	9
(iii)	M.Sc. I year	6
	II year	14
(iv)	P.S.C.	8

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

During the year under report, the Institute continued the research collaboration with the Agronomy and the Soil Science and Agricultural Chemistry Divisions of the Indian Agricultural Research Institute, New Delhi in statistical analysis, summarisation of data, and reporting of results under the All India Coordinated Agronomic Experiments Scheme of the I.C.A.R. and with the Soil Science and Agricultural Chemistry Division of that Institute in the planning and designing of experiments under the Soil Test Crop Response Scheme.

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

1.8 Visitors

During the year under report, three eminent statisticians, Dr. J.D. Colwell, Soil Scientist, C.S.I.R.O., Adelaide, Australia, Dr. D. Basu of the Indian Statistical Institute, Calcutta and Dr. N.C. Giri, Professor of Statistics, University of Montreal, Canada visited the Institute and delivered lectures on topics of current research. Dr. Aly Serry, Director, Division of Crop Nutrition and Plant Physiology, Ministry of Agriculture, United Arab Republic visited the Institute on 3rd March, 1971. Shri Pyara Singh Sahota of the F.A.O. visited the Institute on 6th March, 1971 and discussed the survey plan for organising a survey on fruits in Chile (South America).

Groups of I.S.S. Officer trainees and other trainees of the Central Statistical Organisation and I.E.S. Officer trainees of the Directorate of Economics and Statistics visited the Institute at four different periods during the year under report to attend lectures specially arranged for them in Agricultural Statistics and sampling techniques. Also, F.A.O. Course participants visited the Institute in June, 1971 and they were shown round the computer facilities available at the Institute. Besides, the trainees of the Pre-investment Survey of Forest Resources, Ministry of Agriculture, visited the Institute to attend a four week training programme arranged for them in October - November, 1971.

1.9 Participation in Committees, Panels, etc.

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

Dr. M.N. Das	Scientific Panel for Agricultural Economics, Statistics and Marketing.
Dr. Prem Narain	(1) Scientific Panel for Plant Breeding. (2) Scientific Panel for Fisheries Research. (3) Scientific Panel for Dairy Science. (4) Standing Committee for Animal Sciences Research

Shri M.G.Sardana

1. Scientific Panel for Plant Pathology.
2. Scientific Panel for Soil Science and Agronomy.
3. Scientific Panel for Entomology.

Shri B. Marutiram

1. Scientific Panel for Animal Breeding.
2. Scientific Panel for Animal Diseases and Pests.
3. Scientific Panel for Animal Products Technology.

Shri K.C. Raut

Scientific Panel for Dairy Science.

Shri T. Jacob

Scientific Panel for Animal Nutrition and Physiology.

Shri P.N.Bhargava

1. Scientific Panel for Plant Physiology and Bio-Chemistry.
2. Scientific Panel for Horticulture.
3. Scientific Panel for Medicinal Plants and Minor Crops.

Dr. M.S.Avadhani

Scientific Panel for Agricultural Economics, Statistics and Marketing.

Shri R.K. Khosla

Scientific Panel for Entomology.

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

Shri K.C. Raut

Committee on Pricing of Milk formed by the Department of Agriculture.

Shri T. Jacob

ICAR Working Group for Standardization of Techniques in Animal Experimentation.

Dr. Prem Narian

1. International Bio-metric Society, U.S.A.
2. Society for the Advancement of Breeding Researches in Asia and Oceania (SABRAO), Japan.
3. Indian Science Congress Association, Calcutta.
4. Indian Society of Agricultural Statistics, New Delhi (Editor).
5. Indian Association for Animal Production, New Delhi (Member of Editorial Board)
6. Indian Society of Plant Breeding and Genetics, New Delhi.
7. General Council of the University of Edinburgh; U.K.
8. P.G. School Faculty, I.A.R.I., New Delhi.

Dr. M.N. Das

1. International Bio-metric Society, U.S.A.
2. Indian Society of Agricultural Statistics, New Delhi (Secretary).
3. Indian Association of Statistics, Bombay.
4. Calcutta Statistical Association, Calcutta.
5. Indian Science Congress Association, Calcutta.
6. P.G. School Faculty, I.A.R.I., New Delhi.

Dr. M.N. Das, Senior Professor of Statistics (with effect from 7-5-1971), who took over as Director of the Institute on an ad-hoc basis with effect from 24-5-1971 was ex-officio member of the following Committees, Panels, Working Groups, etc. during the year under report.

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

1.10 Appointments, promotions, transfers, etc.

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

(a) Research and Training Side

Dr. Prem Narain, Professor of Statistics and Dr. B.N. Tyagi, Statistician were appointed as Senior Statisticians with effect from 7-5-1971 and 19-6-1971 respectively. The services of Dr. Tyagi were placed back at the disposal of the Government of Uttar Pradesh with effect from 26-7-1971. Thereupon Shri M.G. Sardana, Professor of Statistics and a member of the Indian Statistical Service was appointed as Senior Statistician with effect from 11-8-1971.

Shri H.P. Singh and Dr. M.S. Avadhani joined the Institute as Statisticians on 1-6-1971 and 14-7-1971 respectively. Shri T. Jacob, Junior Statistician, Shri B.B.P.S. Goel, Programmer and Dr. Aloke Dey, Junior Statistician were promoted as Statisticians with effect from 7-5-1971, 9-8-1971 and 7-9-1971 respectively.

Shri S.C. Rai and Dr. G.M. Saha were appointed as Assistant Professors of Statistics on 1-7-1971 and 14-9-1971 respectively.

Shri Rajindra Singh and Shri R.C. Agarwal were appointed Field Officers on 31-7-1971 and 16-9-1971 respectively.

Shri O.P. Kathuria, Shri D.K. Bahl, and Shri T.C.M. Menon, Junior Statisticians left the Institute on 4-5-71, 31-5-71 and 4-8-71 to join the Indian Agricultural Research Institute, New Delhi as Statistician, Senior Computer Programmer, and Statistician respectively.

Shri J.C. Malhotra, Junior Statistician and Dr. D. Singh, Director joined the Department of Agriculture on deputation as Research Officer (Agricultural Census) w.e.f. 1-3-1971 and Deputy Agricultural Census Commissioner, w.e.f. 24-5-1971 respectively. Also, Shri K.G. Aneja, Assistant Professor of Statistics, joined the National Commission on Agriculture on deputation as Deputy Director (Statistics) with effect from 16-9-1971.

Shri H.K. Chawla, Assistant Statistician, Dr. M. Holla, Professor of Statistics and Shri D.L. Ralhan, Officer on Special Duty (MT) (all members of the Indian Statistical Service) left the Institute on 2-8-1971, 31-8-1971 and 8-11-1971 respectively to join the Expert Committee on Unemployment (Ministry of Labour, Employment and Rehabilitation) as Senior Research Officer, the Office of the Registrar General of India as Senior Research Officer and the Department of Agriculture as Joint Director (Agri. Census).

(b) Administration Side

Shri Badri Nath, Assistant Administrative Officer joined the I.C.A.R. Headquarters at Krishi Bhavan, New Delhi as Section Officer in April, 1971.

The services of Shri S.B. Sharma, Accounts Officer, were placed at the disposal of the Deputy Accountant General, Posts and Telegraphs, New Delhi, with effect from 31-12-1971.

1.11 Miscellaneous

(a) Dr. Prem Narain, Senior Statistician, delivered lectures at the Indian Veterinary Research Institute, Izatnagar on 16th and 17th March, 1971 on "Methods of Sire Evaluation" in a Special Course for Animal Breeders and on 22nd December, 1971 on "Selection Index Method and its Efficiency" in a Staff Course in Cattle Production. He also delivered a series of four lectures on "Stochastic Processes in Population Genetics" from 16th to 19th June, 1971 during a Summer Institute at Andhra University, Waltair.

(b) Kumari C.R. Leelavathi, Junior Statistician, participated in the National Level Training Programme of the All India Coordinated Agronomic Experiments Scheme held at Ludhiana and Coimbatore.

(c) Dr. M.N. Das, Director, attended in September, 1971 a meeting called by the Directorate of Cotton Development, Bombay to discuss the problem of the wide divergence between the official estimates and the trade estimates of cotton production in the country. In November, 1971, he visited several cotton producing centres in the States of Maharashtra and Madhya Pradesh as Chairman of a Sub-Committee of the Committee appointed to look into the said disparity and presented a report of its findings to the Committee.

(d) An Achievement Audit Committee under the Chairmanship of Dr. K. Ramiah, M.P. and with Dr. M.S. Swaminathan, Director, I.A.R.I., New Delhi, Dr. P.V. Sukhatme, Director, Statistical Division, F.A.O., Rome, Dr. C.R. Rao, Director, I.S.I., New Delhi and Prof. V.M. Dandekar, 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 Committee met at New Delhi from 5-10-1971 to 7-10-1971. The report of the Committee was awaited.

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 included in the programme is briefly described in the following paragraphs. The names of the principal investigator and his associate or associates are given at the end of the description.

2.1 Pilot studies on pre-harvest fore-casting of yield of crops.

The objective of the studies was to investigate whether pre-harvest estimates of crop yield can be obtained objectively on the basis of biometrical observations such as plant density, height, diameter etc. of the plant at various stages of crop growth. Investigations on 4 crops, jute, cotton, wheat and paddy were in progress under the project. For each crop, two districts in different States were selected for the study and in each district a representative sample of about 250 fields growing that crop was selected by adopting the stratified multi-stage random sampling technique. In each selected field, two plots of size one square meter each for wheat and paddy crops, 4 square meter each for jute crop, and two rows wide and 5 meters long each for cotton crop were located at random for recording biometrical observations such as plant density, height and girth of the plant etc. at various stages of crop growth. The report on pre-harvest forecasting of yield of jute crop in West Bengal during 1970-71 was submitted for the approval of the Scientific Panel for Agricultural Economics, Statistics and Marketing. The statistical analysis of the data collected on pre-harvest forecasting of yield of jute crop in Bihar State and of Wheat crop in U.P. State during 1970-71 was completed. The analysis of the data collected for cotton crop and paddy crop in different States was in progress during the year under report. The technique applied for collection of the data was stratified multi-stage random sampling and for analysis of the data, multiple regression taking yield as the dependent variate and plant density, height and girth of the plant etc. as independent variates.

In the analysis of the data on jute crop from West Bengal, 4 different models viz. (i) simple scale, (ii) logarithmic scale, (iii) square root scale, and (iv) inverse scale were used. In general, the inverse model followed by logarithmic model appeared to be better for predicting the fibre yield on the basis of the number of plants, height and basal diameter of plants. The percentage of variation in fibre weight explained by the regression equations pooled over the blocks, for different sets of observations varied from 18 to 35, 48 to 58 and 66 to 85 for simple, logarithmic, square root and inverse models respectively. The partial regression coefficients of fibre weight on number of plants were found to be highly significant in all the cases, whereas the partial regression coefficients of fibre weight on height and diameter of plants were found to be significant in not more than 25% of cases.

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to
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(H.P. SINGH, M.G.SARDANA & N.K.OHRI)

2.2 National index of agricultural field experiments

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

During the year under report, experimental data in respect of 2647 experiments for the period 1960-65 and of 2915 experiments for the period 1966-71 were received from the regional staff posted in different states. The analysis of the same was in progress.

(R.K.KHOSLA, M.G.SARDANA & P.P.RAO)

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

(a) Model agronomic experiments (MAE) at research centres:

The objectives of the experiments conducted at research centres under different agronomic conditions in the country were (i) to determine the responses of high yielding varieties of cereals to different

agronomic factors such as fertilizers (including micronutrients), spray fertilization, irrigation, cultural practices, weed control, liming, etc., (ii) to study the manurial requirements of important crop rotations and their effect on soil fertility., (iii) to evaluate various sources of nitrogen and phosphorus for different crops and areas., (iv) to work out the production potential per unit area and per unit time for different agroclimatic regions of the country., and (v) to determine the most suitable cropping patterns and fertilizer responses under rainfed conditions.

During 1970-71, 498 model agronomic experiments were conducted at 43 research (Model Agronomic) centres. About 500 layout plans were prepared for the conduct of experiments during 1971-72 at various M.A. Centres. Complex factorial experiments were conducted as approved by the annual workshop of the project. The progress was reviewed in the weekly and monthly meetings of the Officers at the project headquarters.

The results obtained during the year under report confirmed most of the findings made in previous years and showed that zinc and manganese deficiencies were fairly widespread and a significant response to these micronutrients, even upto the extent of 60 percent over NPK yield, could be obtained in rice, wheat and maize at a number of centres. Combined applications of all the micronutrients together was not beneficial, rather it led to reduction in yield. It was found again that response to micronutrients was more evident during kharif than during rabi, corroborating the previous year's observations. Thus, there appeared to be a strong interaction between climate (season), crop and the response to micronutrients, besides the micronutrients availability in the soil.

The highest total grain production of 14,702 kg./ha was obtained with a maize-wheat-cheena rotation at Kathulia farm, closely followed by 14338 kg./ha at Tirupati with three consecutive crops of rice. At Bharavisagar and Masuteru, a sequence of 3 rice crops yielded 12657 and 12253 kg./ha respectively, while a rice-wheat rotation gave 13083 kg./ha at Varanasi. At Bichpuri, total grain production of 10927 kg./ha was obtained with a maize-wheat-moong rotation and at Rudrur, a sequence of rice-wheat-moong gave a total combined yield of 10063 kg./ha.

(b) Simple fertilizer trials (SFT) on cultivators' fields

The objectives of the trials conducted on cultivators' fields were (i) to study the response of introduced high yielding and locally improved varieties to nitrogen and phosphorus applied alone and in combination and to potassium in the presence of nitrogen and phosphorus under irrigated as well as rain-fed conditions, (ii) to compare different methods of application of nitrogen on cereals under dry farming conditions, (iii) to study the contribution of a package of soil and moisture conservation practices in increasing crop production in dry farming areas, (iv) to study the relationship between crop response to fertilizers and soil test values, and (v) to formulate fertilizer recommendations for different soil and agro-climatic regions of the country.

During the year under report, data of 6209 trials under high yielding variety programme conducted in 33 districts and of 1456 trials conducted in 17 districts under dry farming programme were collected and statistically analysed. A district was divided into three agriculturally homogenous zones. In each zone, two blocks, and in each block, eight villages were selected randomly. In each of the selected villages, an experiment was conducted. A trial in a village constituted a replication within a block. The data were first analysed separately for each zone, and results pooled over zones to get a district estimate.

The salient results achieved during the year under report were as follows:-

RESPONSE TO NITROGEN:

During kharif season, IR-8 variety of rice in Thanjavur gave the highest response of 2429 kg./ha to nitrogen at 120 kg.N/ha. The variety Jaya gave a response of 1779 kg./ha in Chittor, while Padma gave a response of 1280 kg./ha in Coimbatore. Tall varieties (locally improved varieties) generally gave lower order of responses. During rabi season, Jaya gave a response of 1956 kg./ha in Cuttack, while in Shimoga IR-8 and Jaya gave responses of 1788 and 1618 kg./ha respectively.

In case of wheat crop, a response of 2095 kg./ha was obtained to 120 kg.N/ha with Sonalika in Shahabad. In Kanpur and Aligarh responses of 2484 and 2000 kg./ha were obtained with Kalyansona to 120 kg.N/ha, while the response was of the order of 1500 kg./ha in Delhi, Karnal and Monghyr.

A response of 527 kg./ha was obtained to 120 kg.N/ha with CSH-1 variety of Jowar in Jhansi.

The varieties, Ganga-5 and Ganga safed-2 of maize gave a response of 1300 kg./ha to 120 kg.N/ha while to the same level of nitrogen, the bajra varieties like HB-3 and X-3 in Coimbatore gave responses varying between 500 and 700 kg./ha.

RESPONSE TO PHOSPHORUS

The variety IR-8 in kharif season gave a very high response of 1078 kg./ha in Raichur to 30 kg.P₂O₅/ha while in Pondicherry, Shimoga and Raihur it ranged from 500 to 700 kg./ha. With the increase in level of phosphorus to 60 kg.P₂O₅/ha a response of 1490 kg./ha was obtained in Raichur while it varied between 800 and 1000 kg./ha in other three districts. During rabi, application of 30 kg.P₂O₅/ha to Jaya in Shimoga, and to Padma in Raichur and Sambalpur responses ranged between 600 and 700 kg./ha.

The responses to phosphorus at 60 kg.P₂O₅/ha applied to Kalyansona variety of wheat in Monghyr, Ludhiana, Mehsana, Bhavnagar and Aligarh were higher than those obtained to lower level of phosphorus at 30 kg.P₂O₅/ha. The responses ranged between 650 and 850 kg./ha.

Hybrid CSH-1 of jowar in Parbhani gave a response of 213 kg./ha to 30 kg.P₂O₅/ha.

The maize varieties like Ganga-5, Ganga safed-2, and Jaunpur safed gave varying order of responses to application of 30 kg.P₂O₅/ha. The responses varied from 225 kg./ha in Ludhiana to 130 kg./ha in Kanpur.

Application of 30 kg.P₂O₅/ha to hybrid bajra gave responses varying from 100 to 300 kg./ha.

RESPONSE TO POTASSIUM:

The variety IR-8 during kharif gave a response varying between 400 and 600 kg./ha in Thanjavur, Shimoga and Chittor to the application of 60 kg.K₂O/ha over a basal dose of 120 kg.N+60 kg.P₂O₅/ha. The variety Padma tried in rabi season in Sambalpur gave a very high response of 1122 kg./ha to the application of 60 kg.K₂O/ha while responses in Raichur, Shimoga, Chittor and

Cuttack varied from 400 to 600 kg./ha.

In Hoshangabad, Kalyan-sona gave a response of 413 kg./ha to the application of 60 kg. K_2O /ha while Sonalika in Delhi gave a response of 304 kg./ha.

Ganga-5 variety of maize in Aligarh gave a response of 254 kg./ha to the application of 60 kg. K_2O /ha.

Very low responses were observed to the application of potassium to jowar and bajra crops.

DRY FARMING PROGRAMME:

Results of trials conducted under dry farming conditions showed good response to nitrogen. The average response of rice to 25 kg. N/ha varied from 100 to 600 kg./ha in Allahabad, Jabalpur and Mayurbhanj. The trials conducted on wheat in Allahabad, Ambala, Gwalior, Hoshiarpur and Jabalpur showed that application of 25 kg. N/ha gave responses varying from 100 to 313 kg./ha. Response of jowar to nitrogen varied from 80 to 200 kg./ha in Dharwar, Gwalior and Aurangabad. Trials on maize conducted in Hoshiarpur, Ambala and Panch-mahal showed responses varying from 100 to 550 kg./ha to the application of 25 kg. N/ha.

The responses to phosphorus and potassium were low.

Comparison of different methods of application of nitrogen to cereals showed that a single application at sowing/transplanting was as good or better than split application of part of nitrogen through foliage.

(S.K. RAHEJA AND S.R. BAPAT)

2.4 Studies on size and shape of plots in experiments on apple crop.

The objective of the investigation was to determine the optimum size and shape of plots and blocks in experiments on apple crop. The data for the study collected during the years 1965 to 1968 related to the yield of individual trees of the apple crop in the Summer Ford Garden, Nainital. The entire orchard was divided into a number of small homogenous areas. The coefficient of variation for the different plot sizes, (the plot size was defined as number of trees in a plot) with blocks as well as without blocks had to be studied. The coefficient of variation of different block sizes for a given set of plot sizes was also examined. In order to work out the optimum plot size, in addition to the operational convenience of the plot size, the cost function was also taken into account.

The analysis of the data was in progress during the year under report.

(P.N.BHARGAVA, M.G.SARDANA AND
B.P. DYUNDI)

2.5 Critical analysis of crop rotational experiments.

The objective of the study was to examine the data on some of the long term crop rotational experiments conducted in India with a view to developing simple and straight forward methods of statistical analysis of such experiments.

For the purpose of the study, data on rotational experiments of a period of 8 years was collected from the Agricultural Research Station, Amerli. Similar data for about 20 years was supplied by the State Department of Agriculture, Maharashtra.

These experiments were generally of long duration and of a complex nature. The method of analysis was not straight-forward and simple. Every experiment had to be analysed in view of the design adopted and the type of rotations involved. The data collected under the project was analysed by adopting a method similar to split plot design where the years formed the sub plot and the plots over years formed the main plots. This procedure, however, could not be extended for the analysis of the data supplied by the Maharashtra Government. The data had to be treated as non-orthogonal and the analysis had to be developed as in the case of non-orthogonal analysis.

The technical details, namely, analysis of variance table, expectations of various mean squares of interest etc. were worked out. The analysis for both the centres was in progress.

(P.N.BHARGAVA, M.G. SARDANA
AND B.L. CHOUDHARY)

2.6 Study of influence of meteorological factors on crop production.

The data relating to daily rainfall for 21 rain gauge stations spread over the entire Raipur District for a period ranging from 40 to 67 years were collected from the Meteorological Department, Poona. The objectives for the study of the data collected were (i) to examine the variability in the amount of rainfall over different months and fortnights during the crop period, namely, June to September from centre to centre as well as over all the centres, (ii) to find out a suitable frequency distribution function to the total amount of rainfall during the different fortnights and months, (iii) to examine the behaviour of the pattern of the occurrence of rainfall during the crop period, namely, June to September as well as for smaller periods during the crop period and (iv) to study the seasonal as well as cyclical variations.

The study of variability in the total amount of rainfall for different fortnights for different centres as well as over all the centres was conducted separately. The results suggested that the coefficient of variation in the first fortnight in the month of June and the coefficient of variation in the second fortnight of the month of September were sufficiently high. The average amounts of rainfall during these two periods were also of a lower order. A definite trend in the values of the coefficients of variation over the period was also observed for all the centres as well as pooled over all the centres. The value decreased upto first fortnight of July

and thereafter it started increasing. The minimum value obtained was for the second fortnight of July. The study of the coefficient of variation for the months indicated that their magnitude was of lower order as compared to those for the fortnights as was expected. The study of the coefficient of variation suggested that the rainfall in the month of June as well as in the second fortnight of September was quite erratic while for the other months there was a good deal of stability in the amount of variation of the rainfall.

A study of the rainfall reliability through fitting of suitable frequency distribution function was also attempted for different periods, namely, fortnights and months. The results of the study showed that the distribution of rainfall for both the fortnights for the months of July and August could be normalised after making suitable adjustment in the skewness. For the remaining four fortnights of June and September, a search for a suitable transformation in order to normalise the distribution was being made. The study of fitting

distribution function to the total amount of monthly rainfall for the months of June, July, August and September suggested that they followed the normal distribution. It would, however, be also useful to study such distribution for smaller periods.

The use of the distribution functions for the study of rainfall reliability analysis suggested that the method of analysis to be adopted had to be varied over space and time considering the variation in the amount of rainfall. These studies indicated that it was always possible to study the distribution of rainfall for a smaller period like fortnight which was of greater importance as far as the adjustment in agricultural operations and crop planning was concerned.

The data was also examined to study the occurrence of rainfall with the help of Markov Chains for the crop period, namely, 1st June to 31st September. For this purpose, first of all it was investigated whether the occurrence of rain on a day was dependent on the weather conditions of the immediately preceding day or not. The data in respect of each centre was analysed. It was observed that the weather condition of a particular day depended on the weather condition of the immediately preceding day. After this aspect had been examined, Markov Chain Model was fitted to each centre in order to obtain the probability of a day being wet when the previous day was known to be wet (p_1), the probability of a day being wet when the previous day was known to be dry (p_2), and the expected length of dry and wet runs. The mean of the distribution of the wet and dry days and the number of days for arriving at equilibrium state were also worked out. The study indicated that probability (p_2) varied from 0.257 to 0.309 where as probability $1-p_1$ varied from 0.413 to 0.485. The expected length of dry runs varied from 3.25 to 3.96 days and that of wet runs from 1.71 to 2.42 days. The number of days for arriving at the equilibrium state varied from six to eight. It was further found that the pattern of the occurrence of the wet and dry days was similar in respect of the ten centres.

Similar studies for smaller periods were in progress.

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

STATISTICAL RESEARCH IN ANIMAL SCIENCES

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

3.1 Studies in genetic correlations relating to sheep.

The object of the scheme was to study the genetic correlations between various wool quality attributes and other characters.

The data that were collected under the schemes for improvement of sheep and wool on regional basis at the centres at Pashulok (Uttar Pradesh) and Banihal- Reasi (Jammu and Kashmir) sponsored by the I.C.A.R. were scrutinised, compiled and analysed. Data on birth weight, fleece weight, fibre diameter, fibre length, fleece density, crimps and scouring loss were available for analysis. In the case of $\frac{1}{2}$ bred (Rampur Bushair x Polwarth) ewes at Pashulok data on 132 progeny were available arranged according to 10 paternal half - sib groups according to the sires. In the case of $\frac{1}{2}$ bred (Local x Rambouillet) and $\frac{3}{4}$ th ewes at Banihal - Reasi, data on 194 progeny were available arranged according to 11 paternal half - sib groups according to the sires.

Genetic correlations were estimated by the method of half - sib analysis.

The genetic correlations between birth weight on the one hand and the four characters, viz., fleece weight, fibre diameter, fibre length, and crimps on the other, have been estimated as + 0.4602, + 0.4402, - 0.9214, and + 0.8039 respectively, in the case of $\frac{1}{2}$ bred ewes at Pashulok. The genetic correlations between birth weight and fleece weight, fibre diameter and fleece length, fibre diameter and fleece density, and fibre length and scouring loss have been estimated as - 0.2150,

+ 0.8679, - 0.8666, and + 0.8476 respectively, in the case of $\frac{1}{2}$ bred ewes at Banihal - Reasi. The genetic correlations between birth weight and scouring loss, fibre diameter and fleece density, fibre diameter and scouring loss, fibre length and fleece density, fibre length and scouring loss, and fleece density and scouring loss were estimated as + 0.4821, -0.7489, + 0.9642, - 0.8084, + 0.2056, and - 0.3549 respectively, in the case of $\frac{3}{4}$ th bred ewes at Jammu and Kashmir.

The genetic correlations between fleece weight in second clip on the one hand and the three characters, viz., fibre diameter, fleece density, and scouring loss on the other, were estimated as - 0.2273, - 0.1859, and 0.5848 respectively in the case of $\frac{1}{2}$ bred ewes (local x Rambouillet) in Jammu and Kashmir. Other genetic correlations between various wool quality attributes and other characters were either imaginary or inadmissible as estimates.

(R. Gopalan and B. Maruṭiram)

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

The object of the scheme 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.

The data that were collected on white leghorn breed under the scheme for improvement of poultry through family selection at the centre at Kodappanakunnu, Kerala were secured, scrutinised, compiled, and analysed. Data on age at maturity, weight at maturity, egg production in first 100 days of lay, and egg production in first 500 days of birds age were available in the case of foundation stock as well as first generation birds. Data on 200 progeny of foundation stock and 600 progeny of first generation birds were available, arranged according to 20 paternal half - sib groups according to the sires.

The technique applied for the study of the data was the method of intra - sire regression of progeny on dam.

The heritability of age at maturity and egg production in first 500 days of birds age was estimated

as (+) 0.021 and ± 0.1696 (+) 0.099 ± 0.3164 in the case of foundation stock. The heritability of age at maturity and egg production in first 100 days of lay was estimated as (+) 0.073 and (+) 0.095 in 0.0918 ± 0.0878

the case of 600 first generation birds. The heritability of age at maturity was (+) 0.093 ± 0.0938 in the case of 200 selected birds from the first generation stock.

(R. Gopalan and B. Marutiram)

3.3 Measurement of genetic improvement due to crossbreeding in sheep:

The objective of the study was to develop statistical techniques for estimating genetic improvement due to cross-breeding in sheep. The sheep breeding data collected at sheep Breeding Farm, Banihal-Reasi, Kashmir and Central Sheep and Wool Research Station, Pashulok, U.P., in connection with the ICAR scheme for improvement of wool and sheep by cross-breeding on regional basis were taken up for this study.

The data of the former centre were spread over a period of 14 years (1952-66) and characters such as greasy fleece weight, fibre diameter, fibre length, fleece density, scoring loss and crimps per cm. and birth weight were available for ewes and rams. The local ewes were crossed with Rambouillet rams and the cross-breds were crossed back to the exotic breed to obtain three-fourths. The three-fourths were again crossed back to the exotic parent to produce seven-eighths. The data pertaining to the above characters were analysed for as many as 12 clips in the case of ewes. For Pashulok, the data related to a period of about six years (1962-1968). The grades available were Rampur, Bushair, half-bred Polworth, three-fourth Polworth and three-fourth inter-bred. The characters such as weight at birth, weight at 12 months of age, weight at 16 months, greasy fleece weight (second clip), greasy fleece weight (third clip), percentage medullation, fibre diameter, fibre length, fleece density, percentage clean wool yield, crimps per centimeter (second clip), date of disposal and reason for disposal were also available for each sheep.

Records for about 1,000 sheep were to be utilized for this study. The technique of discriminant functions was used to obtain a score for the quality of a sheep on the basis of several characters. These scores were used to rank the various grades available for assessing their potential for genetic improvement.

(Prem Narain and L.K. Garg)

3.4 Efficiency of selective breeding in cattle.

The object of the investigation was to investigate the number and type of characters which should be used as correction for increasing the efficiency of selective breeding on the basis of lactation yield in Indian dairy cattle. The breeding data relating to the three herds, Red Sindhi at Hosur, Kangayam and Tharparkar were used for analysis. This data related to a period of about 25 years. In case of Red Sindhi herd at Hosur, the additional traits for the improvement of milk yield in first lactation were taken as the milk yield in 2nd lactation and milk yield per day in 2nd lactation. In the case of Kangayam, the additional traits considered were length of 2nd lactation, milk yield in 2nd lactation and milk yield per day in 2nd lactation, while in case of Tharparkar, the additional traits considered were milk yield per day in 1st lactation, length of 2nd lactation and milk yield in 2nd lactation.

The technique of partial regression of correcting the variations in the lactation yield due to variations in other traits was used. The efficiency was expressed as the ratio of two genetic gains corresponding to the two situations when the additional traits were taken into account and when they were not. It was estimated with the help of the heritabilities and genetic correlations estimated on the intra-sire basis from the given data. The results indicated that in the case of Tharparkar herd the use of milk yield in 2nd lactation gave an efficiency of the order of 0.97 and the use of length of 2nd lactation gave an efficiency of the order of 0.96 while the use of both these auxiliary traits gave an efficiency greater than one. In the case of Kangayam herd, the use of 2nd lactation length gave an efficiency of the order of 0.96. So far as Red Sindhi herd at Hosur was concerned, the efficiency was found to be very low.

(Prem Narain and Randhir Singh)

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

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

The field work was to be carried out at two centres, viz., (i) Krishna Delta area in Andhra Pradesh and (ii) Dhulia region of Maharashtra state. The field work in Krishna Delta area was taken up during 1967-68 and completed in July, 1969. The work in Dhulia region was initiated in December, 1969. The field work regarding the availability study in Dhulia region was completed in March, 1971 and that for cost study continued during the period under report.

At each centre, 48 villages selected for cost study remained fixed throughout the period of enquiry, while 48 villages selected for the study of availability of milk were selected afresh during each season. In all 192 commercial producer households (four in each 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 utilization of milk, quantity and composition of feeds given to animals, procurement of cattle feeds, etc. The data on milk yield of animals and quantities of feeds fed to them on the day of visit were collected by actual weighment and other information such as details of paid and family labour, capital investment recurring expenditure, etc., through careful observation and enquiry from each stall. After the completion of detailed enquiry in February, 1972 data on prices of feeds and fodders, labour wage rates, etc. were to be collected for a period of two years from these villages to build an appropriate index of cost of production of milk.

The sampling design adopted was stratified multi-stage random sampling for selection of sampling units. Various components of cost per milch animal as well as per Kilogram of milk were obtained to estimate the cost of production.

In Krishna Delta area, the average daily milk yield of a buffalo in milk was estimated to be 2.1 Kg. in rainy season, 2.3 Kg. in winter and 2.2 Kg. in summer season a cow in milk gave about 1.2 Kg. of milk per day in each of rainy and winter seasons and about one Kg. per day in summer season. The net cost of production of buffalo milk was estimated to be Rs.1.04 per Kilogram including family labour and 85 paise per Kilogram excluding it. Feed cost was the major component of cost accounting for about 70 per cent of the gross cost of production. The average market rate per Kilogram of buffalo milk was 90 paise.

Data from Dhulia region, Maharashtra pertaining to the availability study were analysed. The average daily milk yield of a buffalo in milk was estimated to be 3.3 Kg. in summer, 3.1 Kg. in rainy and 4.2 Kg. in winter season. The estimates of milk yield per day for a cow in milk were on Kg. in each of summer and rainy seasons and 1.1 Kg. in winter season.

(K.C. Raut and Shivtar Singh)

3.6 Index of cost of production of milk

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

For the purpose of estimating the cost of production of milk, 24 villages were selected in each of the sub-urban and rural areas of Tamil Nadu and West Bengal. All these selected villages were visited by the supervisors (one each in sub-urban and rural areas) once in each season for collection of relevant data. Out of the remaining villages in each of the sub-urban and rural areas, 16 additional villages were selected at random in each season for collection of data. In each of the villages selected earlier for detailed enquiry, household information was collected from all the four households which had been selected earlier and from four more households

(commercial households) in each village. All the relevant information pertaining to the villages and market rates was collected from the additional villages. In case of urban area household information was collected by the supervisors in each season from all the 54 selected stalls and from 160 freshly selected commercial stalls.

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

During the year under report, field work was completed in Tamil Nadu and D.M.S. milk collection area.

Utilizing the quantities of different constituents of feeds and fodders fed to the animals, the average milk yield as estimated from detailed enquiry and the prevailing market rates of these feeds and fodders, the feed cost per kilogram of milk was calculated. Similarly, the quantum of labour put in for maintenance of milch animals, the milk yield for milch animals at the time of detailed enquiry and the prevailing wage rates were utilised to work out the labour cost per kilogram of milk. Assuming that the ratio of feed cost, labour cost, etc. to the gross cost remained the same, the cost of production per kilogram of milk was calculated.

During the period under report the cost of production of milk was worked out separately for cow and buffalo milk for West Bengal and Tamil Nadu for the year 1970-71.

(a) West Bengal

In Calcutta city the net cost of production per kilogram of milk including unpaid labour was calculated as Rs.1.57 for cow milk and Rs.1.75 for buffalo milk during 1970-71 as against 81 paise and 92 paise for cow milk and buffalo milk

respectively during 1960-62 when large scale enquiry was carried out. The respective indices were 194 for cow milk and 190 for buffalo milk taking 1960-62 as base period. The market rates of cow milk and buffalo milk were Rs.1.62 and Rs.2.05 during 1970-71.

In rural area (Chandernagar Subdivision) the net cost of production per kilogram of cow milk including unpaid labour was calculated as Rs.1.15 during 1970-71 as against 66 paise during 1960-62. The index of cost of production of milk during 1970-71 was 174 taking 1960-62 as base period. The prevailing market rate of cow milk was Rs.1.13 paise during 1970-71.

(b) Tamil Nadu.

In the City of Madras, the net cost of production per kilogram of milk including unpaid labour was calculated as Rs.1.18 both for cow milk and buffalo milk during 1970-71 as against 59 and 58 paise during 1957-59 when large scale enquiry was taken up. The respective indices were 203 and 208 respectively taking 1957-59 as base period. The prevailing market rates for cow milk and buffalo milk during 1970-71 were Rs.1.27 and Rs.1.40 respectively.

In the rural area (Gudiyatham taluk), the net cost of production per kilogram of cow milk and buffalo milk including unpaid labour were calculated as 84 paise and 100 paise respectively during 1970-71 as against 48 paise and 52 paise during 1957-59. The indices of cost of production were worked out to be 175 and 192 during 1970-71 taking 1957-59 as base period. The market rates for cow milk and buffalo milk during 1970-71 were 68 paise and 75 paise respectively.

(K.C. Raut and H.B. Choudhry)

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 methodology for studying the impact of milk supply schemes on rural economy in milk collection areas. This involved specifically the assessment of changes that were likely to accrue as a result of assured market and guaranteed price of milk in respect of the following:-
(i) milk production in the area and its cost; (ii) economics of production of selected fodder and other crops; and (iii) employment due to milk production, its handling and fodder productions. An attempt was also

to be made for assessment of overall income both of milk producers and non-producers.

Bench mark surveys were carried out in the milk shed areas (Meerut, Bulandshahar and Gurgaon) of Delhi Milk Scheme during 1966-67 and in the milk-shed areas of Dudhsagar Dairy, Mehsana (Gujarat) during 1967-68. Data on various aspects such as milk production and its utilization, quantity and composition of feeds given to animals change in number of milch stock, breed and age composition of animals, main and subsidiary occupations of householders, cropping pattern, cost of production of fodder and other alternative crops, return from various crops, income from dairying, fodder production and other sources were collected from a representative sample of households selected at random.

The repeat survey in the milk collection areas of D.M.S. was initiated in Gurgaon and Meerut districts.

For the survey in D.M.S. area a stratified two stage, random sampling design was used. The three districts of Meerut, Bulandshahar and Gurgaon from where milk was being collected for D.M.S. constituted the three different strata with clusters of villages within each stratum as the first stage units and households within a cluster as the second stage units. The villages in each stratum were divided into two groups; those supplying milk to organised milk schemes and those which did not supply milk to any organised milk scheme. In all, 90 clusters of three villages each within a radius of 5 kilometers from one another - 60 clusters from the supplying areas and 30 from the non-supplying areas were selected at random. The allocation of the 60 supplying clusters among strata was made roughly in proportion to the quantum of milk collected from each stratum. Of the 30 non-supplying clusters, 12 were allocated to Gurgaon district and 9 each to the other two districts. With the help of the sampling frame obtained through enumeration of the households, representing various categories of milk producers was selected in each cluster.

In the selected villages, a sample of 40 to 18 households

The design for the bench-mark survey in the rural milk collection areas of Dudhsagar Dairy, Mehsana was quite similar to the one adopted for D.M.S. area except that in this area the groups of contiguous talukas constituted the

different strata and in all 60 clusters of villages were selected.

The data on milk yield of individual animals and feed given to them were recorded by actual weighment and other information such as extent of labour prices of feeds and fodders, inputs for cultivation of crops etc. by careful enquiry and observation.

During the year under report, the final report pertaining to the bench-mark survey conducted in the milk-shed areas of Delhi Milk Scheme was under preparation. In addition, studies on employment pattern and gross annual income in milk producer and non-producer families were carried out.

On an average a family consisted of seven persons, four adults and three children (below 14 years of age). One out of three persons in a family was a worker and one out of five was a helper, who assisted in the family occupation on a part-time basis. Non-milk producing families had a comparatively larger proportion of workers and less of helpers.

Of the total number of workers in commercial households, 40 to 50 per cent were engaged in agriculture, 20 percent in milk production and the remaining in other vocations. In private milk producer households, as many as 80 to 90 per cent of the workers had agriculture as their main occupation. In non-milk producing households, however, field labour accounted for 40 to 50 per cent of the working force, followed by skilled labour (20 to 25 percent). Artisan work and service were the next two vocations, each accounting for about 10 to 12 percent of the working force.

It was estimated that the average annual income of a commercial milk producing family in the supplying area, Rs.4000. The corresponding figures for a private milk producer family in the supplying and non-supplying areas were Rs.6600 and Rs.6400 respectively. In a non-milk producer family the average annual income was Rs.1300 in the supplying area and Rs.960 in the non-supplying area. was
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Among the various sources of income in commercial milk-producer families, agriculture and dairying constituted the two major vocations contributing as much as 48 and 42 percent of the total income respectively in the supplying area and 37 and 44 percent respectively in the non-supplying area. The corresponding figures for private milk producer families were about 60 and 32 per-cent respectively in both the areas. For non-milk

producer families the major source of income was from agriculture-labour and skilled labour accounting as much as 63 percent of the total income in the supplying area and 74 percent in the non-supplying area.

The statistical analysis of the benchmark data from rural milk collection areas of Dudhsagar Dairy, Mehsana remained in progress during the year under report.

(J.P. Jain, K.C. Raut, B.C. Saxena, and R.R. Singh)

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

The objective of the survey was to evolve a suitable sampling technique for objective estimation with a reasonable degree of precision of (i) the area of grazing land, (ii) the average yield per unit of grazing area in different seasons, (iii) the composition of grazing available and its chemical contents in each season and (iv) to obtain information on grazing practices followed in utilizing the grazing area available.

The field work of the survey was carried out in Jhansi district of Uttar Pradesh during the year 1969-70. The details of land utilization statistics, grazing areas and livestock population in the selected villages were recorded from the khasra registers maintained by patwaries. Other details regarding the land actually used for grazing under different categories of land utilization were also recorded. Besides this, the grazing area as recorded by patwari was verified and recorded. Complete enumeration of livestock in the selected villages was also conducted, and the schedules pertaining to grazing practices followed in utilizing the grazing areas of the villages were filled every month. Particulars regarding yield of grass from one square meter cuts were recorded every month. The grass samples were collected, botanically classified and then analysed for determining their chemical contents. Data on

grazing area pertaining to 40 villages and those on yield for 1600 cuts spread over rainy and winter seasons, were analysed.

A stratified random sampling design was used for estimating grazing area. Tehsils in a district were grouped to form strata with roughly equal bovine population. The villages within each stratum were selected without replacement with probability proportional to the bovine population in the village.

For estimating mean yield per cut, three stage sampling with replacement with varying probability was used with village as first stage unit, grazing area within a village as second stage unit and cuts within grazing areas as third stage units.

The estimates of the mean grazing area per village for the rainy season and winter season worked out to be 121.42 hectares and 83.47 hectares respectively with 27 percent as standard error.

The estimate of mean yield of herbage per one square metre cut taken before grazing in rainy and winter season were 62 gms and 18 gms respectively, whereas mean yield per cut taken after grazing in these two seasons was of the order of 54 gms and 15 gms respectively. The standard error ranged from 2 to 5 percent.

Grass samples collected during the survey were analysed for their chemical contents. Nitrogen free extract, crude fibre, ash, crude protein and other extract contained in a sample were about 53, 28, 11, 6 and 2 percent respectively.

The draft of the final report was prepared during the period under report and incorporating the suggestions received from I.G.F.R.I., Jhansi.

(U.G. Nadkarni, K.C. Raut, B.C. Saxena,
P.R. Sreenath of I.G.F.R.I. Jhansi.)

3.9 Pilot survey to study the cost of poultry and egg production.

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

which involved (i) estimation of cost of production of table and hatching type eggs, cost of rearing birds upto various ages covering from day old to adult stage and cost of maintenance of layers and cocks with a reasonable degree of precision and (ii) estimation of various components of cost and their variation, both in monetary terms and in terms of physical quantities; (b) to secure information on factors helping 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 the methodology of building an index of cost of poultry and egg production.

The pilot studies were taken up in two areas, namely, (i) Dasuya - Tanda area of Hoshiarpur district of Punjab State and (ii) Delhi and surrounding villages. The field work in each area was to run for a period of two years and three months including the training of field staff. A complete enumeration of existing poultry farms in the selected areas was under-taken 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 at weekly intervals through personal visits over a period of two years. The field work in Dasuya - Tanda area was taken up in April 1967, while in Delhi and surrounding villages, the field work was taken up in January, 1969. In order to study the relative changes in the cost of production of poultry and egg under commercial management conditions from year to year, collection of information like 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 during October, 1969 and it was continued upto October, 1971.

Keeping in view the objectives of the survey, cost accounting approach was followed. The total cost included the cost on feed, labour (both hired and family labour), management, expenditure/ investment on assets and equipment and miscellaneous expenditure. Data on income through the sale of birds and eggs, etc., was being obtained to work out the net cost of production. Having obtained

the cost of maintenance of layers, the cost of production of table and hatching type eggs, and cost of rearing day old chicks to adult stage could be estimated.

During the year under report, the data on labour and feed from Dasuya and Tanda regions were processed separately to get average quantity of feed consumed by male birds, layers, chicks and young birds of different age groups (upto 12 weeks, 13 to 16 weeks, 17-20 weeks and 21 to 24 weeks). The cost of feed estimated from these averages per bird per day was 2 paise for a chick, 4 paise for young bird upto 16 weeks, 5 paise for young bird over 16 weeks. The feed cost in case of an adult male bird per day was found to be 4 paise while in case of a layer it was about 5 paise. From the analysis of unpaid labour hours, it was observed that a member of the family spent 8 to 10 hours in different types of poultry and non-poultry work. Time spent in different types of labour was analysed. According to prevailing wage rates the wages per family labour varied from 2 to 4 rupees.

(B.Maruti Ram, U.G. Nadkarni, and L.B.S. Soma-
yazulu)

3.10 Statistical study of feed- milk relationship in bovines

The object of the project was to estimate the relationship between intake of nutrients and milk production and to study the level of nutrients required for milk production. The data pertaining to animal nutrition collected under the coordinated scheme 'crossbreeding in hilly and heavy rain fed areas' were utilised for the study.

The data to were processed work out the nutrient in-takes, namely, digestible crude protein (D.C.P.) and total digestible nutrients (T.D.N.). Production function analysis relating milk yield to the nutrients in-take and estimation of nutrient requirements were undertaken.

The data were critically examined, stratified according to area, per-centage of foreign blood, order of location and stage of location and were then processed. Detailed studies were undertaken on data pertaining to $\frac{1}{2}$ Jerrey cross-bred cows from Visakhapatnam and Vikasnagar. Linear, quadratic and Cobb - Douglas functions were fitted relating milk yield to the nutrient in take. Broadly, the quadratic functions gave better fits and in

these cases the multiple correlation coefficient ranged from 0.65 to 0.85. The equations were further examined with a view to working out the nutrient requirements for milk production.

(T. Jacob, and B. Marutiram)

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

The objective of the project was to standardise the procedure of sampling for assessing wool quality 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.

The data on quality characters, viz., fibre length, staple length, crimps per cm., fibre diameter and medullation percentage obtained from composite samples on 22 ewes of Chokla breed and 24 ewes breed of Polworth x Rampur Bushair crosses and the data on regional wool yield per sheep on 24 ewes of Polworth x Rampur Bushair crosses

..... were received from the Central Sheep & Wool Research Institute, Avikanagar (Rajasthan). The data on various wool quality attributes obtained from regional and composite samples on 22 ewes of chokla breed and 24 ewes of Polworth x Rampur Bushair crosses were utilised for the study.

The data on quality characters obtained from regional samples were analysed by analysis of variance technique for studying the variation in wool quality between different regions, between sheep and their interaction. The data obtained from composite samples by three methods were analysed for studying between sheep variation. Since the data pertained to heirarchical classification, respective components of variation were obtained by solving the equations between expected values of variances and their actual estimates. Since as reported earlier the use of weighting factors, viz., number of cuts and number of fibres per region did not reveal any change in the picture as indicated by different means of each character only the estimates using wool yield as weighting factor were obtained.

The statistical analysis of the data on fibre length, staple length, crimps per cm. and fleece density of 2 and 4 - teeth ewes Chokla breed from regional samples and on fibre diameter and medullation percentage of Chokla and Polworth x Rampur Bushair crosses from regional and composite samples was completed.

In the regional sampling procedure between sheep and between region components of variation in respect of all the characters and breeds quoted above were found to be significant in each age group. Sheep x region component of variation in all characters was found to be significant in each age group of Chokla breed and only in medullation percentage in 2-teeth age group of Polworth x Rampur Bushair Crosses. In the composite sampling procedure between sheep variation in fibre diameter was significant in 4 - teeth age group of both the breeds and in medullation percentage in each age group of Chokla breed while in other cases it was significant only in two composite sampling methods.

R. Maratikan,

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

3.12 National index of animal experiments

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

The data pertaining to 275 experiments on Animal Nutrition carried out during the period 1945-65 at I.V.R.I. (Izatnagar), and 73 experiments on Animal Nutrition and 13 on Physiology carried out during 1960-70 at U.P. College of Veterinary Science and Animal Husbandry were utilized for the study. In addition, data on 36 experiments on Animal Nutrition and 3 on Animal Physiology carried out during 1960-70 at N.D.R.I. (Karnal) and its substations and on 50 experiments on Animal Nutrition and 20 on Animal Physiology carried out during 1966-70 at I.V.R.I. (Izatnagar) were collected.

The data pertaining to experiments collected from research Stations were first scrutinised and those which were amenable to statistical analysis were processed and analysed by applying the analysis of variance and covariance techniques. Regression analysis were also made for growth and requirement studies. The results obtained

were then categorised and put in the appropriate format for inclusion in the compendium.

The work relating to the classification of results of 275 experiments pertaining to Animal Nutrition carried out during the period 1945-65 at I.V.R.I. and putting the same in desired format for incorporating them in compendium was completed. The work of preparation of compendium comprising these experimental results was being completed. Analysis of data on 25 experiments pertaining to Animal Nutrition of U.P. College of Veterinary Science and Animal Husbandry was also completed. The work of collection of data from I.V.R.I. (Izatnagar) for the period 1965-70 was started and data on about 70 experiments (50 from Animal Nutrition and 20 from Animal Physiology) had already been collected. Further collection work at I.V.R.I. and the statistical analysis of the collected data was continued.

(A. Dey, T. Jacob, T. B. Jain and S. N. Bajpai)

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

The objective of the scheme was to estimate age specific fertility and mortality rates among cattle and buffaloes with a view to constructing life tables for the purpose of projection of bovine population.

It was proposed to collect information on the number of animals in different age groups, number of calves born, number of migrants, etc. through sample surveys. The work of collection of relevant data was proposed to be taken up within the I.C.D. areas and fringe areas of Vijayawada in the first instance. The age returns by single year of age were to be corrected for systematic bias and smoothing. Age specific fertility and mortality rates were to be estimated. It was also proposed to make an attempt to study the problem of migration among bovines.

The field work for the scheme was yet to start.

B. Marudhan
(T. Jacob, and M. L. Choudhry)

SAMPLE SURVEY INVESTIGATIONS

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

4.1: Pilot sample survey for developing a sampling technique for estimation of production of fresh fruits.

The objectives of the survey were (i) to study the technical and organizational 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 field work of the survey was to be carried out for 18 months in Tamil Nadu. During the period under report, the field assistants and supervisory staff were imparted thorough training in all aspects of the field work by an officer of the Institute. The data which was being 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 during the entire harvesting season (This was collected for major fruits under study, viz. mango, banana, citrus and grapes) and (c) cultivation practices of major fruits such as spacing, method of planting, manuring and other cultural operations,

incidence of pests and diseases, etc.

The sampling technique adopted for the survey was stratified two phase multistage random sampling design with tehsils or groups of tehsils as strata, villages as primary units of sampling and clusters of trees as ultimate units of sampling. 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 were selected according to appropriate probability procedures.

Field work of the survey was still in progress.

(A.H. Manwani, K.R. Rajagopala-
char and A.K. Srivastava)

4.2: Pilot sample survey for developing sampling technique for estimation of production of vegetables.

The objectives of the survey were (i) to examine the feasibility of estimating the area, yield rate and production of different vegetables through random sampling technique and (2) to collect reliable data on manurial and cultivation practices of important vegetable crops.

During the period under report, the initial steps viz. finalisation of proforma, instructions to the field staff and drawing a suitable sample plan for the selection of villages for taking up the field work under the survey were completed. Training was imparted to the field staff for carrying out the sample survey. A sample of 181 villages was selected in Bangalore District of Mysore State. The data which were being collected in 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 on major vegetables grown in the region viz. cabbage, tomato, brinjal, beans, lady's finger, cucumber and root crops e.g. potato, carrot, sweet potato, etc. and (iii) cultivation practices of vegetables grown in the selected fields.

The sampling technique adopted in the survey was one of multi-stage stratified random sampling with taluks in the district as strata. Crop-cutting experiments were conducted for studying the production and average yield of important vegetable crops.

Field work of the survey was in progress.

(A.H. Manwani and A.K. Srivastava).

4.3: Sample surveys for the assessment of high yielding varieties programme.

The objective of the surveys was to collect through assessment surveys based on random sampling technique reliable data on (i) the spread of the high yielding varieties of paddy, wheat, maize, jowar and bajra, (ii) the yield rates of the high yielding varieties of the above crops and comparative estimates of the yield rates of the locally common varieties, and (iii) the extent of adoption of the associated improved practices such as fertilizer application, plant protection measures etc. recommended to the cultivators and their effects on the yield rates under cultivator's conditions.

During the year under report, data pertaining to crop-cutting experiments and A.A.E. enquiry for kharif, 1970-71, were received from the States of Andhra Pradesh, Assam, Gujarat, Haryana, Tamil Nadu, Maharashtra, Mysore, Orissa, Punjab, Uttar Pradesh and Rajasthan. For Rabi, 1970-71, crop-cutting schedules and A.A.E. schedules were received from the States of Gujarat, Haryana, Maharashtra, Mysore, Punjab, Uttar Pradesh and Rajasthan. The entire data were collected through questionnaire by the field staff at the state level. The data were coded at the state-level and received at the I.A.R.S., where a sample check of the filled-in schedules was made and the data computerised for the desired results. For the purpose of analysis the estimation procedure

available for the multi-stage sampling designs was used.

During the year under report, crop-cutting schedules received from the States of Assam, Gujarat, Haryana, Maharashtra, Mysore, Orissa, Punjab, Rajasthan, and Uttar Pradesh for kharif 1970-71 were analysed. The salient results achieved were as below:

(i) Assam: IR-8, the high yielding variety of rice adopted by a majority of the cultivators, yielded on an average 32 Q/ha against a mean yield of 19 Q/ha for the local variety. Nearly 75% of the fields under high yielding varieties were benefitted by the application of chemical fertilizers.

(ii) Gujarat: HB-1, the hybrid variety of bajra adopted by a majority of the cultivators, yielded on an average 20.49 Q/ha against an average yield of 13.41 Q/ha for the local variety. Nearly 50% of the fields growing high yielding varieties of bajra were benefitted by the application of chemical fertilizer.

(iii) Haryana: IR-8, variety of rice tried in Ambala district yielded on an average 28 Q/ha which was nearly 67% more than the yield of the local variety. The hybrids and composite varieties of maize in Ambala district yielded around 29 Q/ha against an average of 20 Q/ha for the local variety. In Hissar and Rohtak districts, the mean yield obtained for hybrid bajra was around 17 Q/ha giving there-by an increase of about 75% in yield as compared to the local common variety. Almost all the fields under high yielding varieties of rice and maize received the benefit of fertilizer application, while in case of bajra, 75% of the fields received this benefit.

(iv) Maharashtra: CSH-1, the most popular variety of hybrid jowar, gave an average yield of 12.86 Q/ha against an average yield of 3.48 Q/ha for the local variety, giving thereby an increase of about 269% over the local variety. HB-1, the hybrid variety of bajra adopted by a majority of the farmers, gave an average yield of 11.47 Q/ha against an average yield of 6.95 Q/ha for the local variety.

IR-8, the most popular variety of rice grown in Nagpur district, gave an average yield of 25.26 Q/ha against an average yield of 16.50 Q/ha for the local variety. All the fields under high yielding varieties of rice received the benefit of fertilizer application while in case of jowar and bajra the percentage of fields receiving this benefit was 87% and 67% respectively.

(v) Mysore: IR-8, the most popular variety of rice, gave an average yield of 33.31 Q/ha against an average yield of 23.20 Q/ha for the local variety although the highest average yield of 37.19 Q/ha was observed in case of a new variety Manila. CSH-1, the hybrid jowar adopted by almost every cultivator, gave an average yield of 31 Q/ha against an average yield of 14.19 Q/ha for the local variety giving thereby an increase of 119% over the local variety. Deccan hybrid variety of hybrid maize was adopted by all the cultivators in Belgaum district, which gave an average yield of 33.55 Q/ha against an average yield of 22.38 Q/ha for the local variety. It was interesting to note that all the farmers growing the high yielding variety of maize applied chemical fertilizers to their fields, while in case of paddy and jowar, the percentage of fields receiving this benefit was 96% and 76% respectively.

(vi) Orissa: As in other States, the most popular variety of rice was IR-8. It yielded on an average 23 Q/ha in Cuttack and 28 Q/ha in Ganjam district. These yield rates were respectively about 60% and 50% more than that of the locally common variety. However, in Bolangir district, the response of the high yielding varieties of rice was not satisfactory. In the districts of Cuttack and Ganjam, nearly 85% of the fields received the benefit of fertilizer application, whereas in Bolangir this percentage stood at 60.

(vii) Punjab: The mean yield obtained for the IR-8 variety of rice varied marginally around 31 Q/ha in all the four districts studied. This yield rate exceeded the yield rate of the indigenous varieties by about 60%. The hybrids of bajra in the districts of Ferozepur and Sangrur yielded about 16 and 15 Q/ha respectively as against 10 Q/ha for the corresponding local variety. The average for the hybrids and composite varieties of maize varied from 21 to 27 Q/ha in the different districts studied. The percentage increase in the yield rate of these over the local variety was maximum in Gurdaspur (67) and least in Jullundur (32). More than 90% of the fields under high yielding varieties of rice, bajra and maize received the benefit of fertilizer application in all the districts studied except in Sangrur where this percentage was 75 for bajra.

(viii) Rajasthan: IR-8, the high yielding variety rice adopted by a majority of the cultivators in Kota district, gave an average yield of 36.14 Q/ha against an average yield of 26.88 Q/ha for the local variety. The hybrid varieties of maize grown in the State were Ganga-5 and Ganga Safed-2, which gave an average yield of 25.5 & 25.9 Q/ha respectively against an average yield of 19.6 Q/ha of the local variety. CSH-1, the most popular variety of hybrid jowar in Chittorgarh, gave an average yield of 14.40 Q/ha against an average yield of 11.01 Q/ha for the local variety. Hybrid-1, the common variety of hybrid bajra grown by the cultivators in Jaipur district, gave an average yield of 18.81 Q/ha against 12.63 Q/ha for the local variety. All the farmers growing high yielding variety of rice applied chemical fertilizers to their fields while the percentage of fields receiving this benefit was 75 in case of maize, 50 in case of jowar and 40 in case of bajra.

(ix) Uttar Pradesh: Hybrid maize-5, although the most popular variety of maize, gave an average yield of 26.69 Q/ha while the highest average yield of 27.06 Q/ha was recorded for hybrid maize-2 which was also grown extensively. The corresponding local average yield stood at 18.33 Q/ha. IR-8, the most popular high yielding variety of rice, gave the highest average yield of 34.41 Q/ha against an average yield of 20.70 Q/ha for the local variety. Nearly 90% of the fields under high yielding varieties of maize and rice were benefited by the application of chemical fertilizers.

(M. Rajagopalan, A.K. Banerjee,
P.C. Mehrotra and S.S. Gupta)

- 4.4: Preparation of a monograph on the methodology for the estimation of egg production and study of certain poultry practices.

The objective of the project was to give the details such as sampling design, method of field work, schedules, type of information to be collected, in regard to the technique and methodology to be adopted for estimation of egg production and study of certain poultry practices. The data collected through pilot sample surveys for estimation of egg production and study of poultry practices in a number of states in the past were analysed for the study. Ratio method of estimation was adopted for estimating the average yield of egg per layer as also the number of layers for different areas. Changes in the number of birds from season to

season were utilised to correct the 1966 livestock census figures of poultry layers so as to obtain estimates pertaining to the whole year rather than to the reference date for the livestock census. Extrapolation was done for obtaining the estimates of egg production for certain areas where surveys were not conducted and including these, all-India estimates of egg production were worked out for the year 1966.

The total egg production in the country during 1966 was estimated at 4701 million eggs of which 3499 millions was the contribution from the non-exotic hens and the remaining from other categories of poultry layers such as exotic hens, ducks, geese and turkies. Per capita availability of eggs in the country was estimated at 8 eggs per year. In individual States, however, the per capita availability varied from 2 eggs per year to 19 eggs per year. The per capita availability was the highest in Kerala.

(B.B.P.S. Goel, D.V.S. Rao and
V.V.R. Murty)

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

The Institute had conducted in the past pilot sample surveys for developing suitable sampling techniques for estimation of annual output of principal livestock products, viz., milk, wool, eggs and meat and for study of livestock practices. The data collected from such surveys had been used to develop techniques for each of the individual products and such techniques were now being used by the State Animal Husbandry Departments for conduct of large scale surveys on individual products and for study of livestock practices. It was felt that there was a need to carry out further research to improve these techniques and to evolve an integrated technique for studying simultaneously the annual output of the livestock products in such a manner that

while each year one product would be studied with sufficient accuracy, a simultaneous study of other products would also be taken up for providing indices of changes in the production and the attendant livestock practices from year to year. The Institute had initiated pilot surveys during Fourth Plan period for developing such techniques. Under this programme, investigations were initiated during 1969-70 in the Northern Region comprising Punjab, Haryana and Himachal Pradesh. In this region, the third round of programme which covered wool and meat as the main products was in progress during 1971. Another investigation was commenced in Andhra Pradesh of the Southern Region during October, 1971 and the field work of this investigation was in progress.

The sampling design used under the two investigations was one of multi-stage stratified random sampling with partial replacement of primary sampling units from season to season. Data on production of each product and on livestock practices through appropriate measurement techniques supplemented by personal enquiries under intensive supervision were collected under these investigations. The investigation in each area was spread over one full year for studying seasonal fluctuations. With the help of the data collected from these surveys, the following studies were initiated:-

- (i) Estimation of changes in production of different products from season to season and year to year,
- (ii) Study of coefficients of correlation between level of production in different seasons, and
- (iii) Study of optimum replacement fraction for different products.

(V.V.R. Murty, J.S. Maini and
B.B.P.S. Goel)

4.6: Preparation of monograph on methodology for estimation of meat production.

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

evolved in estimation of meat production in the country.

Pilot surveys were conducted on meat in Tamil Nadu (1966-67) and Haryana (1968-69) which provided data on the number of animals slaughtered privately, viz. in unregistered slaughter houses (butcher houses) and households and also information on average production of meat per animal from a sample of registered slaughter houses in each state. For the purpose of study, the livestock covered in each State were sheep, goats, pigs, cattle and buffaloes. These data together with those available on the number of animals slaughtered in registered slaughter houses provided an estimate of total meat production in the tract. Data were also collected on the utilization of meat, disposal of hides and skins, etc. A study was taken up from these data to estimate the size of the sample required for estimation of annual meat production in the tract with a fairly high precision. Studies on the practices of disposal of hides and skins and prices of meat were also taken up.

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

4.7: Survey on cashewnut and spices crops.

The objective of the survey was to collect by the method of random sampling information on the extent of cultivation, average yield per bearing tree and various cultivation practices of the cashewnut crop in Tamil Nadu.

The Pilot sample survey on cashewnut was started in Tamil Nadu during the year 1968-69. It was conducted over a period of two years in the form of two independent rounds of one year duration each till August, 1970. The survey covered seventeen important cashewnut growing taluks distributed in five districts viz. Chingleput, South Arcot, Trichirapalli, Thanjavur and Ramanathapuram. These taluks accounted for 93 percent of the area under cashewnut in the State. The estimates of area under cashewnut and total number of cashewnut trees under various categories were obtained on a sample of 227 villages during each year. The information on manurial, cultivation practices and incidence of pests and diseases was collected from 150 randomly

selected orchards, while the estimate of average yield per bearing tree was obtained from a sample of 1350 selected trees in each year. The design adopted was one of the stratified multistage random sampling.

During the year under report, the data pertaining to the extent of cultivation, yield rate and various cultivation practices etc. of cashewnut crop were analysed and the estimation procedures available for multi-stage sampling design were adopted for the analysis of the data. The total number of cashewnut trees in the area covered by the survey was estimated at 63.68 lakhs of which 87 percent were of bearing category and 13 percent of non-bearing category. It was observed that cashewnut crop was mostly grown in orchards. Only 0.12 percent of trees were estimated to be grown in stray form. It was estimated that 85 percent of trees were grown in the reporting area and the remaining 15 percent in the non-reporting area. Even in non-reporting areas, the cashewnut was reported to be grown in orchards to a large extent.

The distribution of trees by age indicated that 54 percent of trees were in the age group of 4 to 10 years, about 83 percent of trees being in the age group of 4-30 years. Trees less than four years of age constituted about 16 percent of the total number of trees. Classification of trees by type of growth viz. erect and spreading and three broad classifications by colour of apples viz. yellow, red and mixed. It was found that 90 percent of trees were of spreading type and the remaining 10 percent of erect type. According to the classification of cashewnut trees by colour of apple, it was observed that 53 percent of trees had apples of red colour and that 29 percent had apples of yellow colour and the remaining trees had apples of mixed colour.

The estimate of average yield per bearing tree was 1.26 kg. with a standard error of 13.49 percent for the year 1968-69 and 1.18 kg. with a standard error of 14.41 percent for the year 1969-70. It was observed that the yield rate was of the same order for trees grown in orchards or in stray form. The results on the performance of the different varieties indicated that there was variation in the yield rates of varieties. The average yield per bearing tree was estimated at 1.24 kg. for trees with red apples and 0.99 kg. for trees with yellow apples. The yield rate was more for erect trees than for spreading ones. The total production of raw cashewnut for the area

colour of apple revealed that there are two types of

covered under the survey was estimated at 6507 metric tonnes with a standard error of 20.13 percent for the year 1968-69 and 6547 metric tonnes with a standard error of 23.21 percent during the year 1969-70. The cultivation of cashewnut in the State was confined to orchards. Among these orchards as many as 97 percent were pure orchards growing cashewnut only. It was observed that about 65 percent of the orchards were found to have less than 100 trees in them. About 30 percent of orchards had trees ranging from 100 to 500. Large orchards with more than 500 trees were also found but such orchards formed only 5.4 percent of the total number of orchards. The proportion of villages having trees between 500 to 2500 was of the order of 25 percent and that of villages having more than 20,000 trees was also 25 percent. It was seen that about 90 percent of trees came to bearing stage between the ages of four to five years.

The average spacing between two adjacent trees was estimated at 7.12 metres. The flowering began in the month of December and lasted upto the end of March. Maximum number of orchards started flowering in the month of February. Peak time of flowering was found in the month of March, about 71 percent of orchards attaining peak flowering in that month. The harvesting of crop commenced in the beginning of March and lasted upto the end of May. Peak time of harvesting was reported in the month of April. In this month, about 75 percent of orchards were harvested. It was estimated that on an average 16 pickings were required to harvest the entire crop.

The crop was not reported to be irrigated in the orchards as well as in areas where trees were grown in stray form. Application of fertilizer as well as manure to the crop was also not observed in any of the orchards or survey numbers growing cashewnut in the sample. Cashewnut crop was reported to be unaffected by the disease in 98 percent of orchards. In two percent of orchards the crop was affected by die-back disease. It was also reported that the crop was attacked by pests like leaf eating caterpillar, stem-borer and aphids in 26 percent of orchards. Preventive measures were not reported to be taken in any of the orchards affected by disease or pests.

(S.S. PILLAI AND J.N.GARG)

4.8. Pilot sample survey on turmeric crop:

The objective of the survey was to evolve a suitable sampling technique for collection of reliable statistics such as extent of cultivation, yield rate and various cultivation practices adopted by the growers of turmeric crop in Orissa State.

The pilot sample survey was started in Phulbani district of Orissa State in July, 1969 and was completed by February, 1970. The survey covered the eleven important turmeric growing Community Development Blocks of the district. The estimate of area was based on a sample of 150 villages. The information on cultivation practices and estimate of average yield per hectare was obtained from a sample of 300 cultivators fields during the year of the survey. The sampling design adopted for selecting sampling units was one of stratified multi-stage random sampling.

During the year under report, the data collected in the survey on turmeric crop in the district were analysed and the estimation procedure available for multi-stage sampling design was adopted for the analysis of the data. Three types of turmeric crop were reported to be grown in the area depending on their durations. The crop with one year duration was most common and was grown in about 88 percent of the total area under the crop. Since the crop was available for three durations, all the area sown with the crop during any year was not harvested in the same year with the result that the area actually harvested in a year was less than the total area under the crop. The average under the crop was estimated at 1818 hectares with a standard error of 13.85 percent. The area actually harvested in the year of the survey was estimated at 1741 hectares with a standard error of 13.65 percent.

The average yield at the district level was estimated at 190.66 quintals per hectare in terms of raw rhizomes. The dry ratio from raw rhizomes to dry cured produce was worked out at 17.67 percent. The yield rate in terms of dry cured produce was of the order of 33.89 quintals per hectare. Total production of dry cured turmeric was estimated at 5858 metric tonnes for the area covered under the survey.

Turmeric crop was reported to be sown in the district from April to June. The preparation of land for sowing usually depended on the period of early shower in the areas. The sowing operation was evenly

spread from April to June. On an average four ploughings were done though it varied from plot to plot. The frequency of ploughing ranged from one ploughing in 2.2 per cent of fields to 3 ploughings in 5.4 percent of fields. Planting materials were usually sprouted before planting season and therefore, in almost all cases sprouted materials were put in the beds. The crop was seldom applied with manures or chemical fertilizers. Before ploughing the fields, the weeds and wild growths were cleared and burnt and these normally served as the basic manurial application. Sowing materials determined the duration of the crop. The practice of growing long duration crops had been given up and the cultivators were more attracted to grow short duration crop. During the year of the survey, it was found that out of the total estimated area of 1818 hectares under turmeric, only 12 percent was under two and three year crops. The crop was seldom irrigated and was usually dependent on rain-fall. It was reported that the crop was free from the incidence of pests and diseases.

(S.S. PILLAI AND J.N. GARG)

4.9: Pilot sample survey for the study of yield and cultivation practices of mango and litchi.

The pilot sample survey for the study of yield and cultivation practices of Mango and Litchi in Muzaffarpur district of Bihar was launched in 1965. The survey was conducted for a period of 3 years in three independent rounds, each of one year duration. The objective of the survey was to evolve a suitable sampling technique for collecting reliable data on extent, yield rates and cultivation practices of Mango and Litchi in Muzaffarpur district of Bihar to obtain data on these characters with a reliable degree of precision.

The sampling design adopted for the survey was two phase stratified multi-stage random sampling. The anchals were grouped into three strata on the basis of information supplied by the revenue authorities. Anchals were taken as primary stage units, villoges the second stage units and cluster of trees as ultimate units of selection. The primary units were selected by varying probability without replacement in the first and second rounds

whereas by varying probability with replacement in the third round. The selection at the second stage was done by simple random sampling. The selected villages at the second stage were completely enumerated to record number of trees according to different fruit crops under bearing and young categories. The studies of yield and cultivation practices were carried out in a sub-sample of villages in each anchal. The data for extent of cultivation of fruits was collected by completely enumerating the trees in the selected villages. The data on average yield and total production of fruit was collected by actual weighments and count of the produce during the harvesting season while that on cultivation practices was collected by enquiring from the selected orchardists.

During the year under report, the final report of the scheme was prepared. The total number of fruit trees planted in the regular orchards in the area covered under the survey during the period 1965-68 was estimated to be 1272.3 thousands. Apart from these, 67.5 thousand trees were planted in stray plots. There were 1277.3 thousand trees of bearing age, whereas 63.0 thousand trees were of young age. Among the fruit trees of bearing age mango accounted for nearly 56%. Among different varieties of mango, Langra accounted for 12.1% of the total number of trees followed by Sukul, Sipia, Bombai and Bathua accounting respectively 9.8, 9.5, 8.3 and 3.3% nearly. Nearly 57% of the trees were accounted by Desi varieties and others. Among different varieties of litchi, Shahi accounted for 84% bearing trees followed by China accounting for 10.9%. Among varieties of banana, Muthia accounted for 49% of the trees. As regards the age distribution of mango trees, only 4 percent were below 10 years of age whereas 25% of the trees were more than 40 years old. Among Litchi trees 18% of the trees were below ten years of age whereas only 5% of the trees were more than 40 years old. Nearly 64% of the orchards were having less than 25 trees whereas only 14% were having more than 100 trees. The average yield of mango per bearing tree in 1966-67 was found to be 73.6 kg. as compared to 46.7 kg. in 1965-66 and 29.9 kg. in 1967-68 thereby showing that 1966-67 was a good year for mango. The average yield of litchi was found to be 7.1 kg., 9.4 kg. and 13.4 kg. per tree in the successive years. For mango the variety Bathua gave the highest average production of 66.6 kg. or 554 fruits followed by Sukul giving 61.2 kg. or 297 fruits. For Litchi, the variety Shahi was found to provide maximum average yield of 10.6 kg. or 828 fruits. In case of banana, the variety Barhani was found to be the best yielder having 112 fruits per bearing tree. The cultural operations and manuring etc. were found to be a rare practice in the district.

(A.H. Manwani)

STATISTICAL STUDIES IN AGRICULTURAL ECONOMICS

During the year under report, the Institute continued to give technical guidance on the statistical aspects of the research schemes in agricultural economics financed by the I.C.A.R. The economic aspects of some of the schemes of the Institute were also studied with the help of the available data.

Study of employment of labour in agriculture.

The study was carried out in Delhi State during the year 1969-70 with the object to collect information on the various aspects of employment like types of labour, wages paid, modes of payment and the extent to which different types of labour are utilized during the crop season. For this purpose, a random sample of 150 cultivators was taken. The design adopted was a stratified multi-stage random sample. The district was divided into five zones. From each zone 6 villages were selected and 5 cultivators were selected in each of the selected villages. The data was collected through enquiry by the field staff appointed under the I.A.D.P. Scheme. The information regarding the employment of labour and other aspects was collected for the entire year by interviewing the cultivators only once.

The results of study indicated that there was a great deal of variation between the holding size groups in respect of the pattern of labour engaged for different agricultural operations. The family labour constituted the major proportion of labour engaged in agriculture. It was seen that the female and child family labour were usually engaged for lighter work, the casual labour for post-sowing operations like weeding, irrigation and harvesting and the permanent labour for all types of agricultural operations. The total payment of wages per worker employed on a permanent basis for the entire year varied considerably among the different holding sizes. This was Rs.750/- on an average for the holding size of 2 - 4 acres while it was Rs.1700/- for the holding size group of more than 4 acres. It was observed that the cultivators of larger holdings preferred to make payment in cash to permanent labour while the major portion of the payment made to casual labour was in kind. The payment to female as well as to child labour was invariably made in cash.

(P.N. BHARGAVA AND BHAGAT SINGH)

BASIC RESEARCH IN STATISTICS

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

(a) Sampling

- (i) A simple and practicable procedure for utilizing ancillary information in survey situations in an optimum fashion to get a more efficient estimate of the parameters of interest than many in vogue was evolved.
- (ii) A difficult but important problem regarding the selection of a sample of required size with unequal probabilities without replacement was tackled through modified systematic sampling scheme, suitable for adoption in practice.

(b) Genetic Statistics

- (i) A problem relating to the genetic basis of the stability parameters describing the interaction between genotype and environment was tackled.
- (ii) A rigorous theory of the transition matrix approach for studying the change in the frequency of a gene in finite populations was developed.

(c) Design of Experiments

- (i) A model for analysing the experiments involving rankings in fractional paired and trial comparisons was developed.
- (ii) Some new incomplete block designs, suitable for agricultural and animal husbandry experiments, were developed.
- (iii) Important theoretical contributions were made in incomplete block designs and weighing designs.

TRAINING ACTIVITIES

The Institute conducts training in agricultural and animal husbandry statistics mainly for three groups of students. Two courses called the Junior Certificate Course and the Senior Certificate Course of which the former is of six months and the latter is of one year duration respectively 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 Diploma Course, each of one year's duration are conducted for the benefit of students deputed by the State Governments and Research Institutes who have a post-graduate degree in Mathematics or Statistics and possess experience of handling statistical data in a responsible capacity. In the latter course, the student is required to work on a research project for a period of one year and submit a thesis thereon which should be such as to form the basis of a paper of publishable standard. The third group consists of students who wish to qualify for the M.Sc. and Ph.D. degrees in Agricultural Statistics. These degrees are awarded by the Indian Agricultural Research Institute. All courses in Mathematics, Statistics, Computer Science, etc. for this group of students are offered at this Institute while the courses in agricultural sciences are taught in the Indian Agricultural Research Institute.

The final examinations of the Junior Certificate, the Senior Certificate and the Professional Statistician's Certificate Courses and the qualifying examinations for the M.Sc. and the Ph.D. students were held during the year under report. The students of the Senior Certificate Course and the Professional Statistician's Certificate Course conducted a survey for the estimation of the number and products of livestock in Himachal Pradesh during June, 1971. The officers and the staff of the Institute supervised the field work and offered technical suggestions.

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

The new session for the Junior Certificate, Senior Certificate and Professional Statisticians' Certificate Courses started in August, 1971 while that for the M.Sc. and Ph.D. courses, in September, 1971. The number of students admitted to these courses were 16, 19, 8, 9 and 5 respectively.

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

- 1. Dr. J.D. Colwell, Soil Scientist, C.S.I.R.O., Adelaide, Australia. "Soil Fertility Investigation and Studies on Soil Test Crop Response Correlation in Australia".
- 2. Dr. D. Bazu, Indian Statistical Institute, Calcutta. "Survey Sampling from a neo-Bayesian point of view".
- 3. Dr. N.C. Giri, Prof. of Statistics, University of Montreal, Canada. "Group Theory and Multivariate 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. Shri I.C. Sethi "A study of rotation sampling."
- 2. Shri D.S. Thakur "Techniques for assessing marketing efficiency".
- 3. Shri S.S. Palled "Attitude Measurement".
- 4. Dr. Aloke Dey "Some aspects of weighing designs".
- 5. Shri A.K. Mishra "On the efficiency of selective breeding".
- 6. Dr. G.M. Saha "Construction of T_m - type P.B.I.B. designs".
- 7. Sh. K.V.K. Nampoothiri "Experimentation in perennial crops".
- 8. Shri T.K. Gupta "Main effect plans for $2^n \times 3^n$ factorial experiments".

9. Shri V.K. Paturkar "Economics of crop rotations".
10. Shri B.C. Borah "Some models for non-response in mail surveys".
11. Shri A. Govindan "Methods for estimation of area under H.Y.V."
12. Shri B.L. Sharma "Response of Nitrogen and Phosphorus Fertilizers to grain yield of tall and dwarf wheats."
13. Shri H.T. Trivedi "Methods of analysis of confounded asymmetrical factorial designs".
14. Shri Dharam Vir "Studies on the quality of wool".
15. Shri V.K. Mahajan "Methodology of pre-harvest forecasting of jute crop."
16. Shri K.T. Mittu "Non-additive interactions in Biometrical genetics."
17. Shri M.G. Singh "The estimation of sampling variance in large scale surveys".
18. Shri M.G. Singh "Analysis of variance and covariance."
19. Shri P.P. Rao "Analysis of Groups of Factorial Experiments conducted at different places over a number of years."

Lectures were arranged for the trainees of other organisations during the year under report as indicated below:-

<u>Organisation</u>	<u>Trainees</u>	<u>Period</u>
1. Directorate of Economics & Statistics, Govt. of India.	I.E.S. Officers	9.6.71 to 7.7.71
2. Central Statistical Organisation	Statistical Officers	9.6.71 to 7.7.71

3. Central Statistical Organisation Trainees of the Inter-National Statistical Education Centre, Calcutta. 15.10.71
4. Central Statistical Organisation Trainees of the Inter-National Statistical Education Centre, Calcutta. 6.11.71 to 9.11.71
5. Central Statistical Organisation Indian Statistical Service Trainees 1.12.71 to 4.12.71.

A training programme for the period of four weeks from 11th October, 1971, to 10th November, 1971 was also arranged for the trainees of the Pre-investment Survey of Forest Resources, Ministry of Agriculture.

DATA PROCESSING

The Institute is equipped with an IBM-1620 Model II electronic computer with 40 K capacity, a card read punch, an on-line printer and an auxiliary memory hardware comprising of three disk drives, each having a capacity of storing and processing 2 million digits of information. There are 32 card punching and verifying machines and 7 pieces of tabulating equipment like sorters, collators, reproducing punch, etc.

The installation of the electronic computer has given a powerful fillup to the research activities of the Institute and the various agricultural research organizations which are effectively using the facilities of this Computer Centre. It has considerably reduced the time lag between the collection of data and the publication of results. As a large number of research workers are going in for complicated designs and methods of analysis for their research problems, the demand for time on the electronic computer has been increased considerably.

On the recommendation of Dr. Carl F. Kossack, F.A.O. Data Processing Expert assigned to the Institute in 1969, the electronic computer was shifted to its new premises in May, 1972. This reduced the loss of computer time due to high temperature to only 4% during the year under report. The computer worked round the clock, even on some holidays and Sundays.

During the year under report, the Mechanical Tabulation unit carried out the work of punching, sorting, listing, and tabulation pertaining to the various research schemes of the Institute and the different research problems of its students. Similar help was also rendered to the students of other Institutes like I.A.R.I. and I.V.R.I. and Agricultural Universities at Hissar, Ludhiana and Pantnagar in programming their research problems as well as to outside agencies like the Pre-investment Survey on Forest Resources, Ministry of Agriculture and the Timely Reporting Scheme of the Department of Agriculture, Uttar Pradesh. About 15.63 lakh cards were punched and verified and about 2500 listings and 300 tables were prepared. About 250 sorting jobs were also undertaken. The Unit also provided assistance in coding the data relating to the various research schemes of the Institute; about 70,000 schedules were coded.

During the year under report, about 80 per cent of the utilized time (4830 hours in 284 working days) on the computer was shared by IARS and IARI. Agricultural Universities and Research Institutes utilized about 10% and the Directorate of Economics and Statistics, about 5% of the utilized time. The remaining 5% was spent for paid jobs.

A good number of agricultural research workers (about 40) from the institutes under the ICAR and agricultural universities were extended help in preparing computer programmes for the analysis of their research problems.

Two training courses in computer programming each covering about 30 hours of lectures and 40 hours of laboratory work were arranged by the Centre at the end of the year under report for the officers of the Pre-investment Survey of Forest Resources (Ministry of Agriculture) and in-service staff of the Institute. Certificates were issued to the participants at the end of each course.

Shri D.L. Ralhan who was officer on special duty, and was incharge of the Computer Centre and Mechanical Tabulation Unit left the Institute on 0th November, 1974 to take up the work of Joint Director, Agricultural Census, Govt. of India and Shri S.S. Pillai, Statistician in the Institute took charge of the Centre and the M.T. Unit. To meet the requirements of the Computer Centre a separate administrative section was also set up.

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. The research schemes submitted to the I.C.A.R. by the different Research Institutes, Universities, and State Departments of Agriculture and Animal Husbandry were examined critically by the Institute from the statistical point of view.

A brief description of the technical advice and guidance given by the Institute during the year under report is given below.

Agricultural Sciences

(a) During the year under report, the technical programmes of 23 new schemes were critically examined and necessary advice given. The annual reports of 10 different schemes in operation were examined and suggestions for proper analysis of the data and interpretation of results were given. Besides, 11 final reports were also examined and necessary advice was rendered to make them more meaningful.

(b) The detailed statistical procedure for carrying out the analysis of covariance in respect of the split plot, 3^3 confounded and lattice designs was supplied to the Assistant Statistician, College of Agriculture, Junagarh (Gujarat). The detailed procedure of analysis for 6×6 and 10×10 triple lattice designs was provided to the Agronomist of the College.

(c) The necessary advice in respect of some plans for laying out manurial-cum-varietal trials on mosambi, orange, chicku and banana was given to the Horticulturist, Department of Agriculture, Government of Gujarat, Junagarh.

(d) The Principal, Gram Sevak Training Centre, Burdwan (West Bengal) requested the Institute to analyse the data on wheat crop experiments conducted at the Centre. The needful was done for him.

(e) Technical advice was given to the Horticultural Research Institute, Bangalore on statistical analysis of breeding trials with straw-berry.

Animal Sciences

(a) Technical advice was given to the following organizations in regard to the method of statistical analysis of the data, interpretation of results and preparation of reports of the projects mentioned against them..

1. Department of Animal Husbandry, Uttar Pradesh. (i) Evolving a new type of pig by cross-breeding local pigs with middle white Yorkshire, C.D.F., Aligarh.
(ii) Improvement of sheep and wool on regional basis, Pipalkoti.
2. Department of Animal Husbandry, Jammu and Kashmir. Improvement of sheep and wool on regional basis, Banihal-Reasi.
3. Agricultural University, Andhra Pradesh. Selective breeding of Aseel breed of poultry, Kakinada.
4. Department of Animal Husbandry, Maharashtra. (i) Improvement of sheep and wool on regional basis, Maharashtra.
(ii) Scheme for developing mutton breeds of sheep in Southern Region, Maharashtra
5. Department of Animal Husbandry, Rajasthan. Improvement of sheep and wool on regional basis, Jobner.
6. Indian Veterinary Research Institute, Izatnagar. Project for the use of diallel crossing for broiler production, I.V.R.I.
7. Department of Animal Husbandry, Bihar. Improvement of sheep and wool on regional basis, Gaya.
8. Department of Animal Husbandry, Gujarat. Improvement of sheep and wool on regional basis, Patan.

(b) Technical advice was given to the Progeny Testing Farm, Hissar (Haryana) in the execution of the project of progeny testing of Haryana and Murrah bulls.

(c) Technical advice was also given to the research workers in Animal Nutrition at the I.V.R.I. Izatnagar, U.D.R.I., Karnal and the U.P. Institute of Agricultural Sciences, Kanpur in planning of experiments, analysis of data, and interpretation of results.

(d) Technical advice was also given to the organisations named below on the problems and projects mentioned.

1. U.P. Agricultural University, Pantnagar. Formation of a selection index in poultry.
2. N.D.R.I., Karnal. Bio-chemical polymorphism in cattle.
3. Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur. Quantitative genetic studies with Major Indian Crops.
4. Institute of Agriculture, Anand. Pilot scheme for genetic improvement of Kankrej and Gir cattle in Gujarat through cross-breeding.

Sample Surveys

Technical advice was rendered to (1) the Bureau of Economics and Statistics, Mysore State in organising sample surveys on fruits and vegetables, (2) the Statisticians of Animal Husbandry Department of the States of Haryana, Madhya Pradesh and Maharashtra in conducting sample surveys on livestock products, and (3) the Statistical Officer, Directorate of Animal Husbandry, Haryana on sample surveys for estimation of wool and poultry production in the State of Haryana.

PARTICIPATION IN INTER-ORGANIZATIONAL 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. 58th Session of the Indian Science Congress held at Bangalore in January, 1971.
Dr. M.N. Das
2. International Symposium on "Soil Fertility Evaluation" held at New Delhi in February, 1971.
Km. C.R. Leelavathi.
3. First Workshop of the All India Co-ordinated Project on Sheep for Fine Wool and Mutton held at Jaipur in February, 1971.
Dr. P. Narain.
4. Workshop on Potato Research held at New Delhi in February, 1971.
Shri M.G. Sardana.
5. Summer Institute on "Stochastic Processes and their application to Biology and Population Problems" held at the Andhra University, Waltair in June, 1971.
Dr. P. Narain.
6. Seminar (UNDP) on "Dairy Cattle Breeding" held at N.D.R.I., Karnal in July, 1971.
Dr. P. Narain.
7. Annual workshop of Wheat Research Workers held at the U.P. Institute of Agricultural Sciences, Kanpur in August, 1971.
Shri M.G. Sardana.
8. Combined Workshop (ICAR) on (i) "Soil Salinity & Water Management and (ii) "Cropping Pattern & Water use in Selected Areas" held at the University of Agricultural Sciences, Bangalore in September, 1971.
Shri P.N. Bhargava.
9. Annual Workshop of Oilseeds Research workers held at the Tamil Nadu Agricultural University, Coimbatore in October, 1971.
Shri R.K. Khosla
10. Annual workshop of the All India Co-ordinated Agronomic Experiments Scheme (I.C.A.R.) at Bangalore in November, 1971.
Km. C.R. Leelavathi.

PAPERS PRESENTED IN INTER-ORGANIZATIONAL SEMINARS, WORKSHOPS, ETC.

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

1. 58th Session of the Indian Science Congress held at Bangalore in January, 1971.
DAS, M.N. on sampling with varying probabilities.
2. Symposium on "Socio-economic Implications of Agricultural Development" held at Kanpur in February, 1971.
SINGH, D., SARDANA, M.G. and KHOSLA, R.K. Estimates of avoidable loss in yields of paddy, wheat and maize.
3. International Symposium on "Soil Fertility Evaluation" held at New Delhi in February, 1971.
MAHAPATRA, I.C. and LEELAVATHI, C.R. Response of rice to agro-techniques and their relationship with fertilizers in soil climatic complexes.
4. Annual workshop of the All India Co-ordinated Rice Improvement Project-(ICAR) held at Hyderabad in February, 1971.
MAHAPATRA, I.C., RAHEJA, S.K. and LEELAVATHI, C.R. Agronomic investigations on rice at Model Agronomic Centres.
5. Summer Institute on "Stochastic Processes and their application to Biology and Population Problems" held at the Andhra University, Waltair in June, 1971.
NARAIN, P. Stochastic processes in Population Genetics.
6. Seminar (UNDP) on "Dairy Cattle Breeding" held at N.D.R.I., Karnal in July, 1971.
NARAIN, P. Experimental designs for selection studies in dairy cattle.
7. Workshop on "Soil Test-Crop Response Correlation" held at Ludhiana in October, 1971.
GOSWAMI, N.N., RAHEJA, S.K. and BAPAT, S.R. Fertilizer recommendations on cultivators fields - Soil fertility approach.

During the year under report, thirty-eight papers by the officers, members of staff and research students of the Institute were published in standard journals, while thirteen papers were accepted for publication. A list of these papers is given as Appendix IV. Also, a list of the dissertations approved during the year for the award of the Ph.D. and M.Sc. Degrees and the Diploma in Agricultural Statistics as mentioned earlier in Section 7, is given in Appendix III.

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

1. MAHAPATRA, I.C., GOSWAMI, N.N., PRASAD, RAJENDRA, RAHEJA, S.K., LEEELAVATHI, C.R., BAPAT, S.R., MITTAL, M.G. and LEEUMRIK, D.M. (i) Annual Report of the All India Coordinated Experiments Scheme, 1970-71 and (ii) Summary of the Annual Report of the All India Co-ordinated Experiments Scheme, 1970-71.
2. SETH, G.R., SUKHATME, B.V. and MANWANI, A.H. Cultivation of mango and guava. (Technical Report).
3. SETH, G.R., SUKHATME, B.V. and MANWANI, A.H. Sample survey for study of yield and cultivation practices of lime. (Technical Report).
4. SETH, G.R. and MANWANI, A.H. Sample survey for estimation of extent of cultivation and production of apple and other temperate fruits - Nainital region of Uttar Pradesh. (Technical Report).

SUMMARY OF THE REPORT

13.1 Statistical Research in Agricultural Sciences13.11 Pilot studies on pre-harvest fore-casting of yield of crops.

During the year under report, the statistical analysis of the data on jute crop in Bihar and wheat crop in Uttar Pradesh was completed while that of the data on cotton and paddy crops in different States was in progress. The report on the study of data on Jute crop in West Bengal was submitted to the ICAR Scientific Panel for Agricultural Economics, Statistics and Marketing. In this study, four different models, viz. simple, logarithmic, square root and inverse scales, were used to examine multiple regressions of yield on the biometrical characters of plants (density, height and basal diameter) recorded at different stages of crop growth. The percentage of variation in fibre weight explained by the regression equations varied from 18 to 35, 48 to 59, 28 to 45, and 66 to 85 respectively for the four models. The partial regression coefficients of fibre weight on number of plants were found to be highly significant in all cases, whereas those on height and basal diameter were found to be significant in not more than 25 per cent, of the cases.

13.12 Statistical analysis and summarization of data collected under the All India Co-ordinated Agronomic Experiments Scheme.(a) Model agronomic experiments (M.E) at research centres.

During 1970-71, 498 model agronomic experiments were conducted at 43 research centres. The results obtained during the year under report confirmed most of the findings of the previous years. It was seen that zinc and manganese deficiencies were fairly wide-spread and a significant response to these micro-nutrients even upto the extent of 60 per cent. over NPK yield, could be obtained for rice, wheat and maize at a number of centres. Combined application of all the micro-nutrients together was not beneficial; rather, it led to reduction in yield. Response to micro-nutrients was more evident during kharif than during rabi.

The highest total grain production of 14,702 Kg/ha was obtained with a maize-wheat-chena rotation closely followed by 14,338 Kg/ha with three consecutive crops of rice.

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

Data of 6209 trials under the high yielding varieties programme conducted in 33 districts and 1456 trials conducted in 17 districts under the dry farming programme were collected and analysed. A study of responses of cereal crops to nitrogen, phosphorus and potassium during Kharif IR-8, Jay and Padma varieties of rice gave the highest responses of 2429 Kg/ha, 1779 Kg/ha and 1280 Kg/ha respectively to nitrogen at 120 Kg/ha, whereas during rabi the highest responses of the Sonalika and Kalyansona varieties of wheat to the same level of nitrogen were 2095 Kg/ha and 2484 Kg/ha respectively. The variety IR-8 in Kharif gave a very high response of 1078 Kg/ha to 30 Kg P₂O₅/ha and 1490 Kg/ha to 60 Kg P₂O₅/ha. The variety Padma in rabi gave a very high response of 1122 Kg/ha to potassium at 60 Kg K₂O/ha. The responses of jowar and bajra to the application of potassium were very low. Trials conducted under dry farming conditions showed a good response to nitrogen but low responses to phosphorus and potassium. The average response of rice and wheat to 25 Kg N/ha varied from 100 to 600 Kg/ha and from 100 to 313 Kg/ha respectively.

13.13 Study of influence of meteorological factors on crop production.

The data relating to daily rainfall for 21 rain gauge stations spread over the Raipur District for periods ranging from 40 to 67 years were used for the study during the year under report. The study on variability in the total amount of rainfall showed that the rainfall in the month of June as well as in the second fortnight of September was quite erratic while for the other months there was a good deal of stability in the amount of variation of the rainfall. The data were also examined to study the rainfall reliability through fitting of suitable frequency distribution functions for different periods, viz, fortnights and months as well as to study the occurrence of rainfall with the help of Markov Chains for the crop period, viz, 1st June to 31st September.

In addition to the above investigations, studies were also conducted on the size and shape of plots in experiments on apple crop and critical analysis of crop rotational experiments. Also, data on 2647 experiments for the period 1960-65 and 2915 experiments for the period 1966-71 were analysed for incorporation in the National Index of Field Experiments.

13.2 Statistical research in animal husbandry

13.21 Studies in genetic correlations relating to sheep.

0.4602,
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The data available for the study were collected under the I.C.A.R. schemes for improvement of sheep and wool on regional basis at the centres at Pashulok (U.P.) and Banihal - Reasi (J&K). The genetic correlations between birth weight on the one hand and fleece weight, fibre diameter, fibre length and crimps on the other were estimated as $+ 0.4402$, $- 0.9214$ and $+ 0.8039$ respectively in the case of $\frac{1}{2}$ bred (Rampur Bushair X Polworth) ewes at Pashulok. In the case of $\frac{1}{2}$ bred (local x Rambouillet) ewes at Banihal - Reasi, the genetic correlations between birth weight and fleece weight, fibre diameter and fleece length, fibre diameter and fleece density, and fibre length and scouring loss were estimated as -0.2150 , $+ 0.8679$, and $+ 0.8476$ respectively, whereas in the case of $\frac{3}{4}$ bred ewes, the genetic correlations between birth weight and scouring loss, fibre diameter and fleece density, fibre diameter and scouring loss, fibre length and fleece density, fibre length and scouring loss, and fleece density and scouring loss were estimated as $+ 0.4821$, -0.7489 , $+ 0.9642$, -0.8084 , $+ 0.2056$ and $- 0.3549$ respectively. Also, in the case of $\frac{1}{2}$ bred ewes at Banihal - Reasi, the genetic correlations between fleece weight in second clip on the one hand and fibre diameter, fleece density and scouring loss on the other were estimated as $- 0.2273$, -0.1859 and $+ 0.5848$ respectively.

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

The data collected on white leghorn breed under the scheme for improvement of poultry through family selection at the centre at Kodappanakunnu (Kerala) were utilized to study the efficiency of selection on the basis of part-time production and to estimate heritability of important characters. The heritability of age at maturity and egg production in first 500 days of birds' age was estimated as $(+)$ 0.021 (± 0.1696) and $(+)$ 0.099 (± 0.3164) in case of foundation stock. The heritability of age at maturity and egg production in first 100 days of lay was estimated as $(+)$ 0.073 (± 0.0918) and $(+)$ 0.095 (± 0.0878) in the case of 600 first generation birds. The heritability of age at maturity was $(+)$ 0.093 (± 0.0938) in the case of 200 selected birds from the first generation stock.

13.23 Efficiency of selective breeding in cattle.

The breeding data relating to the Red Sindhi, Kangayam and Tharparkar herds for a period of about

25 years were analysed to investigate the number and type of characters which should be used as corrections for increasing the efficiency of selective breeding on the basis of lactation yield in Indian dairy cattle. Using the technique of partial regression for correcting the variations in the lactation yield due to variations in other traits and expressing the efficiency as the ratio of the genetic gains accruing when the additional traits were or were not taken into account, it was found, with the help of the heritabilities and genetic correlations estimated on the intrasire basis from the data, that, in the case of Tharparkar herd, the use of milk yield in 2nd lactation gave an efficiency of the order of 0.97 and the use of length of 2nd lactation gave an efficiency of the order of 0.96 while the use of both these traits gave an efficiency greater than one. In the case of Kangayam herd, the use of the length of 2nd lactation gave an efficiency of the order of 0.96. The efficiency in the case of Red Sindhi herd was found to be very low.

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

The data collected in the Krishna Delta area of Andhra Pradesh and Dhulia region of Maharashtra were analysed for the study. For the Krishna Delta area, the average daily milk yield of a buffalo in milk was estimated to be 2.1 Kg. in the rainy season, 2.3 Kg. in winter and 2.2 Kg. in summer, whereas that for a cow in milk it was 1.2 Kg. in the rainy and winter seasons and about 1 Kg. in summer. The net cost of production of buffalo milk was estimated to be Rs. 1.04 per kilogram including family labour and 85 paise per Kilogram if family labour was excluded. Feed cost was the major component of cost, accounting for about 70 per cent of the gross cost of production. The average market rate of buffalo milk was 90 paise per Kilogram.

The average daily milk yield of a buffalo in milk in the Dhulia region was estimated to be 3.3 Kg. in summer, 3.1 kg. in the rainy and 4.2 kg. in the winter season, whereas that for a cow in milk was 1 kg. in the summer and rainy seasons and 1.1 kg. in winter. The data for the cost study was still being collected.

13.25 Index of cost of production of milk.

During the year under report, the cost of production of milk was worked out separately for cow and buffalo milk for the sub-urban and the rural areas of West Bengal and Tamil Nadu

for the year 1970-71. The net cost of production per kilogram of milk (including unpaid labour) in Calcutta city during 1970-71 was calculated as Rs.1.57 for cow milk and Rs.1.75 for buffalo milk as against 81 paise and 92 paise respectively during 1960-62 when a large scale enquiry was carried out. The respective indices of cost of production of milk worked out to be 194 and 190 during 1970-71, taking 1960-62 as base period. The market rates during 1970-71 were Rs.1.62 and Rs.2.05 respectively. For the rural area (Chandernagar Sub-division), the net cost of production per kilogram of cow milk was Rs.1.15 during 1970-71 as against 66 paise during 1960-62. The index during 1970-71 was 174 and the market rate, Rs.1.13.

The net cost of production per kilogram of milk (including unpaid labour) in Madras city during 1970-71 was calculated as Rs.1.18 both for cow milk and buffalo milk as against 59 paise and 58 paise respectively during 1957-59 when a large scale enquiry was conducted. The respective indices worked out to be 203 and 208 during 1970-71 were Rs. 1.27 and Rs.1.40 respectively. For the rural area (Gudiyatham Taluk) the net cost of production per kilogram of milk during 1970-71 was 84 paise for cow milk and 100 paise for buffalo milk as against 48 paise and 52 paise during 1957-59. The respective indices during 1970-71 were 68 paise and 75 paise respectively.

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

The data collected in a bench-mark survey conducted in the milk collection areas of the Delhi Milk Scheme during 1966-67 were further analysed during the year under report for studies on employment pattern and gross annual income in milk producer and non-producer families. It was seen that, on an average, a family consisted of seven persons, four adults and three children below 14 years of age. One out of three persons in a family was a worker and one out of five, a helper who assisted in the family occupation on a part time basis. Non-milk-producing families had comparatively a larger proportion of workers and less of helpers. Of the total number of workers in commercial house - holds, 40 to 50 per cent were engaged in agriculture, 20 per cent in milk production and the remaining in other vocations. In private milk producer house - holds, as many as 80 to 90 per cent of the workers had agriculture as their main occupation. In non-milk-producer house-holds, however, field labour accounted for 40 to 50 per cent of the working force, followed by skilled labour accounting for 20 to 25 per cent of it. Artisan work and service were the next two vocations, each accounting for about

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71 were

10 to 12 per cent of the working force.

The average annual incomes of a commercial milk-producer family, a private milk-producer family and a non-milk-producer family in the supplying area were estimated to be Rs.4700, Rs.6600, and Rs.1300 respectively, whereas for the non-supplying area these were Rs.4000, Rs.6400, and Rs.960 respectively. Agriculture and dairying contributed as much as 48 and 42 per cent respectively of the total income of a commercial milk-producer family in the supplying area and 37 and 44 per cent respectively in the non-supplying area. The corresponding estimates for a private milk-producer family were 60 and 32 per cent respectively for both the areas. For non-milk-producer families the major source of income was agriculture labour and skilled labour accounting for as much as 63 per cent. of the total income in the supplying area and 74 per cent in the non-supplying area.

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

During the year under report, the data collected in the survey carried out in Jhansi district of Uttar Pradesh during 1969-70 were further analysed and a final report was prepared. The over - all estimates of the grazing area per village now worked out to be 121.42 hectares for the rainy season and 83.47 hectares for the winter season. The estimates of mean yield of herbage per one square metre cut taken before grazing in the rainy and the winter seasons were 62 gms. and 18 gm respectively and for cuts taken after grazing, 54 gms and 15 gms respectively. The analysis of chemical contents of grass samples collected during the survey showed that nitrogen free extract, crude fibre, ash, crude protein and ether extract contained in a sample were about 53, 28, 11, 6 and 2 per cent respectively.

13.28 Pilot survey to study the cost of poultry and egg production.

During the year under report, the data on labour and feed collected from the Dasuya and Tanda regions of Hoshiarpur district of Punjab State were processed. It was seen that the cost of feed per bird per day was 2 paise for a chick, 4 paise for a young bird upto 16 weeks, 5 paise for a young bird over 16 weeks, 4 paise for an adult male bird and 5 paise for a layer. It was observed that a member of the family spent 8 to 10 hours in different types of poultry and non-poultry work and, on the basis of prevailing wage rates for the different types of labour, the wages per family labour varied from 2 to 4 rupees.

In addition to the above investigations, studies were also conducted on measurement of genetic improvement due to cross-breeding in sheep, feed-milk relationship in bovines, and standardization of the procedure of sampling from fleeces for the study of wool quality. Besides, pilot studies for estimation of birth and death rates in bovines for preparation of life tables were also initiated during the year under report. The work of collection of data on animal experiments, analysis of the data collected and classification of the results for incorporation in the National Index of Animal Experiments under compilation was also continued.

13.3 Sample survey investigations

13.31 Sample surveys for assessment of high yielding varieties.

During the year under report, the yield data pertaining to kharif, 1970-71 received from the States of Assam, Gujarat, Haryana, Maharashtra, Mysore, Orissa, Punjab, Rajasthan and Uttar Pradesh were analysed for assessment of spread and yield rates of high yielding varieties of rice, maize, jowar and bajra vis-a-vis the common local varieties and the extent of adoption of improved cultivation practices. It was seen that the increase in the yield rate of IR-8, the most popular variety of rice over that of the local variety ranged from 34 per cent in Rajasthan to 68 per cent in Assam and that 90 to 100 per cent of the fields under this high yield variety of rice received chemical fertilizers except in Assam where the percentage of fields receiving this benefit was 75. The increase in the yield rate of HB-1, the popular variety of hybrid bajra, ranged from 49 per cent in Rajasthan to 75 per cent in Haryana and the percentage of fields under this variety that received the benefit of the application of chemical fertilizers varied from 40 in Rajasthan to 90 in Punjab. In the case of CSH-1, the most popular variety of jowar, the increase in the yield rate was 269% in Maharashtra, 119% in Mysore, and 30% in Rajasthan while the percentage of fields under this high yielding variety that received chemical fertilizers was 87, 76 and 50 respectively. The hybrid varieties of maize were superior to the local variety in yield by 32 per cent in Rajasthan to 67 per cent in Punjab and 90 to 100 per cent of the fields under these varieties received the benefit of the application of chemical fertilizers except in Rajasthan where this percentage was 75.

13.32 Preparation of a monograph on the methodology for estimation of egg production and study of certain poultry practices.

The data collected through pilot sample surveys for estimation of egg production and study of poultry practices conducted in a number of States in the past were utilized for the study. All-India estimates of egg production were worked out for the Livestock census year 1966. The total egg production in the country during 1966 was estimated at 4701 million eggs of which 3499 million were the contribution from non-exotic hens and the rest from other categories of layers such as exotic hens, ducks, geese and turkies. Per capita availability of eggs in the country was estimated at 8 eggs per year. It varied from 2 to 19 eggs per year for the various States, being the highest in Kerala.

13.33 Survey on cashewnut and spices crops:

During the year under report, the data collected in a pilot sample survey on cashewnut conducted in Tamil Nadu during the years 1968-70 were analysed. Of the total number of cashewnut trees in the area estimated at 63.68 lakhs, 87 per cent were of bearing category and only 0.12 per cent of the trees were estimated to be grown in stray form. About 46 per cent of the trees were less than 4 years of age. Classification of the trees by type of growth and colour of apples showed that 90 per cent of them were of spreading type and the remaining 10 per cent of the erect type and that 53 per cent of trees had apples of red colour, 29 per cent, of yellow colour, and the remaining 18 per cent, of mixed colour. The average yield per bearing tree was 1.26 Kg. with a standard error of 13.49 per cent for the year 1968-69 and 1.18 Kg with a standard error of 14.41 per cent for the year 1969-70. The yield rate varied for different varieties of trees. The total production of raw cashewnut for the area during the two years was estimated as 6507 and 6547 metric tonnes respectively with respective percentage standard errors of 20.13 and 23.21. It was seen that about 65 per cent of the orchards had less than 100 trees and about 30 per cent had trees ranging from 100 to 500. The crop was not irrigated nor was any fertilizer or manure applied to it. Only 2 per cent of the orchards were affected by disease and 26 per cent were attacked by pests but no preventive measures were taken against disease or pests.

13.34 Pilot sample survey on turmeric crop:

During the year under report, the data collected in a pilot sample survey conducted in Phulbani district of Orissa during 1969-70 were analysed. It was seen that three types of turmeric crop with durations of one year, two years and three years were grown in the area. The crop of one year duration was most common and was grown in 88 per cent. of the total area under the turmeric crop estimated at 1818 hectares (with a standard error of 13.85 per cent). The area actually harvested in the year 1969-70 was estimated at 1741 hectares (with a standard error of 13.65 per cent). The average yield was estimated as 190.66 quintals per hectare in terms of raw rhizomes and 33.89 quintals per hectare in terms of dry cured produce. The total production of dry cured turmeric for the area was estimated at 5858 metric tonnes. It was observed that the crop was seldom irrigated and was free from incidence of pests or diseases.

13.35 Pilot sample survey for the study of yield and cultivation practices of mango and litchi.

During the year under report, the final report on the study of the data collected during the pilot sample survey conducted in Muzaffarpur district of Bihar during the years 1965-68 was prepared. It was estimated that the total number of fruit trees growing in orchards was 1272.3 thousand while 67.5 thousand trees grew in stray plots. Nearly 64% of the orchards had less than 25 trees whereas only 14% had more than 100 trees. Mango accounted for nearly 56% of the fruit trees of bearing age. Of the different varieties of mango, Langra, Sukul, Sipia, Bombai and Bathua accounted for 12.1, 9.8, 9.5, 8.3, and 3.3 per cent of the trees respectively while Desi and other varieties accounted for 57 per cent. Among the different varieties of litchi, Shahi accounted for 84% of the bearing trees followed by China that accounted for 10.9 per cent. The variety Muthia of banana accounted for 49 per cent of the trees. The average yield of mango per bearing tree for the three successive years was 46.7 kg., 73.6 kg. and 29.9 kg. respectively, showing that the year 1966-67 was a good year for mango. The variety Bathua gave the highest average yield of 66.6 kg. or 554 fruits followed by Sukul giving 61.2 kg. or 297 fruits. The average yield of litchi per tree was 7.1 kg., 9.4 kg. and 13.4 kg. respectively for the three years. The variety Shahi was seen to provide the maximum average yield of 10.6 kg or 828 fruits. In case of banana, the variety Barhari was the best yielder, having 112 fruits per bearing tree. It was observed that cultural operations and manuring, etc. were a rare practice in the area.

In addition to the survey investigations summarised above, the field work of a pilot sample survey for developing a sampling technique for estimation of production of fresh fruits in Tamil Nadu was undertaken during the year under report. Field work for a similar survey for estimation of production of vegetables in Mysore State was also in progress. Besides, investigations were in progress in the Northern Region comprising Punjab, Haryana and Himachal Pradesh and in Andhra Pradesh of the Southern Region in connection with the pilot surveys initiated during the Fourth Plan period for evolving an integrated technique for studying simultaneously the annual output of livestock products, viz, milk, wool, eggs and meat, in such a manner that, while each year one product would be studied with sufficient accuracy, a simultaneous study of other products would also be taken up for providing indices of change in the production and the attendant livestock practices from year to year. Also, with the help of the data collected in the pilot surveys on meat conducted in Tamil Nadu during 1966-67 and in Haryana during 1968-69, studies were taken up for preparation of a monograph on methodology for estimation of meat production and study of the practices of disposal of hides and skins and prices of meat.

13.4 Statistical studies in agricultural economics

With a view to study the pattern of employment of labour in agriculture, data were collected during the year 1969-70 from 150 cultivators in the Union Territory of Delhi on the various aspects of employment like types of labour employed, wages paid, modes of payment of wages, etc.. The analysis of the data collected was completed during the year under report. It was seen that family labour constituted the major proportion of labour engaged in agriculture in case of all holding size groups. Only large holdings employed permanent labour for all types of work. Casual labour and family female and child labour were employed for post - showing operations. The pattern of employment, the mode of payment of wages and the amount of the total wages paid varied largely with the size of the holding larger holdings preferred to pay more in kind to casual labour but more in cash to permanent labour.

13.5. Basic research in statistics:

During the year under report, significant contributions were made in application of statistical techniques to problems in sampling, genetical statistics, and design of experiments. A simple and practicable procedure for utilising ancillary information in survey situations in an optimum fashion to get a more efficient estimate of the parameters of interest than many in vogue was evolved. A difficult but important problem regarding the selection of

a sample of required size with varying probabilities without replacement was tackled through modified systematic sampling scheme suitable for adoption in practice. A model was developed for analysing the experiments involving rankings in fractional paired and triad comparisons. Some useful designs suitable for agriculture and animal husbandry experiments had been suggested as also the analysis of data from such experiments. A problem relating to the genetic basis of the stability parameters describing the interaction between genotype and environment was tackled. A rigorous theory of the transition matrix approach for studying the change in the frequency of a gene in finite populations was developed.

13.6 Publications:

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

APPENDIX-I

List of Class I Officers in position as on
31.12.1971.

Members of Indian Statistical Service.

Dr. M. N. Das	Director,
Shri M. G. Sardana	Senior Statistician.
Shri B. Marutiram	Statistician.
Shri S. K. Raheja	Statistician.

Research

Dr. Prem Narain	Senior Statistician.
Shri K. S. Krishnan	Senior Statistician.
Shri S. D. Bokil	Statistician.
Shri V. V. R. Murty	Statistician.
Shri S. S. Pillai	Statistician.
Shri K. C. Raut	Statistician
Shri M. Rajagopalan	Statistician
Shri T. Jacob	Statistician
Shri S. S. Narula	Statistician
Shri H. P. Singh	Statistician
Dr. M. S. Avadhani	Statistician
Shri A. H. Manwani	Statistician
Shri B. B. P. S. Goel	Statistician
Shri P. N. Bhargava	Statistician
Dr. Aloke Dey	Statistician
Shri U. G. Nadkarni	Junior Statistician.
Shri J. N. Garg	Junior Statistician
Shri J. P. Jain	Junior Statistician
Miss C. R. Leelavathi	Junior Statistician
Shri R. Gopalan	Junior Statistician
Shri A. K. Banerjee	Junior Statistician
Shri S. R. Bapat	Junior Statistician
Shri J. S. Maini	Junior Statistician
Shri M. G. Mittal	Junior Statistician
Shri P. C. Mehrotra	Junior Statistician
Shri L. K. Garg	Junior Statistician
Shri V. S. Rastogi	Junior Statistician
Shri P. N. Soni	Junior Statistician
Shri R. K. Khosla	Junior Statistician
Shri S. N. Mathur	Junior Statistician.
Dr. G. M. Saha	Assistant Professor of Stats
Shri S. C. Rai	Assistant Professor of Stats
Shri A. C. Kaistha	Mechanical Tabulation Office
Shri R. C. Agaarwal	Field Officer.
Shri Rajendra Singh	Field Officer.

Administration

Shri R. S. Saksena	Chief Administrative Officer
Shri M. R. Garg	Administrative Officer
Shri S. S. Grewal	Assistant Administrative Off:

APPENDIX II

List of sanctioned posts as on 31.12.1971.

<u>Sl. No.</u>	<u>Post</u>	<u>Scale of pay</u>	<u>No. of posts</u>
<u>Class-I.</u>			
1.	Director	Rs.1600-2000	1
2.	Joint Director	Rs.1300-1800	1
3.	Senior Professor	Rs.1100-1600	3
4.	Senior Statistician	Rs.1100-1400	7
5.	Chief Scientist	Rs.1100-1400	1
6.	Chief Administrative Officer	Rs.1100-1400	1
7.	Administrative Officer	Rs. 700-1250	1
8.	Statistician	Rs. 700-1250	21
9.	Agri.Economists	Rs. 700-1250	1
10.	Programmer (cc)	Rs. 700-1250	4
11.	Junior Statistician	Rs. 400-950	25
12.	Mechanical Tabulation Officer	Rs. 400-950	2
13.	Field Officer	Rs. 400-950	2
14.	Asstt.Administrative Officer(cc)	Rs. 400-950	1
<u>Class-II</u>			
1.	Accounts Officer	Rs. 590-900	1
2.	Section Officer	Rs. 350(400)-900	3
3.	Statistical Investigator	Rs. 325-575	40
4.	Electronic Computer Operator	Rs.325-575	6
<u>Class-III</u>			
1.	Assistant Incharge	Rs.210-530	1
2.	Assistant	plus Rs. 40/-	
3.	Cashier	Rs.210-530	11
4.	Personal Assistant	plus Rs.40/-	
5.	Junior Accounts Officer	Rs.210-530	8
6.	Statistical Assistant	Rs.270-575	2
7.	Technical Assistant	Rs.210-425	81
8.	Asstt.Electronic Computer Operator	Rs.210-425	1
9.	Caretaker	Rs.210-425	4
10.	Assistant Librarian	Rs.210-425	1
11.	Junior Accountant	Rs.180-440	2
12.	Senior Computer	Rs.168-300	67
13.	Card Librarian	Rs.168-300	2
14.	Stenographer	Rs.130-300	10
15.	Upper Division Clerk	Rs.130-300	
16.	Punch Supervisor	Rs.110-200	
17.	Machine Operator	plus Rs.40/- S.P.	8
18.	Key Punch Operator	plus Rs.15/- S.P.	4
19.	Lower Division Clerk	plus Rs.15/- S.P.	75
20.	Telephone Operator	Rs.110-180	29
21.	Jeep Driver	Rs.110-180	2
22.	Carpenter	Rs.110-180	1
23.	Tubewell Operator	Rs.125-155	1
		Rs.125-180	1

Class-IV

1. Jr. Gestetner Operator	Rs. 80-110	1
2. Daftry	Rs. 75-95	4
3. Lab. Attendant	Rs. 75-95	11
4. Jamadar	Rs. 75-95	1
5. Chowkidar	Rs. 70-85	8
6. Frash	Rs. 70-85	4
7. Mali	Rs. 70-85	5
8. Beldar	Rs. 70-85	2
9. Peon	Rs. 70-85	13
0. Sweeper	Rs. 70-85	8

Field Staff

Class-II

1. Asstt. Field Officer	Rs. 350-900	2
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Class-III

1. Inspector	Rs. 210-425	5
3. Supervisor	Rs. 130-300	14
3. Enumerator	Rs. 110-200	55

APPENDIX-III

List of dissertations approved during the year 1971 for award of Ph.D., and M.Sc. Degrees and Diploma in Agricultural Statistics.

Ph.D. Degree

1. GUPTA, P.C. On some estimation problems in sampling using auxiliary information.
2. GUPTA, T.K. Contribution to designs and analysis of incomplete factorials.
3. PONNUSWAMY, K.N. Some contributions to design and analysis for diallel and triallel crosses.

Diploma

1. BOHRA, R.K. On a method of contribution and analysis of confounded asymmetrical factorial designs in single replicate.
2. LAL, BASANT. On plans for fractional factorials with blocks.
3. MISHRA, A.K. On efficiency of selective breeding.
4. PAL, SATYA. Contribution to groups of experiments.
5. SETHI, I.C. On procedures of rotation sampling.
6. SINGH, RANDHIR. Contribution to successive sampling.
7. SINGH, SHIVTAR. Contribution to successive sampling in multi-stage design.
8. SUNDRAM, S.S. Designs and models for fractional pairs.

M.Sc. Degree

1. BORAH, B.C. Some models for non-response in mail surveys.
2. MAHAJAN, V.K. On the methodology of pre-harvest forecasting of jute crop.

3. MITTU, K.T. Non-additive interactions in Biometrical genetics.
4. PODUVAL, A.G. Methods of estimation of area under H.Y.V.
5. RAO, P.P. Analysis of groups of factorial experiments conducted at different places during different years.
6. SINGH, M.G. Estimation of sampling variance under large scale surveys.
7. TRIVEDI, H.T. On a method of analysis of confounded assymmetrical factorial designs.
8. VIR, DHARAM. Studies on the quality of wool.

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APPENDIX-IV.

List of papers published or accepted for publication during the year 1971.

(a) Papers published

1. AMBLE, V.N. and AVADHANI, M.S. Inter-censal estimates of livestock numbers. Jour. Ind. Soc. Agril. Stat. Vol. 23. No. 1, 67-88.
2. DAS, M.N. and JAIN, R.C. On component method of analysis of factorial experiments. Biometrics, Dec., 1970.
3. DAS, M.N. On sampling with varying probabilities. Proc. Ind. Sci. Cong., 58th Session, Jan., 1971.
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5. GOSWAMI, N.N., BAPAT, S.R. and PATHAK, V.N. Studies on the relationship between soil test values and crop responses to phosphorus under field conditions. Proc. Int. Symp. Soil Fert. Evaln. Feb., 1971.
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