

Statistics Day 2008

Homage to

Professor Prasanta Chandra Mahalanobis
(1893-1972)



“Scientific laws are not advanced by the principle of authority or justified by faith or medieval philosophy; statistics is the only court of appeal to new knowledge”

29 June 2008



Central Statistical Organisation
Ministry of Statistics and Programme Implementation
Government of India
www.mospi.gov.in



राष्ट्रपति
भारत गणतंत्र
**PRESIDENT
REPUBLIC OF INDIA**

Message

I am happy to learn that Statistics Day is being observed on June 29, 2008 and the Ministry of Statistics and Programme Implementation, Government of India is organising a curtain raiser function on this occasion, coinciding with the birth anniversary of the development planner and eminent statistician Prof. Prasanta Chandra Mahalanobis.

Ours is a developing economy and statisticians of today can draw inspiration from Prof. Mahalanobis's life and labour to credibly sketch our development process through statistics. I am sure that Statistics Day will inspire all our statisticians to further improve our statistical data base and contribute to nation building.

I wish the Day every success.

(Pratibha Devisingh Patil)

New Delhi

June 18, 2008

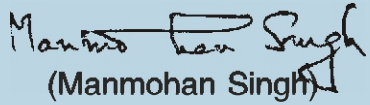


प्रधान मंत्री
Prime Minister

Message

In recognition of the contribution made by Professor Prasanta Chandra Mahalanobis in the fields of economic planning and statistics, our Government decided to observe 29 June, the birth anniversary of Professor Mahalanobis, as Statistics Day. On the occasion of the second Statistics Day, I once again pay tribute to the memory of Professor Mahalanobis. He was one of the architects of development planning in India. Inspired by the vision of Mahatma Gandhi and Jawahar Lal Nehru, Professor Mahalanobis dedicated himself to India's development as a democratic nation. His contribution to institution building both in Kolkata and New Delhi, where he built the Indian Statistical Institute and the Planning Commission, will always be remembered with pride by all patriotic Indians. Professor Mahalanobis inspired young researchers and those associated with data collection to create a reliable statistical basis for development planning in India.

On Statistics Day, I urge all those engaged in data collection and analysis to dedicate themselves to honestly and painstakingly gather accurate information so that policy planning and investment decisions, consumer choices and public opinion are shaped by reliable information. A modern economy needs reliable data. Let us observe Statistics Day by committing ourselves to the cause of generating such reliable information.


(Manmohan Singh)

New Delhi
26 June, 2008



प्रणब मुखर्जी
PRANAB MUKHERJEE



विदेश मंत्री, भारत
MINISTER OF EXTERNAL AFFAIRS
INDIA

Message

I am happy to learn that the Ministry of Statistics and Programme Implementation is bringing out a commemorative brochure on the occasion of the 2nd Statistics Day on 29th June, 2008.

Statistics Day dedicated to the memory of Professor Prasanta Chandra Mahalanobis, the doyen of Statistics & Statistical applications in India, is a befitting tribute to this great personality.

To make the process of economic reforms and liberalization more effective, statistics and its applications should be made integral to our planning of social and economic programmes.

I wish the function all success.

(Pranab Mukherjee)



एम.एस. आहलुवालिया
MONTEK SINGH AHLUWALIA



उपाध्यक्ष
योजना आयोग
भारत
DEPUTY CHAIRMAN
PLANNING COMMISSION
INDIA

Message

I am happy to note that the Ministry of Statistics & Programme Implementation is organizing a function to create public awareness about the role of statistics in socio-economic planning and policy formulation on 'Statistics Day 2008'. A brochure containing selected essays of Prof. P.C. Mahalanobis and other eminent statisticians will also be released on that day.

Prof. Mahalanobis was an eminent statistician and the architect of India's Second Five Year Plan. His contributions to statistics are numerous and impressive. He introduced the concept of pilot surveys and advocated the usefulness of sampling methods. He was instrumental in the establishment of the Indian Statistical Institute. As a member of the Planning Commission, he emphasized the role of industrialization in the development of the country.

Good quality statistics play a vital role in policy formulation and are a precondition to effective macroeconomic management. Any economy needs to have at its disposal the capacity to promptly identify any adverse trends in the economy and to take remedial action. Continued improvement in statistics and development of a strong institutional base for generating statistics should be an important objective of government.

I wish the programme all success.


(Montek Singh Ahluwalia)

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G.K. VASAN



सत्यमेव जयते

राज्य मंत्री (स्वतंत्र प्रभार)
सांख्यिकी और कार्यक्रम कार्यान्वयन

भारत सरकार,

नई दिल्ली

MINISTER OF STATE (INDEPENDENT CHARGE)
STATISTICS AND PROGRAMME IMPLEMENTATION
GOVERNMENT OF INDIA
NEW DELHI

Message

It is most satisfying for me as the Minister in Charge of Statistics that we are observing the 2nd Statistics Day commemorating the 115th birth anniversary of Prof. P.C. Mahalanobis on 29th June 2008. This celebration comes at a period during which we have achieved a number of statistical milestones that we had set for ourselves. Among these, the formulation of the National Strategic Statistical Plan, Release of the results of the Economic Census 2005, release of the 2007 Country Report on MDG, Release of web enabled DevInfo India 2.0 database system, India's chairing the UN Advisory Group on Gender Statistics Training and Curricula, and introduction of a centrally sponsored scheme for basic statistics on local level development are the most significant. These are testimonials not only of the statistical productivity we have achieved, but also the commitment of our Government to make our statistics more inclusive, transparent and extensively available.

As we usher in a new era of knowledge and information management, our statisticians have to look beyond their traditional roles and try to emulate the spirit that guided the pioneering stalwarts of Indian statistics. In this commemorative brochure, the high and growing importance of statistics as an independent intellectual discipline and a work of dedicated and imaginative collection of data have been highlighted. Timeliness, credibility and adequacy are indeed important credentials of a sound statistical system, but imagination and ingenuity are no less important. Statisticians are frequently confronted with new challenges in keeping up with the ever-changing dimensions of socio-economic development and demands of the users. I wish the new generation statisticians draw inspiration from Prof. Mahalanobis and strive hard for making statistics more meaningful and relevant to the society.

Date: 26-06-2008


(G.K. Vasan)



डॉ. सी. रंगराजन
DR. C. RANGARAJAN

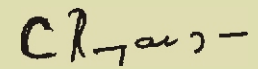


अध्यक्ष
प्रधानमंत्री की आर्थिक सलाहकार परिषद्
विज्ञान भवन सौध 'ई' हाल
मौलाना आज़ाद रोड
नई दिल्ली-110011
CHAIRMAN
Economic Advisory Council to the Prime Minister
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June 14, 2008

Message

In a fitting tribute to Prof. P.C. Mahalanobis, June 29, his birthday, has been declared as the Statistics Day. I am happy to associate myself with the second anniversary celebrations of this day. The Indian statistical system owes much to Prof. Mahalanobis. He was the guiding spirit behind it particularly in the early years after Independence. The three important characteristics of a good statistical system are timeliness, credibility and adequacy. A good statistical system is indispensable for policy formulation and for monitoring the progress of the various sectors of the economy. The Report of the National Statistical Commission while recognising the strengths of the Indian statistical system also drew attention to the weaknesses that need to be corrected. I am quite sure that we will take all necessary steps to restructure our statistical system and make it a model for other developing countries to emulate. I wish the function all success.


(C. Rangarajan)

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**C.R. Rao, Sc.D., F.R.S.
Padma Vibhushan Awardee
University of Hyderabad Campus
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Due to some unfortunate circumstances I am unable to attend the National Statistics Day celebrations to honor the memory of Professor P.C. Mahalanobis. I was associated with the Professor (as he was known to Government officials and all his associates alike) for over three decades and worked under his guidance to develop educational and training programs in statistics and to demonstrate its use in all areas of human endeavors. I am disappointed that I will be missing the opportunity to pay homage to the Professor and talk about the future of statistics reflecting his vision on the use and development of statistics.

Professor Mahalanobis was the founder of the Indian Statistical Institute (ISI), the first of its kind, a unique organization in the world devoted to training of statisticians and demonstrating the important role of statistics in interdisciplinary research. The Indian parliament declared ISI as an institute of national importance. ISI also received worldwide recognition as the Indian School of Statistics based on its fundamental contributions to statistical science and the outstanding statisticians it produced.

The Professor was not content with developing statistics as a pure scientific discipline. Besides its role in interdisciplinary research, he saw its immense potential in generating information for solving problems of human welfare. He emphasized that "statistics must have a purpose" and recommended to the government the strengthening of statistical offices at the center and establishing statistical bureaus in the states for systematic collection of data needed for making short range policy decisions and long range economic planning. He also recommended the establishment of National Sample Survey to collect periodically data not ordinarily available through official channels. The Indian National Statistical system as envisaged by the Professor and implemented by the government is considered to be one of the best in the world.

It is quite fitting that the government of India decided to observe Professor's birth anniversary, June 29, as statistics day to be celebrated every year country wide to remind us of what he has done and to inspire us to follow the program he has set for the development and use of statistics.

I wish the celebration a great success.

C.R. Rao

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डा. प्रणव सेन
DR. PRONAB SEN



सचिव / Secretary
भारत सरकार / Government of India
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PREFACE

This commemorative brochure on the occasion of Statistics Day 2008 is devoted to rediscovering what Prof. Mahalanobis aptly put as “statistical craftsmanship”. Statistical prowess, which Indians have demonstrated in ample measure, usually is taken to mean only the skill of using imaginative methods of estimation and analysis, but not looking very much beyond. However, what we tend to forget is that no amount of technical brilliance can go beyond the limits placed by the raw material of all statisticians – the data. The data used by the analytical experts take shape in the hands and minds of a large number of unheralded statisticians, investigators, compilers and validators. These are the statistical craftsmen – the women and men for whom data is not a raw material but the finished product. The skills that are required of them are possibly different from those of their ‘clients’, but are no less demanding.

Realizing the importance of data in generating statistics for development planning and policy, and the critical role of statistical craftsmen in producing credible data for statistical applications, Government of India accepted Mahalanobis’s vision of this country’s official statistical system, and the need to create an organised service and Institutions to sustain it across the length and breadth of the country.

This unglamorous aspect of statistical work, where data are produced and processed through the sieves of statistical artisans before getting dressed up for the users including the statistical elite, has unfortunately received less than adequate attention in the intervening years since the statistical system was created in its present form. In the wake of technological advancement in data processing, the traditional quality control methods and the attention to every minute technical or organizational detail, which were embedded in primary work for data preparation, started getting neglected. Automated checks and validation protocols started replacing judicious troubleshooting. The institutional system in the country found itself more occupied with keeping watch on the timeliness of statistics using technological solutions rather than the methods and procedures used in generating reliable data.

The speed of data flow, processing and compilation has certainly increased significantly with the help of technology, but new demands for statistical products in practically every application area has expanded even faster. In the midst of this proliferation, the stewardship of a visionary like Mahalanobis is being sorely missed. In the scramble to meet the ever-increasing demand for data and analysis, both within the government and without, statistical craftsmanship has suffered.

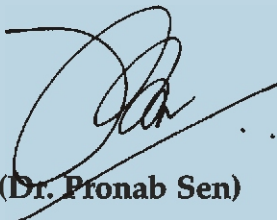
Advances in information technology has no doubt eased much of the drudgeries of statistical collection and compilation, but the aptitude for addressing basic and fundamental issues of data integrity that

characterized the traditional methods of collection and compilation of statistics in India has certainly not lost importance. While professionalism in the field of statistics has grown substantially since the time of Prof. Mahalanobis, the formal breeding process of statisticians in India still remains mainly in the realm of mastering the theoretical arcana of the subject. This process has certainly served us well in the use of mathematical or analytic statistics in scientific and technological work, where India's statisticians have made remarkable contributions. But it fails to address the gap between the art and the science of the subject. This gap has historically been bridged by the training and on-the-job learning imparted by the official statistical system, but this is presently under stress.

The attractive white collar jobs in the private and corporate sector of the country and abroad for statisticians coming out of colleges and universities is creating vacuum in the official system. Creating adequate number of trained statisticians and para-statisticians to deal with the problems of collection, processing and interpretation of data and to integrate them in a manner which is not only practicable but also meet the requirement of reliable data for administrative and policy decisions has become a major issue.

I wish to make it clear that there is a need to revisit our policies towards development of statistical human resource. The Ministry of Statistics & Programme Implementation has its own policy for human resource development in the field of statistics for enhancement of the capacity of in-service statistical professionals. There is perhaps a need to have similar policy for developing post-schooling vocational courses in statistics with curricula suited to develop diagnostic and validation skills besides understanding behaviour of data under different conditions. There are varieties of employment opportunities in the field of statistics, both in Government and private sectors. The present educational curricula of universities in the country are not oriented towards statistical craftsmanship in the various fields of the economy, particularly for micro-planning needs. Employability of the students of statistics can be enhanced through proper training and guidance and there is much scope for developing infrastructural facilities and course material for imparting training in order to enhance the capability of those who enter into the official statistical system. In a wider perspective, there may be a need also to orient the curricula in the colleges and universities so as to make these supportive to the needs of not only the Govt. but private sector as well.

We are one of the few developing countries to conform to the discipline of the IMF's Special Data Dissemination Standards under which India is committed to providing quality data in a host of areas relating to the real, financial and external sectors of the economy and at regular intervals. We have an elaborate infrastructure to capture a wide variety of data for an economy that is both large and decentralized. However, due to over-dependence on the administrative set up and traditional records, the system has not been able to keep pace with changing times. Liberalisation has also ushered in significant structural changes in the economy – changes that need to be captured by the statistical system. The restructuring of the system to meet the data requirements has to find the link with human resource to fall back upon. This is the challenge of the coming years.



(Dr. Pronab Sen)

Secretary (S&PI) and Chief Statistician of India

THE LAST LAP OF THE PROFESSOR

Dr. S.K.Nath, DG, CSO

It was January 1972. A few months back we had joined the ISS. As a part of probationary training programme we were to go to Calcutta on a short visit during January 1972. This included a visit to the Indian Statistical Institute (ISI), Calcutta. Professor Mahalanobis was seriously ill at that time. It was our ill luck that we could not get an opportunity of meeting him. Almost during the same time the Govt. of India had decided to transfer ISI-part of NSS (now DPD and SDRD of NSSO) under the Department of Statistics in the Cabinet Secretariat. The workers of ISI were not happy with this decision of the Govt. of India.

The physical condition of Professor Mahalanobis started deteriorating very fast. The doctor suspected a growth in his colon and advised him to go for surgical operation. Most probably even a date of operation was fixed. Just before Professor got admitted in a Nursing home at Calcutta, Mrs. Indira Gandhi- the then Prime Minister of India came to Calcutta on an official mission and came to know about the ill health of the Professor. She telephoned Professor Mahalanobis and enquired from him about his physical condition. But the mind of Professor Mahalanobis was engrossed about the future of ISI in spite of his severe illness, particularly, because the next meeting of the Governing Council of ISI was fixed on 2nd July 1972. His concern was evident from his letter to Mrs. Gandhi. Professor wrote to Mrs Gandhi on 24th May 1972.

" Dear Indiraji,

I was deeply touched by hearing your voice over the phone when you came to Calcutta last week. I am going to a nursing home this afternoon.

I had conveyed to you, briefly, that the Indian Statistical Institute is passing through a crisis more serious than at any time in its history. "..... Pitambar Pant during his two recent visits to Calcutta has learnt a good deal about the difficulties in Institute affairs. I believe, the Cabinet Secretary has realized the seriousness of the position and has been very helpful....."

On 24th May 1972, Professor Mahalanobis got admitted into a Nursing home. Initially the date of operation was fixed on 30th May 1972. But he could not take rest. His mind was restlessly brooding over the future of the ISI. On 27th May lying on a bed of the nursing home, he called Shri Kali Babu to take a dictation for expressing his views to Smt. Indira Gandhi on how to get rid of the problems of the ISI. He wrote

" Dear Indiraji,

I hope you have received the letter which I sent on 24 May, 1972 through the hands of Pitambar Pant. After thinking over the matter, I feel I should write to you again. I hope to be forgiven for this intrusion.

This letter is going to be entirely different in mood from the earlier letter, the difference in mood of a man who was coming to a Nursing Home and of a man who is waiting for a hazardous operation very soon. I feel that I must be more outspoken about my health and also the help I should like to ask from you about the affairs of the Indian Statistical Institute.

The operation for which I have come to the Nursing Home will take place in about four days or so. Even if the worst fears of the doctors, who are suspecting a malignant growth in my colon, are not confirmed, they will in any case have to remove a large part of the colon. For a person of my age, it means that I may be, more or less, ineffective for quite a long period after the

operation. Before going in for this operation, my mind is full of anxieties for the institution for developing which I have given the greater part of my life, over forty years in a formal way, and over half a century in fact. It is unfortunate that there is danger of the Institute getting into the control of one group of people in the Council who are not inspired by academic ideals but are motivated only by love of power. I told you the other day over the phone that I am not a good judge of men and most of the blame for introducing some of these people into the Council of the Institute rests on me. But this is not the time for apportionment of blame. I would not mind if all the blame is thrown on me if the Institute which is one of national importance is saved.

After giving most anxious thoughts to the subject, I have reached the conclusion that the only thing which can completely ensure the safety of the Institute is to induce you to take it under your care. If the Institute could be placed under the charge of a small ad hoc body of persons nominated by you until such time as a proper scheme of reorganization is finally settled. I shall have no fear about the future of the Institute. The manner of doing it has to be left to your discretion. I have been thinking of some action on the lines of what you did to save an institution of greater national importance, the Viswabharati University.

Today, I am thinking of Panditji's first visit to the Institute in March, 1946 when he stayed in Amrapali for five days or so; other visits; and the last time I saw him on the 11th May, 1964 when he was in good health and cheerful."

For some reason, the date of his operation was shifted to 7th June 1972. He was operated upon on 7th June. 3-4 days after his operation, Professor told Smt Rani Mahalanobis "I will not survive upto 29th June. I feel like going back to Amrapali but you cannot take me there".

His concern was that he might not be able to attend the council meeting fixed on 2nd July 1972. "They told me that council meeting has been fixed on 2nd July. It will not matter to me since I will not be in this world in July. Even I will not survive till 29th June", he said to his wife.

His terminal day was fast approaching but Professor's brain did not stop functioning. One early morning suddenly he started speaking at length on "Evolution of Human civilization". One day he told his wife "I have got two new conjectures. I wanted to tell C.R.Rao but no body is calling him".

The last moment finally arrived. Professor knew it very well. On 28th July early morning he asked Rani-ji "tell me what is the exact date today- the day, date, month and the year". She replied, " 28th June, Tuesday, 1972". Knowing fully that it was his last day, he asked Rani-ji, " Please call Biman Bose and D. Das, I have something to discuss with them". When Shri Bose and Das arrived, Professor asked them "Have you circulated the papers which I gave to you". "Yes, Sir, we have done the needful. Now kindly take rest", they replied. Two hours after that Professor breathed his last. So he rightly predicted that "I will not be there on 29th June". Great visionaries in the history of mankind, they say, were able to foresee when they would be no more and Professor Mahalanobis was no exception.



Sukhatme Award 2007-08

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PROF. P.V. SUKHATME

(27 July, 1911 – 28 January, 1997)

Pandurang Vasudeo Sukhatme was born to Vasudeo Hari Sukhatme and Satyabhama Sukhatme on 27th July, 1911 in the village Budh, district Satara, 100 miles south of Pune. After completing his school education in Pune he graduated in 1932 from Fergusson College with Mathematics as the principal subject and Physics as a subsidiary subject. During 1933-36, he studied at the University College, London and was awarded a Ph.D in 1936 and a D.Sc. Degree in 1939 for his work on bipartition functions. This work was published in the "Philosophical Transactions of the Royal Society of London, Series A", June, 1938.

Whilst in London, Prof. Sukhatme came under the influence of such eminent authorities in Statistics as R.A. Fisher, Jerzy Neyman and E.S. Pearson and did valuable research in Statistical Theory of Sampling, his two most significant contribution being, one to bipartitional functions under the guidance of R.A. Fisher and the other to sampling theory entitled "Contributions to the Theory of the Representative Method" under the guidance of J. Neyman and E.S. Pearson. The latter paper laid solid foundations for his subsequent pioneering research in the sampling theory of surveys and improvement of agricultural

statistics which ushered in what may be appropriately termed as the Sukhatme era in the development of agricultural statistics in India and the world.

When P.V. Sukhatme returned to India, while searching for a University job, he had an interview with the Late Pandit Madan Mohal Malviya, Vice Chancellor, Banaras Hindu University. Though Panditji was satisfied with the brilliant career of P.V. Sukhatme and agreed to create a Department of Statistics in the University to accommodate him but he wanted to know from Sukhatme how a Chair in statistics would help our poor country - India. P.V. Sukhatme did not know how to answer this question nor did he join Banaras Hindu University but this question must have moved him sufficiently in determining his future file, particularly his fundamental work on nutrition.

During 1939-40, he was a Professor at the All India Institute of Hygiene and Public Health, Calcutta. In 1940 he joined ICAR as a Statistician, and was later on appointed as Statistical Advisor to the Council to head its Statistical Unit. On account of his dynamic leadership, following the path and tradition set by him, the statistical branch of ICAR

eventually grew to become a full-fledged Institute (Indian Agricultural Statistics Research Institute) exclusively devoted to research in Agricultural Statistics. In the context of the green revolution the importance of statistical techniques in agricultural research hardly needs any emphasis.

Prof. Sukhatme, as a founder of the Indian Society of Agricultural Statistics, devoted a good deal of his time and energy to the popularization of statistical methods among the practitioners of agricultural, veterinary and related sciences. He served as the First Honorary Secretary of the Indian Society of Agricultural Statistics for a number of years. The Society owes him a lot for his continued valuable guidance as well as for shouldering the responsibility, as its President during 1991 and Executive President since 1970 till his demise. From its inception to 1963 he worked closely with Dr. Rajendra Prasad (Founder President of the Society), the then Minister for Food and Agriculture and later President of India.

In 1951, he was a Visiting Professor at Iowa State University, Ames Iowa, USA where he completed his textbook on sampling. During 1952-70, he headed the Statistics Division of the Food & Agriculture Organisation (FAO) of the United Nations in Rome. After retiring from the UN in 1971 he served as Regents Professor, University of California at Berkeley and then settled in Pune, carrying out valuable work on nutrition at the Maharashtra Association for the Cultivation of Science. He authored several books on the various scientific topics of interest and published more than 200 research papers in reputed national and international journals.

Prof. Sukhatme was well known in the field of nutrition for the Sukhatme-Margen

hypothesis which in plain language implies the following: At low levels of calorie intake, energy is used with greater metabolic efficiency and efficiency decreases as the intake increases over the homeostatic range.

He was awarded the Guy Medal by the Royal Statistical Society for his paper on nutrition which he presented to the Society in 1963, the B.C. Guha Memorial Lectureship of the Indian Science Congress Association in 1965 and the B.D. Tilak Lectureship of the Indian National Science Academy in 1982. Among the numerous other honours he had received, mention must be made of the Fellowship of the American Statistical Association, National Academy of Sciences, Allahabad, Indian Academy of Sciences, Bangalore and Indian National Science Academy, New Delhi. He was elected member of the International Statistical Institute, Netherlands and its Vice President in 1969-70. For his outstanding contribution to Science and Human Welfare, he was conferred the Padma Bhushan by the President of India in 1973. He was awarded the Hari Om Ashram Trust Award by the University Grants Commission in 1983. For the distinguished service to the cause of Statistics and its application to agriculture and allied fields, he was conferred with the honour of Sankhyiki Bhushan in 1989 by the Indian Society of Agricultural Statistics, New Delhi. He also received the P.C. Mahalanobis Award at the Jaipur Session of the Indian Science Congress Association.

Prof. Sukhatme expired on 28 January, 1997 at Pune. With the demise of Prof. Sukhatme, the scientific community in general and the Agricultural Scientists in particular have lost a great statistician, true advisor, dynamic leader, well-wisher of humanity and a renowned personality of international fame.



PROF. B. L. S. PRAKASA RAO
JAWAHARLAL NEHRU CHAIR
PROFESSOR
DEPARTMENT OF MATHEMATICS
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UNIVERSITY OF HYDERABAD

Prof. Bhagavatula Lakshmi Surya Prakasa Rao, was born on 6th October 1942 at Porumamilla, Andhra Pradesh. He did B.A. (Hons.) from Andhra University in 1960. Having done M. Stat. from Indian Statistical Institute, Calcutta in 1962, he obtained Ph. D degree from Michigan State University in 1966. Currently he is serving as Jawaharlal Nehru Chair Professor, Department of Mathematics and Statistics, University of Hyderabad, Hyderabad.

He studied the asymptotic distribution of the maximum likelihood estimator in non-regular cases such as estimation of the location of the cusp for a family of densities which includes double exponential; developed cube root asymptotics underlying the basic distribution theory for the study of the maximum likelihood estimator of a unimodal density under restrictions on the shape of the density; contributed extensively to the parametric and nonparametric inference for stochastic processes and characterization problems and limit theorems in probability.

During the last 40 years, Prof. Prakasa Rao has been working on the study of asymptotic inference of parametric and non-parametric estimation for continuous as well as discrete

time stochastic processes. He has developed the basic asymptotic theory for the estimation of the drift parameters of a diffusion process. Prof. Rao's recent work consists of estimation of parameters for processes driven by a fractional Brownian Motion which is very important for modeling problems connected with traffic patterns of packet flows in high speed data networks such as the internet.

Having published over 200 papers in national and international journals, he has reviewed over 60 books for international and national journals and has authored, coauthored and edited ten books dealing with parametric and non-parametric inference for stochastic processes. He has guided students towards their Ph. D on inference for stochastic processes. He has been editor or a member of the Editorial Board of international and national journals such as Statistical Inference for Stochastic Processes, Statistics and Decisions, Statistics and Probability Letters, Electronic Journal for History of Probability and Statistics, Sankhya and Indian Journal of Pure and Applied Mathematics.

He was the Director of Indian Statistical Institute during 1992-95. He was also a Chairman or a Member of various committees

appointed by CSIR, Government of India and was editor of publications, Indian National Science Academy during 1991-93.

He has served as Visiting Professor (UPE) 2004-2006, Distinguished Scientist and Director, Indian Statistical Institute, Kolkata during 1992-1995, Professor, Indian Statistical Institute, Delhi during 1976-1986 and 1988-1991 and Distinguished Scientist, Indian Statistical Institute, Delhi during 1992-2004. He has also served as Assistant Professor and Associate Professor at Indian Institute of Technology, Kanpur. He has been a Visiting Professor at University Of Iowa, Iowa City, USA; University of California, Davis, USA; University of Wisconsin, Madison, USA; University of Illinois, Urbana, USA.

He was awarded gold medal and a special certificate of merit by Andhra University for record breaking performance at the B.A. Hons.

in 1960. He received Bhatnagar Award for Mathematical Sciences (1982). He is an elected member of the International Statistical Institute (1982). He was elected Fellow of the Institute of Mathematical Statistics, USA (1983); elected Fellow of the Indian National Science Academy (1984); elected Fellow of the Indian Academy of Sciences (1992); elected Fellow of the National Academy of Sciences (1993); elected President of the Section on Statistics (83rd session) of the Indian Science Congress Association (1995-96). He was selected as National Lecturer, University Grants Commission (1985-86). He was awarded outstanding Alumni Award by Michigan State University 1996. He was also awarded distinguished service award by Mathematical Association of India 1999. He was awarded best paper in the field of Statistical Methodology by the Indian Society of Agricultural Statistics 2000.



Statistical Science, A Pursuit of Truth

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PROFESSIONAL TRAINING IN STATISTICS

by P. C. Mahalanobis¹

The demand for trained statisticians is steadily increasing in India, but the statistical education given in the universities has not been found adequate for professional work. It is recognized that there is a great need of providing professional training of a high quality for a statistical career.

The nature of professional work in statistics varies widely, and it is convenient to break it up into 4 or 5 special fields (each of which, of course, may be further sub-divided into more specialized sectors).

- (i) Official and administrative statistics in Government and semi Government Departments or on the management side of large commercial and industrial concerns.
- (ii) Statistical work in connection with economic analysis and planning in Government, semi-Government, or commercial and industrial offices.
- (iii) Applications of mathematical or analytic statistics in scientific and technological work and research.
- (iv) Statistical sampling in various kinds of surveys.
- (v) Statistical education, training and theoretical research.

A comprehensive programme for professional training must include three things. First, training in certain statistical "crafts" or "skills" which would be same for all five groups; secondly, a basic educational course also same for all groups; and, thirdly, specialized courses for each group separately.

The first group, official and administrative statistics, offers the largest volume of employment in India, and although a large number of posts are being created and filled, the quality of work is still low for lack of trained personnel.

The demand for specialists in economic analysis and planning has just begun and the shortage of competent statisticians is most acute in this sector. In the third sector (that is, in the use of mathematical or analytic statistics in scientific and technological work) the position in India is appreciably better. Present arrangements for education and training are directed mainly or almost exclusively to this particular group.

(In consequence little or no attention has been given to statistical craftsmanship with the result that statisticians with a great deal of knowledge of mathematical statistics have often been unable to deal with the professional work in official and administrative statistics).

There has been a rapid growth in the use of statistical sampling in India, and the supply of sampling statisticians falls far short of the demand because facilities for training in this subject are very meager.

Training and opportunities for research in mathematical and analytic statistics have, however, expanded in India during the last 10 or 15 years and the position is not unsatisfactory. The supply of teachers for the usual academic type of statistical education has also expanded fairly rapidly.

¹Bulletin of the International Statistical Institute Vol 33 No 5 (1951)

But basic training in what may be called the “statistical crafts” have been neglected with unsatisfactory consequences. I shall consider these “crafts” under a number of heads.

Preparation of questionnaires and schedules: Training and skill in preparing questionnaires and schedules are essential requirements for professional work. Unfortunately, in India, this subject is almost completely neglected. I have continually found a kind of feeling among mathematical statisticians that the framing of a questionnaire or a schedule is not their concern. In consequence, questionnaires and schedules, which have been used in the past or are still current, are often of a poor quality. Usually there is much waste of paper together with lack of space needed for entering the data in a logical manner. The arrangement is often haphazard and without any reference to the procedure to be adopted in collecting the material. Concepts and definitions are not properly worked out, and so on. My own experience has been that it takes a good deal of time and practice for a junior statistician to learn how to prepare good forms and schedules

Collection of primary data: It is necessary, in my opinion, for every professional statistician to have some personal knowledge and experience of actual methods of collection of data. Unfortunately this important aspect of statistical work usually has no place in the teaching programme. Most of the statisticians working in Government offices have, therefore, no idea of the difficulties or the conditions under which the data are actually collected

Scrutiny of primary data: R. A. Fisher has stated somewhere that the first duty of a statistician is to cross-examine his data. In India so far very little attention has been given to this important subject. One reason is that, as

“STATISTICS MUST HAVE A PURPOSE”

.....Before starting to collect any new statistics it is useful to pause and enquire “for what purpose?” When a statistician is requested to collect some statistics his first responsibility is to ask the person or authority making the request to explain as clearly as possible the purposes for which the information would be used. One may find, for example, that statistical data are already available which would serve the purpose. Or, it may turn out that information of some other kind than that suggested at first would be more suitable. Also, when a complete census is suggested, a sample survey would be often found fully adequate..... When the National Sample Survey first started collecting information on unemployment in India the concepts and definitions adopted were broadly the same as those used in the western countries. It was, however, soon found that the western concept of unemployment was inadequate because millions of persons in India work on their own account in household enterprises. They may have to sit partly idle for lack of work; but they can neither gain nor lose paid jobs. It became necessary, therefore, to think not only of paid jobs, which one may get or lose but also of the amount of work one is doing, or the amount of money he is earning by such work. It was necessary to introduce the concept of “normal period of work” and “normal earnings”; and to collect information on the actual period of time during which the person is gainfully engaged in work and express this period” of time as a fraction of the normal period of work; or to ascertain the actual amount earned in a given period and express this amount as a fraction of normal earnings; and to use these fractions as measures of employment. Sometimes it is not possible to speak of the degree of employment or unemployment (even in terms of period of work or of earnings) of a single individual; and it is necessary to refer to the household enterprise as a whole. It is necessary continually to construct new concepts and definitions to suit the needs of underdeveloped countries. ##

Presidential Address: Third Pakistan Statistical Conference, Lahore, 1956 mentioned above, statistical developments in India have been heavily concentrated in the third sector in which the statistician is usually associated with experienced scientific workers who undertake

the responsibility for making the scientific observations or collecting the statistical data. For example, in meteorology a great deal of attention is given, as a routine measure, to the continuing calibration of meteorological instruments. In agricultural and biological experiments the scientific worker is much concerned with controls and the validity of the observational data. In consequence, at least in India, it has not been necessary for the statistician to give attention to the accuracy of the data and he has been free to use his analytic methods without much primary scrutiny. Because of the collaboration of other scientific workers who have undertaken the responsibility of producing reliable data, this arrangement has worked satisfactorily in the case of meteorological observations and controlled experiments in the laboratory or the field.

Lack of training and experience in cross-examining data has had however most unsatisfactory consequences in the field of economic and social statistics, and also in large-scale surveys where the data have to be collected by ordinary investigators without scientific training, who are usually scattered over large areas and over whom the statistician has little or practically no control. In official and administrative statistics the result has been the growth of a “ritualistic” attitude of mind (to borrow the phrase aptly used by Stuart A. Rice). Most of the official and administrative statistics which comes to Government of India is collected through agencies at the periphery over which the Central Government often have no direct control. The statistician who deals with the material in the Central Government usually has no knowledge about the methods of collection of the primary material or the agency or men employed for this purpose. He simply accepts the data as something given. He has no curiosity or desire to question the

accuracy (except in the very formal or trivial sense of reconciling misprints and discrepancies in totals or the results of similar arithmetic calculations). A senior statistician in Delhi told me, for example, that he did not know of a single instance in which the validity of a figure was ever challenged in his whole experience.

A second consequence has been the growth of a somewhat legal or formalistic attitude. A figure is received from State Government or other agency, and it is usually assumed that the Centre has no right (or in any case, it is not proper) to challenge its validity. It is something like the record of a first or original Court of Law, which has come up to a Court of Appeal where the evidence cannot be re-opened but arguments can be made only on points of law. (It is gratifying to note, however, that the present Census Commissioner is conducting, for the first time in India, a check on the census enumeration).

What is true of the Central Government is also generally true of the State Government because here also the statisticians usually deal with data, which come up to them from sources and agencies at the periphery. The



Smt. Indira Gandhi, Prime Minister of India, inaugurating the Delhi Campus (subsequently a centre) of ISI, in the presence of P.N. Haksar, Chairman of the ISI council, on 31 December 1974. Prof. B.S. Minhas was also present.

State statistician also deals with the material as something given. In this way a great deal of statistics is collected and sent up to the Central Government the reliability of which is not questioned or examined at any stage.

Because of this legalistic or ritualistic attitude towards primary data, statisticians themselves have sometimes tended to take a purely formal view of statistical work. The statistician puts up some statistical data for analysis, and finds that this is not to the liking of his immediate superior officer or somebody higher up in the hierarchy (possibly even the Minister himself) who desires to have some other kind of analysis or even data which in his intuitive judgment is more realistic. Usually (but, of course, not always,) the statistician feels that, as a good civil servant, it is his duty to change his analysis or even his data.

In sample surveys my greatest difficulty in India has been to make highly trained statisticians (with a great deal of knowledge of mathematical statistics) realize the importance of investigator bias and response error. All their attention is focussed on the sampling error. In fact, the general attitude is to look upon the non-sampling error as something, which does not concern the statistician, or in any case is a kind of dirty job, which a highbrow statistician need not bother about. This is why the use of inter-penetrating samples has been persistently opposed in India as sheer waste of money.

I have dealt at some length with this particular point because in my opinion the lack of interest and skill in cross-examining the primary data constitutes the biggest single source of weakness of Indian statistics at the present time, and makes a great deal of the work in social and economic statistics more or less formal and unreal.

Computational work: A certain amount of laboratory practice in computation work is included in many (but not all) statistical courses in India. Sufficient emphasis is, however, not always given. One of my greatest difficulties has been to persuade a young M.Sc. in statistics to take up himself any serious computational work. Statistical education (and training) in India is often somewhat formal so that the student tends to think that his real concern is with mathematical and algebraic symbols, and that computations and calculations can be done by clerks (who belong to an entirely lower order of beings). I have often quoted (but usually without much effect) R. A. Fisher's statement that he learnt all his statistics through computations. In India, this negative attitude towards computational work is also partly conditioned by the general resistance against manual work, which is considered to be derogatory to the dignity of educated or professional workers.

Organization of statistical processing: Even when the statistician has done a good deal of computational work in the practical class, he usually has no experience of the organization of processing of statistical work by computers. He has no knowledge of proper programming or of making even rough estimates of the time likely to be required to complete a job. In consequence, trained statisticians with high academic or research qualifications are often unable to cope with large scale processing work. My impression is that there is great deal of inefficiency and waste of money in such work in India.

Costing and budgeting: Because of the lack of knowledge about time requirements, the statistician is often unable to prepare realistic estimates of cost. I have seen even senior



A. Kosygin, first deputy chairman, USSR Council of Ministers, with Pandit Jawaharlal Nehru and P.C. Mahalanobis 1961

statisticians in India giving estimates of cost sometimes less than one-fourth or one-fifth of that actually required in practice or sometimes even four or five times higher. One serious consequence has been the lack of reality in the scrutiny of estimates of statistical projects by the Finance Ministry or Finance Departments of State Governments. Sometimes the budget is cut down in such a way as to seriously hamper the work. Sometimes much larger grants are sanctioned than are really necessary. Estimates are prepared in a more or less standard administrative pattern. For example, if there is one senior statistician it would automatically follow that he would have so many assistants, so many research workers, so many investigators, etc., irrespective of the nature of the work. This is quite natural as estimates tend to be judged by yardsticks, which have sole reference to work of a more or less routine type. Also, quite naturally, there is a tendency to put up much higher estimates than are considered really necessary on the view that the Finance Department would cut it down in any case by 50% or some such margin. This has led to a great deal of waste in

both men and money at least in the Government of India.

Preparation of statistical tables and statements: Like the preparation of questionnaires and forms, the preparation of tables and statements does not find any place in most teaching programmes, and in consequence tends to be looked upon as no concern of the highbrow mathematical statistician. Usually tables and statements in Government offices are prepared by junior clerks, and often hide those very aspects, which require to be brought out. And yet the tables and statements are the final end products on which depend to a large extent the impression created on the mind of the administrator. My experience has been that it takes a great deal of time and practice to acquire skill in the presentation of statistical data.

Preparation of statistical reports: The statistical report contains the final results of a long process of statistical work of various kinds. If the statistics are to be used in any way, such use must be based on the statistical report. It is necessary and desirable that a great deal of attention should be given to this part of the professional work. Unfortunately, usually this again has no place in the teaching programme. I have seen many statistical reports, which are lacking in organization of thought, logical order of presentation of facts and conclusions, and written in a slovenly style. When care is given to the writing of the report, the tendency sometimes is to make it a kind of imitation of a technical paper suitable for publication in a scientific journal. Technical terms and jargons are used in abundance, which simply annoy the administrator and create resistance. On the other hand, sometimes the reports are written in a highly polished administrative style, in which the entire attention is given to the form

and the surface phrasing without bringing out the significant statistical facts or conclusions. A third type of report, which, also is unfortunately too common, deals in a very elaborate and theoretical manner with small changes in say a statistical series which may be entirely due to chance fluctuations or simply to the unreliability of the primary material. Economists without professional training in statistical are often inclined to handle the statistical material in this superficial way which has created a good deal of unfavorable impression in administrative circles.

I have drawn attention to eight handicrafts of statistics which are much neglected in teaching programmes in India. Basic training in these subjects should be given to all students who intend to take up statistics as a professional career. These statistical crafts are of particular importance for work in official and administrative statistics. Professional workers desiring to enter these sectors should, in my opinion, have a great deal of advanced training and practice (besides the basic course) in these subjects.

Basic training in these subjects would improve the quality of work of statisticians engaged in the application of mathematical statistics in science and technology. Such training should also be obligatory for those who wish to take up statistical education and research as their profession. I am prepared to agree, however, that such training is not necessary for a person capable of doing "intuitive" work at the highest level. If, for example, a Ramanujan is discovered in the field of mathematical statistics he may be given full freedom to work in his own way.

Much thought has been given during the last 4 or 5 years in many countries of the world

RESEARCH AND TRAINING

"..... We are now trying to provide professional training in the Indian Statistical Institute, the Central Statistical Organization or within the National Sample Survey and other agencies. Here also I feel it my duty to throw out a warning. There is a tendency in certain quarters in India (and in other countries also) to try to make out as if "mathematical statistics" is a subject by itself without any reference to any applications to scientific research or practical problems. I must confess I do not understand this position. To me statistics must always have a purpose which may be, of course, to help in drawing valid conclusions from scientific observations for purely theoretical researches (for example, the distribution of galaxies of stars or other problems in astrophysics); or, to help in selecting best varieties for agricultural production; or, to help in industrial or economic development. There is plenty of scope for mathematical researches in connection with statistical problems. I should like to give all possible encouragement to really able mathematicians to enter the field of statistics. But I should still hold that statistics is not a branch of mathematics but a field for the application of mathematics. Pure mathematics has its own justification independently of applications. But immediately one thinks of applications there must be a reference to some purpose that is, to some contingent problem required to be solved. One must then work on contingent relations, which are capable of being observed or measured and on the basis of which it would be possible either to draw valid inferences in scientific matters, or to take decisions in practical problems....." ##

Presidential Address: Third Pakistan Statistical Conference Lahore, 1956

to the basic educational course dealing with the general theory and practice of statistical methods. A good deal of this basic course can be conveniently and profitably integrated with general education. I have discussed in a separate paper (recently prepared for a UNESCO publication) the possibility of introducing mathematical statistics as a subject of study in secondary schools.

At a higher level, that is, at the stage of bachelor's or the master's degree it should be possible of course to cover a good deal of the more general part of the formal and mathematical theory together with a broad general knowledge of statistical methods and applications. General educational courses in statistics thus, in my opinion, can be conveniently given (in secondary schools in the first instance, and then) in the universities.

Professional training in statistics, however, requires a different type of institution. The position is somewhat analogous to medical science. Training in some of the basic subjects such as physics, chemistry, botany, zoology, physiology, etc. can be given in the universities. Professional training in medical subjects, however, requires specialized institutions working in close connection with clinical hospitals and surgeries. In the same way professional training in statistics can be given in an adequate manner only in close touch with statistical projects. The skills and craftsmanship, which I have described in this paper, for example, can be more conveniently acquired in statistical workshops rather than in university classrooms.

But professional training is not confined merely to the acquiring of statistical craftsmanship but must go much further. I have no time to discuss this point at length. In the ultimate analysis professional competence is determined by the ability

(a) to judge when the solution of a particular problem or the making of an administrative decision requires the help of statistical information;

- (b) to analyze, integrate and make a critical appreciation of relevant information if already available; and
- (c) when such information is not available, to prepare a project for the collection of the required information and their subsequent analysis and integration; also
- (d) when a certain policy or action programme has been decided to develop statistical controls for the assessment of the progress of implementation; and
- (e) to recommend changes in the policy or action programmes in the light of experience based on statistical information of the required degree of validity and precision.

These are the higher skills or techniques, which a statistician must acquire in order to do fruitful work in statistics. Training and experience in professional work at this level can only be given in a specialized institution where such work is being actually done.



P.C. Mahalanobis with J.K. Galbraith, U.S. Ambassador to India, and L.B. Johnson, then Vice President of the USA in New Delhi, May 20, 1961.

STATISTICS: A NEW TECHNOLOGY OF MODERN AGE²

by Sir Ronald A. Fisher
Fellow of Royal Society, London

It is now just about 25 years, since I first had the pleasure and privilege of meeting in India both Professor Mahalanobis and the very able group of friends and students whom he had gathered to form the Indian Statistical Institute. I had, indeed, before that known something of Mahalanobis' work, for I was much concerned to view, if necessary only from a distance, the movements or thought in different parts of the world associated with the rapid development of statistical understanding in my own country; and I had recognised the appearance in the East of a new movement which was putting India not far from the centre of the statistical map.

A movement comparable in importance, for example, with that of *Yates* in the extension and elaboration of Experimental Design, or of that which under the impulse of *Walter Shewhart* was soon to storm through the United States under the banner of Quality Control. I need hardly say that I refer to the emergence of a statistically competent technique of Sample Survey, with which I believe Professor Mahalanobis' name will always be associated.

What at first most strongly attracted my admiration was that the Professor's work was not imitative. That is a fault which has been ascribed to Indians, but as every statistician knows nations are composed of very many,

and very different individuals. They do not share the same list of faults, and, at the present time you have only to look at any bunch of newly published books, on statistics for example, to see that this fault is by no means a monopoly of any one people. Imitative books are as common as dirt; and work of striking originality is as rare now, as it was when I first read of the surveys of the jute crop of Bengal in which the Professor was trying out his new ideas.

"Imitative books
are as common
as dirt"

During the inter-war period and indeed before, there had been some discussions at the International Statistical Institute on sampling for the ascertainment of demographic and economic data. The conditions imagined were very different from those of practical work in India, and indeed the theoretical principles also had been very imperfectly appreciated. Even so elementary a requirement as randomization was at first ignored. What was striking therefore in the Indian contribution to the problems of Sample Survey, was that it combined a clear realization of statistical principles with a down-to-earth experience of the practical difficulties, in a country in which education was, on the whole, backward, of getting such work done, on a

"..the accuracy of
sample surveys when
competently organised,
have now been put
beyond question"

²Lecture delivered at the 1st Convocation of Indian Statistical Institute in February, 1962.

large scale, and yet with the primary scientific requirement of ascertainable and demonstrable precision. From that point the standard set has never gone back, and publicly organised censuses and surveys in all parts of the world look to the Indian Sample Survey as a basis for comparison. Difficulties of course there are, in India, and also elsewhere, but the speed and economy, as well as the accuracy of sample surveys when competently organised, have now been put beyond question.

The needs of India, which are always, I fancy at the heart of the Professor's thinking, show themselves again in the utilisation of those aptitudes in which Indians have shown themselves to be especially gifted. From time to time as new editions of Statistical Tables are required, I go over those contributions of sufficient importance to be noticed in the preface, especially to combinatorial problems arising from Yate's work on experimental design and his invention of balanced incomplete blocks. Mathematicians of many nations have contributed to our knowledge of this very intriguing field, but I do not think I exaggerate if I say that the Indian names are as numerous as all others together, and this must particularly be ascribed to the fact that early in the Institute's history several of the young mathematicians brought into intellectual contact by the Institute's activity, found in this subject a type of problem ideally suited to their gifts. Again the important work in multi-factorial analysis

"..teaching, instruction or training in statistics is bound to gravitate to an exhibitionism unless it is linked as intimately as may be...with fact-finding projects in the traditional statistical fields of demography and economics"

"Literary men and journalists have often shown their aptitude for getting hold of the wrong end of the stick"

in which I have been glad to see extensions and amplifications of my own early work, has been chiefly, if not wholly taken up by past and present members of the Institute such as *Bose* and *Roy* in North Carolina, and especially by *Rao* here in Calcutta.

Every time I see the Institute it is bigger and I hope better. On this visit I am sure I have not seen it all. It certainly shows no sign of narrowness or standardization. New facets are

always appearing—a paleontological museum or a garden of Indian cultivated plants. I take these bold excursions to mean that the Director believes, as I most certainly do myself, that teaching, instruction or training in statistics, at whatever level is bound to gravitate to an

exhibitionism in useless mathematics, unless it is linked as intimately as may be, on the one side with fact-finding projects in the traditional statistical fields of demography and economics, and on the other side with opportunities to gain first-hand familiarity with at least some field in the natural sciences. Moreover, the science with which the student

is to become acquainted must be genuine research in its own right, not what is eloquently called a "mock-up" for the use of students only.

Visitors are often surprised when they learn that Miss Robinson and her colleagues are actually digging up some of the early inhabitants of India, and writing a new chapter in Indian mesozoic history. They ask what has that to do with statistics. That sort of question

reveals well how comparatively narrow and trivial a subject statistics was in the nineteenth century. It has *grown* since then, almost explosively; and it is certainly proper, some would say it is a prime requirement, if the Statistical Institute also widens its range of interests. The answer to the question, therefore, of what the sciences have to do with statistics lies in the part they must play in the education of any competent statistician. And that the Institute's future stands or falls by the *quality* of the education it offers.

The implementation of this broad educational policy seems to me extremely difficult. For its educational programme the Institute needs not only leaders in mathematical thought like Professor Rao, who can uphold and maintain the high place in world opinion that Indians have already won, but they need also that patient and obstinate class of scientific workers, who alone can transmit the feel and know-how of the natural sciences. There is very little of the aggressive and self-advertising about such men: though they may be among the most gifted of teachers, for whom even the best text books are no

substitute at all. I do not suggest that they are easy to find, only that, here as elsewhere, they are fitted to play the most important part in scientific, technological and technical education.

These, may I insist, *are not castes*. Though literary men and journalists have often shown their aptitude for getting hold of the wrong end of the stick, by suggesting that technologists in particular are less than highly educated. Nothing could be further from the truth. Scientist, indeed may, at their own risk, narrow their interests in order to gain special proficiency in one line. Technicians also may develop by ample practice very special aptitudes. The technologist must talk the language both of the scientist and of the technician. His education must be broader than theirs, though at points less intensive. He has to see both sides of the fence, and is the channel through which alone the skills of the others can be made effective. It is, I believe, in recognising Statistics as the key technology of our century, that we appreciate the special features of the Indian Statistical Institute.



R.A. Fisher and Prasanta Chandraa signing the register on the occasion of the award of medals in the city hall of Paris in September 1961

FISHER AND MAHALANOBIS: TWO PERSONALITIES OF GREAT RESEMBLANCE

	R. A. Fisher	P. C. Mahalanobis
<i>Born on</i>	Feb.17,1890	July 29, 1893
<i>Died on</i> <i>(71 years)</i>	July 28, 1962 <i>(79 years)</i>	June 28, 1972
<i>Father's profession</i>	Business	Business
<i>Studies</i> <i>Math-Physics</i>	Cambridge, 1909-1913 Physics	Cambridge, 1913-1915
<i>Influence and</i> <i>motivation</i> <i>Karl Peat1lon</i>	<i>Mathematical Theory</i> <i>of Evolution</i> by Karl Pearson	<i>Biometrika</i> journal edited by
<i>First publication</i>	1912	1922
<i>Editor</i>	<i>Annals of Eugenics</i>	<i>Sankhya</i>
<i>Active in statistics</i>	50 years	50 years
<i>Contributions</i> <i>in scientific research</i> <i>(inductive inference)</i>	*Statistics as a method in increasing efficiency of all human efforts	*Statistics as a tool
<i>*Experimentation for</i> <i>comparative studies</i>	*Sample surveys for fact finding	

STATISTICS: SCIENCE, TECHNOLOGY, OR ART³

As I have already said, statistics in the original etymological sense is the science of statecraft, which represents the activity of collection and compilation of data and their use in policy making. The applications were mainly confined to economic data.

During the nineteenth century, statistics, which meant data, began to acquire a new meaning as interpretation of data or drawing conclusions from data irrespective of their source. How do we conclude whether certain experimental data support or contradict a given theory? How can we make forecasts of socio-economic characteristics of a population based on current trends? Will it rain tomorrow? What is the uncertainty in our conclusions? Questions of this kind began to be raised. But it is only in the beginning of the 20th century satisfactory answers could be found using the concepts of probability, actuarial science and theory of errors, which began to be studied earlier more or less independently. Statistics developed as a methodology for extracting information from data and expressing the amount of uncertainty in decisions we make.

Is statistics, as studied and practiced today, a science, technology or art? Perhaps it is a combination of all these.

It is a science in the sense that it has an identity of its own with a large repertoire of techniques derived from some basic principles. These techniques cannot be used in a routine way; the user must acquire the necessary expertise to choose the right technique in a given situation and make modifications, if

necessary. Statistics plays a major role in establishing empirical laws in soft sciences. Further, there are philosophical issues connected with the foundations of statistics – the way uncertainty can be quantified and expressed - which can be discussed independently of any subject matter. Thus in a broader sense statistics is a separate discipline, perhaps a discipline of all disciplines.

It is a technology in the sense that statistical methodology can be built into any operating system to maintain a desired level and stability of performance, as in quality control programs in industrial production. Statistical methods can also be used to control, reduce and make allowance for uncertainty and thereby maximize the efficiency of individual and institutional efforts.

Statistics is also an art, because its methodology which depends on inductive reasoning is not fully codified or free from controversies. Different statisticians may come to different conclusions working with the same data. There is usually more information in given data than what can be extracted by available statistical tools. Making figures tell their own story depends on the skill and experience of a statistician, which makes statistics an art, as in the example of the Red Fort Story⁴.

What is the future of statistics? Statistics is now evolving as a metascience. Its object is the logic and methodology of the other sciences- the logic of decision making and the logic of experimenting in them. The future of

³ Extract from "Statistics and Truth" by C. R. Rao, 1989

⁴ The story with the title 'Salt in Statistics' is also included in this Brochure

statistics is in communication of statisticians with research workers in other branches of learning; it will depend on the way the principal problems are formulated in other fields of knowledge.

On the logical side, the methodology of statistics is likely to be broadened for using expert evidence in addition to information supplied by data in assessment of uncertainty.

Having said that statistics is science, technology as well as an art-the newly discovered logic for dealing with uncertainty and making wise decisions-I must point out a possible danger to its future development. I have said earlier that statistical predictions could be wrong, but there is much to be gained by relying on statistically predicted values rather than depending on hunches or superstitious beliefs. Can the customer for whom you are making the prediction sue you if wrong? There have been some recent court cases. I quote from the editorials of The Pittsburgh Press.

Saturday, May, 1986

Forecasters Breathe Easier

A federal appeals court has wisely corrected a gross miscalculation of government liability in a case involving weather forecasting.

Last August, a U.S. District judge awarded \$ 1.25 million to the families of three lobster-men who were drowned during a storm that had not been predicted. The judge said the government was liable because it had failed to repair promptly a wind sensor on a bouy used to help forecast weather conditions off Cape Cod.

The award was overturned the other day by the appeals court on grounds that weather forecasting is a "discretionary" function of government and not a reliable one at that.

"Weather predictions fail on frequent occasions" the appeals court said. "If in only proportion parties suffering in consequence succeeded in producing as expert who could persuade a judge.....that the government should have done better, "The burden on the government" would be both unlimited and intolerable".

The case isn't over yet, since it probably will be appealed to the Supreme Court. But government meteorologists practicing their inexact science are breathing a bit easier.

"...Statisticians working in the Government and in Industry are often faced with language barriers with their bosses. The chief of a statistical office, an officer in administrative service, was meeting a group of statisticians who complained that in a report received from another organization some estimates were given without the standard errors. The chief was reported to have immediately remarked, 'Are there standards for errors too?'

A report submitted to a Tea Board by a consulting statistician contained a table with the caption: Estimated number of people taking tea with standard error, economic status. Soon a letter was sent to the statistician asking what kind of snack standard error was, which people take with tea."

SALT IN STATISTICS⁵

“.....and, what is still more extraordinary, I have met with a philosophical work in which the utility of salt has been made the theme of an eloquent discourse, and many other like things have had a similar honour bestowed on them.”

Pheadrus (Plato's Symposium on Love)
There were communal riots in Delhi in 1947 immediately after India achieved independence. Large number of people of a minority community took refuge in the Red Fort which is a protected area, and a small number in the Humayun Tomb, another area enclosing an ancient monument. The Government had the responsibility to feed these refugees. This task was entrusted to contractors, and in the absence of any knowledge about the number of refugees, the government was forced to accept and pay the amounts quoted by the contractors for different commodities purchased by them to feed the refugees. The government expenditure on this account seemed to be extremely high and it was suggested that statisticians (who count) may be asked to find the number of refugees inside the Red Fort.

The problem appeared to be difficult under the troubled conditions prevailing at that time. A further complication arose as the statistical experts called in to do the job belonged to the majority community (different from that of the refugees) and their safety could not be guaranteed if the statistical techniques to be applied by them for estimating the number of refugees required their getting inside the Red Fort. Then the problem before the experts was to estimate the number of persons inside a given area without any prior information about the order of magnitude of the number, without

having any opportunity to look at the concentrations of persons inside the area and without using any known sampling techniques for estimation or census methods.

The experts had to think of some way of solving the problem. Giving up might be interpreted by the government as failure of statistics and/or of the statisticians. They had, however, access to the bills submitted by the contractors to the government, which gave the quantities of various commodities such as rice, pulses and salt purchased by them to feed the refugees. They argued as follows.

Let R , P and S represent the quantities of rice, pulses and salt used per day to feed all the refugees. From consumption surveys, the per capita requirements of these commodities are known, say, r , p and s respectively. Then R/r , P/p and S/s must provide parallel (equally valid) estimates of the same number of persons. When these ratios were computed using the values R , P and S quoted by the contractors it was found that S/s had the smallest value and R/r the largest value indicating that the quantity of rice, which is the most expensive commodity compared to salt, was probably exaggerated. (The price of salt was extremely low in India at that time and it would not pay to exaggerate the amount of salt). The estimate S/s was proposed by the statisticians for the number of refugees in the Red Fort. The proposed method was verified to provide a good approximation to

⁵ Extract from “Statistics and Truth” by C. R. Rao, 1989

the number of refugees in the Humayun tomb (the smaller of the two camps with only a relatively small number of refugees), which was independently ascertained.

The salt method arose out of an idea suggested by the late J.M. Sengupta who was associated with the Indian Statistical Institute for a long time. The estimate provided by the statisticians was useful to the government in

taking administrative decisions. It also enhanced the prestige of statistics which received good government support ever since, for the development in India.

The method used is unconventional and ingenious, not to be found in any text book. The idea behind it is statistical reasoning or quantitative thinking. Perhaps, it also involves an element of art.



United Nations Statistical Commission, New York, 16 April-3 May, 1956, with P.C. Mahalanobis in the chair

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Words of Inspiration

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PM'S INAUGURAL ADDRESS AT 'STATISTICS DAY' CELEBRATION JUNE 29, 2007 NEW DELHI

"I am delighted that we are commemorating the birth anniversary of Late Professor Prasanta Chandra Mahalanobis as Statistics Day in India. This is a tribute to his enduring, pioneering and multifaceted contributions to the discipline of statistics. He was a world leader in the discipline. Along with Professor R.A. Fisher, Professor Mahalanobis is rightly credited for giving a distinct status to statistics as an independent scientific discipline and placing it among the world of modern sciences.

Professor Mahalanobis was not merely a great academician. He never accepted statistics as a purely academic discipline meant only for formal teaching and research. He conceived it as an essential and integral tool for guiding social and economic development. To put it in his own words:

"If the problem is one of theoretical nature, statistics supplies a valid method for drawing general conclusions from particular experience. If the problem is a practical one, statistics supplies the basis for choosing a particular course of action (in preference to other possible courses) by balancing the risks of gain and loss."

Prof. Mahalanobis believed that it was important to develop innovative statistical techniques appropriate to each social and economic sphere. In doing so he emphasized the universal applicability of tools of statistics in all major scientific disciplines. His pioneering contributions encompassed a wide range of areas of practical application. These included anthropology, educational testing and statistical quality control, on the one hand, and agriculture, flood control and meteorology on the other. There is indeed, practically no

aspect of human endeavour in this country that his genius did not touch, directly or through the people he inspired.

Professor Mahalanobis was also a great institution builder. By founding the Indian Statistical Institute in 1931, and starting the world famous journal 'Sankhya' in 1933, he provided an institutional umbrella for catalyzing the spread of teaching and research in statistics. India today can proudly boast of having a distinct Indian School of Statistics – an achievement that few other scientific disciplines enjoy in our country. Certainly individual scientists have made path-breaking contributions in other disciplines, but in none have they created a special niche for India within the international order, as ISI has done in the field of statistics.

Professor Mahalanobis's recognition of the importance of institutional structures and his all-encompassing vision of statistics were also responsible for the active interest he took in developing the official statistical system in our country. He was appointed Honorary Statistical Adviser to the Union Cabinet in 1949 and was the Chairman of the first National Income Committee in 1950. He conceptualized and brought into existence, the two major pillars of the official statistical system in our country today, namely, the Central Statistical Organisation (CSO) for systematization and collection of administrative data and the National Sample Survey Organisation (NSSO) for conducting large scale sample surveys as a guide to policy planning. Indeed, the NSSO had its origin in the Indian Statistical Institute and became a part of the official statistical system only much later.

Prof. Mahalanobis also recognised that the decentralized statistical system in India and the federal principles of our polity require effective systems of coordination for the collection of statistics in such a large country. He, therefore, organized the Inter-Ministerial Standing Committee in the Cabinet Secretariat and the biennial Conference of Central and State Statistical Organisations, which provided sound institutional mechanisms for horizontal and vertical coordination of statistical activities in our country. At the international level, he contributed to the establishment of the United Nations Statistical Commission.

We celebrate Statistics Day today not only to honour the memory of this great man, but also to give due recognition to the fact that statistics affects and influences all major decisions we take, big or small in public life. Often in ways we may not even realize. As we progress in our path of development towards becoming a knowledge economy, and as we integrate with the international economic order, the role of statistics will become progressively more important. In such a situation, the hallmark of a country's reputation will be the credibility and transparency of its statistical system and the statistical data emulating from that system.

We are indeed fortunate that over the years we have been able to maintain the high standards of integrity in our official statistics. However, in such matters perceptions are as important as the reality. It is for this reason that our government took a major step last year by bringing into existence the National Statistical Commission, which is an independent body of professionals, for guiding the official statistical system. I am very happy that my esteemed friend, Professor Tendulkar is the Chairman of this highly prestigious national institution.

Its arms length relationship with the

Government should give our official statistics enhanced international credibility and transparency. It should also help improve the level of confidence that people and organizations have in the confidentiality of the data that they provide, thereby improving both the completeness and the accuracy of the data so collected.

Of the wide-ranging mandate that we have given to the National Statistical Commission, two are of particular importance. The first is to evolve and lay down national quality standards in different fields of statistics; and the second is to exercise statistical coordination between central Ministries, Departments as well as State Governments. I appeal to all concerned to extend fullest possible cooperation to the National Statistical Commission and to actively seek its assistance in improving our statistical data bases.

Official statistics, of course, is only one part of the wide variety of data that is required by a modern dynamic economy. This Statistics Day is also meant to recognize the contribution of many statisticians who work in various academic institutions, private enterprises, non profit organizations and other institutions dealing with quality control.

They all provide essential information required for optimal decision making in diverse fields. We should all be proud of our collective heritage in the field of statistics and resolve to take our country to the pinnacle of this very important discipline. I am certain that our young statisticians will continue to lead the world in theoretical and applied statistics, and bring a further sense of pride and accomplishment to our Nation. That will be a befitting tribute to the memory of Prof. P.C. Mahalanobis. I therefore feel a great sense of pride to honour Professor Mahalanobis by naming his birthday as 'Statistics Day'.

Thank you."

STATISTICAL SYSTEM OF INDIA: SOME REFLECTIONS

Rakesh Mohan*

I am delighted and honoured to be at this auspicious occasion of the first Statistics Day and to inaugurate first Annual Conference on Financial Statistics. As a member of the statistics community, it is matter of great pride that June 29, birth anniversary of (late) Professor Prasanta Chandra Mahalanobis, has been declared by the Government of India as Statistics Day. I am particularly happy that Professor Parikh is here who began his professional life in the ISI Statistical Unit in the Planning Commission and had a great deal of interaction with Professor Mahalanobis.

Statistics in simple terms is defined as the study of the 'laws of chance'. On this Statistics Day, let me however not take a chance to talk about field statistics. In the preface to his book on "Statistics and Truth", C.R.Rao (1989) writes, which I thought is worth quoting at length,

"Statistics as a method of learning from experience and decision making under uncertainty must have been practiced from the beginning of mankind. But the inductive reasoning involved in these processes have never been codified due to the uncertain nature of the conclusions drawn from given data on formation. The breakthrough occurred only in the beginning of the present century with the realization that inductive reasoning can be made precise by specifying the amount of uncertainty involved in the conclusions drawn. This paved the way for working out an optimum course of action involving minimum risk, in

any given uncertain situation, by a purely deductive process. Once this mechanism was made available, the floodgates opened and there was no end to the number of applications impatiently awaiting for methods which could really deliver the goods. From the time of Aristotle to the middle of the 19th century, chance was considered by scientists as well as philosophers to be an indication of our ignorance which makes predictions impossible. It is now regarded that chance is inherent in all natural phenomena, and the only way of understanding nature and making predictions (with minimum loss) is to study the laws (or the inner structure) of chance and formulate appropriate rules of action. Chance may appear as an obstructor and an irritant in our daily life but chance can also create. We have now learnt to put chance to work for the benefit of mankind. All knowledge is, in the final analysis, history. All sciences are, in the abstract, mathematics and all methods of acquiring knowledge are essentially statistics."

What has been the historical development of the statistical system in India? Who have been its main architects? What has been the role of the Reserve Bank in the national statistical system? I thought these questions will be of interest to the audience assembled here today.

Historical developments

Let me go back in history. India has a long historical tradition of collection and use of

*Inaugural address by Deputy Governor, Reserve Bank of India on the Statistics Day and Annual Conference on Financial Statistics, on June 29, 2007 at Department of Statistical Analysis and Computer Services, Reserve Bank of India, Mumbai. Assistance of A K Ray and Abhiman Das in preparing the speech is gratefully acknowledged.



Rajendra Prasad, President of India, speaking at the inauguration ceremony of the International Statistical Conference, Rastrapati Bhavan, New Delhi, 5 December, 1951, in presence of P.C. Mahalaobis

various kinds of statistics. Kautilya's Arthashastra (321-296B.C.), one of the greatest treatise of economics, indicates a system of census and data collection relating to agriculture, population and other economic activities, covering villages and towns. In addition, the concept of crosschecking and validation by independent agents was very much part of the data collection system. Thus, early evidence established the coexistence of economics and statistics, and their application for the welfare of the states. Subsequent historical anecdotes based on Huen Tsang's writings (dated late seventh to early eighth century) give a detailed description of the plan of cities, construction of houses, and an account of common products of India and data on the area of kingdoms and the distances between them. During the *Moghul* period, evidence and application of statistical knowledge was prominent in *Ain-i-Akbari* by Abul Fazal. Documentary evidence includes the system of legalised measurements, land classification and crop yields by season, etc. The system of land tenure and land revenue, followed during the *Moghul* period, had enough empirical basis.

The statistical system was strengthened during the British period. During this period, the statistical development was geared

towards administration, tax collection, revenue, trade and commerce and related activities as might be expected. With a view to rationalize and establish a sound system of revenue collection, the East India Company in 1807 emphasized the need of a statistical survey of the country. A small department of statistics was founded in the India House in 1847. In 1848, the first census relating to the area and revenue of each in North-West Provinces was released. In 1853, the department released the first series of statistical papers on India. Impressed by the trend in statistical activities, the Secretary of State ordered the Governor-General in Council to prepare a 'comprehensive and coordinated scheme of statistical survey' for each of the twelve great provinces of the then British India and Dr. W.W. Hunter was appointed as Director-General of Statistics in India in 1869, who can perhaps be regarded as the original precursor to the Chief Statistician of India today. The Statistical Account of Bengal (the present Bangladesh, West Bengal, Bihar and Orissa) was published in 20 volumes. For each district there were details on topographical data, ethnic divisions and creeds, agricultural situation, commerce, working of district administration and finally the sanitary and health aspects. Although censuses of Calcutta were undertaken in the year 1822 and in 1847, the operation of a decennial census for the whole country started in 1881 and is continuing ever since. The report on the Census of British India taken in 1881 was published in three volumes.

The need for timely and accurate collection of agricultural data was felt by the Indian Famine Commission and agricultural departments were organised in various provinces which resulted in the publication of 'Agricultural Statistics of British India' in

1886. To scrutinise and summarise the data collected by the agricultural departments, a statistical Bureau was formed at the centre in 1895 to coordinate the agricultural, foreign trade, prices, wages and industrial statistics. During 1905, a separate body Directorate General of Commercial Intelligence and Statistics (DGCI & S) was constituted to collect/publish commercial and trade statistics and to help trade and business. The first issue of Indian Trade Journal was released in 1906 and first price statistics based on a survey was released in 1910. The Economic Enquiry Committee set up in 1925 under the Chairmanship of Dr. Visweswarayya and more importantly the Bowley- Robertson Committee set up later in 1934, were mainly responsible for the government's decision to set up an Inter-Departmental Committee with the Economic Adviser to the Government of India as the chairman. The Inter-Departmental Committee recommended the formation of a Central Statistical Office for coordination, institution of a statistical cadre, establishment of State Bureaus at State Head Quarters and maintenance of important statistics for the entire country.

Architect of Modern Statistical Methods in the Indian Subcontinent

The developments in statistics that took place between 1930 and 1960 are quite remarkable and in some sense unique. No other discipline in India recorded such growth and development during the same period in India. There were several important ingredients. In statistics, unlike other disciplines, India was not a late starter. Indeed, much of the development even in the United States came later. Only Britain had started earlier. This helped creation of an Indian school of statistics with its own mix of theory and applications. The architect of modern statistical



Professor P.C. Mahalanobis in a field visit in Giridih Branch, in 1953

methods in the Indian subcontinent was undoubtedly Professor Prasanta Chandra Mahalanobis. He was helped by a very distinguished group of scientists that included R.C. Bose, S.N. Roy C.R. Rao, S.S. Bose, K.R. Nair, D.B. Lahiri and many others. There were others like P.V. Sukhatme, and V.G. Panse who worked independently of Mahalanobis. The history of statistics is basically a history of some of these persons as well as a history of institutions and interactions between persons and institutions. The institute around which all these development took place is none other than the Indian Statistical Institute (ISI), Calcutta. Looking back at the history, one observed that 1950s was inarguably the golden period of ISI. Besides, Prof. Mahalanobis and C. R. Rao, the faculty of ISI included R.R. Bahadur, D. Basu, G. Kallianpur, D.B. Lahiri, M. Mukherjee, R. Mukherjee and many other distinguished luminaries. Some of them studied abroad and subsequently joined ISI as a faculty. D. Basu joined the ISI as a student and later became a Professor as well as the first Dean of Studies. D. B. Lahiri was a self-taught mathematician, contributed significantly on sample survey methods. Between them Rao, Bahadur, Basu and Kallianpur and a new group of brilliant students including K.R. Parthasarathy, R. Ranga Rao, V.S. Varadarajan, S.R.S. Varadhan made fundamental

contributions to probability and classical inference during this period which were as important as the earlier contributions of Bose and Roy to design of experiments and multivariate analysis. Among the other earlier students of the Institute who achieved international reputation are G.P. Patil, T.N.Srinivasan, R.G. Laha, J. Roy, Sujit Kumar Mitra, D.K. Roy Choudhury, and others. I may also mention that S.R.S. Varadhan, currently a professor of mathematics at New York University and only Indian ever, won the prestigious Abel prize (which is perhaps equivalent to a Nobel Prize) in mathematics this year.

Professor P. C. Mahalanobis and Statistics

As the Statistics Day is being celebrated in honour of the birth anniversary of (late) Professor Prasanta Chandra Mahalanobis, I thought a brief sketch of his life will be appropriate at this juncture. Born on June 29 1893 in a well-to-do progressive Brahmo family, he passed away on June 28, 1972. He graduated in physics from Presidency College, Kolkata and went on to study in Cambridge in 1913 and in 1915 finished his Tripos in

Natural Science with a first class. His first encounter with Statistics was also a chance-event, when his tutor Macaulay drew his attention to some bound volumes of *Biometrika*. He got so interested that he bought a complete set of *Biometrika* volumes towards his journey back to India. Mahalanobis set up the Statistical Laboratory in the Presidency College sometime in the 1920s. His contribution to statistics is enormous. During the 1920s and until the mid-1930s, all or nearly all the statistical work done in India, was done single-handedly by Mahalanobis. The early statistical studies included analyses of data on stature of Anglo-Indians, meteorological data, rainfall data, data on soil conditions, etc. Some of the findings of these early studies were of great impact in the control of floods, development of agriculture, etc., and led to the recognition of Statistics as a key discipline. His passion and conviction was truly guided for the solutions of applied problems. His further work on anthropological data resulted in new methodology for classifying or distinguishing populations characterized by such measurements called Mahalanobis D-square.¹ Another very important initiative undertaken by Professor Mahalanobis was the initiation of Crop Cutting Surveys to estimate agricultural production in India, which was a novel idea of that time. These surveys have continued till today and continue to be important in the estimation of agricultural production. The Indian Statistical Institute was founded in a small room in the Presidency College as a society on 17 December, 1931. *Sankhya*, the Indian Journal of Statistics, was founded two years later. Mahalanobis' influence was so ubiquitous that even students of Physics began to take interest in statistics. Later, several talented young scholars joined



P.C. Mahalanobis with Professor Haris and Meghnad Saha at Amrapali, in ISI, in 1953

¹ He submitted the paper in *Biometrika* for publication. Pearson had expressed reservations about Mahalanobis D-square and thus did not publish it. However, Mahalanobis published it in other place.

to form an active group of statisticians. Mahalanobis continued to be the nucleus. Theoretical research in Statistics began to flourish in all the areas of statistics including design of experiments, statistical quality control, operations research, etc. Research on large scale sample surveys won Mahalanobis a Fellowship of the Royal Society. Design and analysis of agricultural experiments also bloomed and led to some international contacts, notably with Sir Ronald A. Fisher. At the request of the Government of India, a draft



Pandit Jawaharlal Nehru, Prime Minister of India, inaugurating studies on national planning at I.S.I., Calcutta, on 3 November 1954

of the second Five Year Plan was prepared at the Indian Statistical Institute in 1954 by Mahalanobis. The second plan pattern of industrial investment, with its marked shift in favour of capital good industries, was deeply influenced by the two-sector growth model developed by Mahalanobis. The substantial contributions of the Institute to theoretical and applied work, its training and promotional activities culminated in recognition by the Government of India. The Parliament passed the Indian Statistical Institute Act, 1959 which declared the Institute as an "Institution of National Importance" and empowered it to

award degrees and diplomas in Statistics. The first computer of the country was installed in ISI in 1960. Subsequently, ISI made significant contributions to the development of advanced numerical algorithms.² Mahalanobis' mastery over empirics was exemplary as illustrated in using the method of fractal graphical analysis of consumption data, which was published in *Econometrica* (1960).³ It is also understood that the concept of interpenetrative sub-sampling and pilot survey, pioneered by Mahalanobis, essentially form the basis of sequential analysis and modern bootstrap methods.

Evolution of the Statistical System after Independence

After independence in 1947, the country saw an urgent need for a statistical framework suitable for economic and social development. Mahalanobis was appointed as an Honorary Statistical Adviser in 1949 to the Government of India and Central Statistical Unit was setup under his technical guidance which was later named as Central Statistical Organization (CSO) in 1951. This organization was setup mainly to coordinate the statistical work done in various ministries and other government agencies and to advise them, to maintain standards with regard to definitions, concepts and procedures, to provide consultancy, to liaison with international statistical organizations, to prepare and publish a Monthly Statistical abstract and an Annual Statistical Abstract and to inform annual statistical information to public. In India, prior to 1947, the estimation of national income was attempted by individual economists and scholars for specific years. Among these, the most systematic work was that of V.K.R.V. Rao in his book *National Income in British India 1931-*

² It is also believed that the seed of computer and IT revolution in India was germinated in ISI.

³ The editor of *Econometrica* published a shorter version of this paper what reportedly Mahalanobis did not like. As a result, he again published the full version of the paper in *Sankhya*.

32 (London; MacMillan 1940), which formed the basis of national income estimation in the post-independence period. In 1949, the Government of India formed the National Income Committee (NIC) under the Chairmanship of P.C. Mahalanobis, with V.K.R.V. Rao and D.R. Gadgil as members. From then onwards the national income estimation has been steadily strengthened. NIC recommended the holding of an annual conference on national income and wealth. The First Indian Conference on Research in National Income was organised by the Central Statistical Organisation (CSO) in early 1957. In 1964, this conference was converted into the Indian Association for Research in National Income and Wealth (IARNIW). Dr. V.K.R.V. Rao was the first President of IARNIW. He is credited with the building of IARNIW as an independent research body under the aegis of the Central Statistical Organization. In order to improve the quality and fill up the gaps in statistical information, it was decided to establish a National Sample Survey Organisation (NSSO). This organization had four divisions: Survey design and research, Field operations, Data processing, and Economic Analysis. The national sample survey (NSS) is the largest multi-purpose socio-economic survey.

The coverage and scope of data collection and dissemination of CSO has increased manifold in recent times. Its current activities include National Income Accounting, conduct of Annual Survey of Industries, Economic Censuses and its follow up surveys, compilation of Index of Industrial Production, as well as Consumer Price Indices for Urban Non-Manual Employees, Human Development Statistics, Gender Statistics, imparting training in Official Statistics, Five Year Plan work relating to Development of Statistics in the States and Union Territories;

dissemination of statistical information, work relating to trade, energy, construction, and environment statistics, revision of National Industrial Classification, etc.

The National Statistical Commission (NSC) set up by the Government in January 2000 under the Chairmanship of Dr. C. Rangarajan reviewed the statistical system and the entire gamut of Official Statistics in the country. Core functions of NSC, inter alia, include identification the core statistics which are of national importance and are critical to the development of the economy, to evolve national policies and priorities relating to the statistical system and to evolve standard statistical concepts, definitions, classifications and methodologies in different areas in statistics and lay down national quality standards on core statistics. One of the key recommendations of this Commission was to establish a permanent National Commission on Statistics to serve as a nodal and empowered body for all core statistical activities of the country, evolve, monitor and enforce statistical priorities and standards and to ensure statistical coordination among the different agencies involved. In line with the above recommendations, the Government of India ordered the setting up of a permanent



P.C. Mahalanobis with the statisticians of C.S.O. during a reception at his New Delhi residence, 8 King George Avenue, 3 December, 1954

National Statistical Commission (NSC) on 1st June 2005. The present setup of NSC is a type of umbrella organization covering both CSO and NSSO.

National Statistical System and the Role of the Reserve Bank

Reserve Bank of India (RBI) collects and analyses statistics on various economic transactions of banking and other financial institutions in the process of implementing its policies towards achieving its implicit twin objectives of growth and price stability. A major part of the statistics in RBI is collected through either statutory or control returns, which are exclusively used for monetary policy and supervision. In the field of information generation and analysis we adhere to international standards and practices. To collect supplementary statistics, RBI conducts surveys in the fields of credit to rural/urban households, industrial outlook, inflation expectations, different aspects of banking sector, external sector and the private corporate sector.

At present, the surveys conducted by RBI can be broadly classified into five categories:

(a) **external sector** including (1) survey of foreign liabilities and assets for corporate,

insurance & mutual fund sectors, (2) coordinated portfolio investment survey, (3) survey on software export, (4) unclassified receipt survey used for BoP, (5) survey on balances in Nostro / Vostro account used in BoP, and (6) survey on non-resident deposits;

(b) **banking sector** including (1) survey on distribution of credit, deposits and employment in banks, (2) survey on composition and ownership of deposits with scheduled commercial banks, (3) survey on investment portfolio of scheduled commercial banks, (4) survey of debits to deposit accounts with scheduled commercial banks, (5) survey on international assets and liabilities of banks and (6) survey of small borrowal accounts;

(c) **corporate sector** including survey of performance of private corporate business sector, conducted since 1951-52;

(d) **monetary policy** including (1) industrial outlook Survey, (2) inflation expectation survey for households and (3) survey of inventories, order books and capacity utilization;

(e) **ad hoc**: Census of non-banking financial companies not accepting public deposits.

In addition to the abovementioned surveys, recently RBI has initiated steps to make use of survey methods for various operational purposes, e.g., to assess the extent of success and realities of implementation of financial inclusion. You may be aware that in India, Government as well as the central bank attach enormous importance towards financial empowerment of the rural poor and RBI has taken steps for financial inclusion and spread of Self Help Groups. In support of monetary



United Nations Statistical Commission, New York, 16 April-3 May, 1956, with P.C. Mahalanobis in the chair.

policy, we propose to introduce survey of professional forecasters, as done in most of the central banks in developed countries. In addition, it may be necessary to collect necessary information for compiling housing starts, in view of the increasing importance of housing construction in the economy. However, in view of the current state of data availability with local authorities, this will need considerable additional work before any significant progress can be made. Other Central Banks conduct a number of other surveys, both ad hoc and regular ones, in order to help more informed monetary policy meeting, and other needs as they arise. As we improve the technical basis of our monetary policy apparatus we will need to keep innovating in this area.

Traditionally RBI is directly involved in national accounts compilation, especially in savings estimation and flow of fund compilation. Basic information on household and corporate savings is provided to CSO for preparing the final estimates. Besides, data on output of banking system in GDP is imputed from the data supplied by us. RBI also has a long tradition of conducting important surveys in collaboration of NSSO. The first comprehensive survey conducted by RBI is known as All-India Rural Credit Survey, with 1951-52 as the reference period. The objective of the survey was to collect such data/information as would assist the RBI and the Government of India in formulating an integrated credit policy for rural credit and to assess the extent of indebtedness of rural households to financial institutions in the organized and unorganized sectors. Findings of this landmark survey subsequently changed the entire landscape of Indian banking and culminated in introducing the world's biggest social banking experiments in the form of rural

credit and priority sector lending. Such All-India surveys were conducted decennially and the latest survey pertained to the year 2002-03. While the 1951-52 and 1961-62 surveys covered only rural households, the subsequent surveys covered urban households also. The surveys of 1971-72 and 1981-82 were conducted jointly with NSSO, Government of India, whereas those of 1991-92 onwards were conducted entirely by NSSO.

The other area, which has direct consequence with RBI activities, relates to measurement of output and price. As member of the Technical Advisory Committee of National Accounts Statistics (NAS), Statistics on Prices and Cost of Living (SPCL), revision of WPI and CPI series, etc., RBI has been playing a critical role. Let me highlight a few recent initiatives. The procedure of converting current price estimate into constant price followed earlier, especially for estimating the output of financial sector, resulted in some kind of anomalies. In some cases, while estimate at current price was negative, constant price estimate was positive and increasing. However, in the last GDP revision (1999-00 series), this problem was corrected



Smt. Indira Gandhi, Prime Minister of India, delivering her speech on the occasion of Golden Jubilee Celebration of the Institute in Calcutta. Prof. C.R. Rao and Prof. Kallianpur are on the dais along with others, 20th January 1982.

after a series academic discussion with CSO. Similarly, treatment of some of the financial intermediaries like mutual funds was not defined clearly in SNA 1993. And treating mutual funds similar to banks was conceptually not correct. Recently, CSO set up a committee in RBI to look into this matter and the recommendations of the committee has been accepted by TAC of NAS. Besides, RBI is also working in close collaboration with CSO for implementing the ensuing changes of SNA revision due this year.

Let me cite an example of RBI's recent involvement in price measurement issues. The



J.B.S. Haldane on his birthday with P.C. Mahalanobis at Amrapali, 5th November, 1957

need for integration CPIs is nothing new. The National Statistical Commission (2001) recommended, *inter alia*, that the current CPIs do not provide changes in the prices for the entire rural and urban population since they are designed to measure the changes in the prices of goods and services consumed by specific segments of the population and hence there is a need to compile the CPI separately for the entire rural and urban population. In this context, a Sub-Group set-up in RBI, recommended the compilation of separate CPIs for whole rural and urban population and provided a roadmap for compilation. I happy to note that TAC on SPCL has finally accepted this and shortly we shall have CPI(U) and CPI(R). Needless to mention that these price indices will be very useful for monetary policy purposes.

Application of Statistical Methods in RBI: Need for Further Work

Before I conclude, let me outline a few areas of work in RBI where statisticians can contribute significantly. First, as monetary policy formulation largely depends on the forwardlooking behaviour of the economy, the use of forecasting techniques automatically comes in the forefront. While traditional time series techniques are useful, we need to build up expertise on forecasting using calibrated models. Such models have definitive advantage of incorporating economic agents utility, requires less data and can be maneuvered easily with different alternatives. Second, RBI incurs a huge expenditure on management of currency through out the country. Operations research techniques could be utilized effectively in the areas of inventory, transportation, etc., so as to develop an efficient and cost effective currency management

systems. Third, risk analysis under a statistical framework is a pre-requisite for implementing Basel II norms. Fourth, innovative sample surveys in the area of financial inclusion, development of leading indicators like house-start index, inflation expectation, etc., could be very useful tools. Fifth, we do not have an appropriate measure of potential output. It is not an easy task; however, efforts should be made to devise a suitable methodology for estimating potential output at the earliest.

Finally, let me conclude by saying that knowledge building is an ongoing activity. Frontiers are shifting upwards consistently and thus demanding a persistent catching up with the advanced knowledge. Central banking today is more challenging than ever and accurate information is the key to supplement policy decisions. I hope the Statistics Day and the conference on financial statistics pave the platform of knowledge sharing and understanding of advanced frontiers.



Gallery

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AWARDS AND THE RECIPIENTS

Prof. P.V. Sukhatme National Award in Statistics for Senior Statisticians

S. No.	Year	Name of the Awardees/Recipients
1	1999-2000	Prof. J.K. Ghosh, former Director, ISI, Kolkata.
2	2001-2002	Prof. Prem Narain, former Director, IASRI, New Delhi.
3	2003-2004	Prof. Belvant Keshav Kale, former Professor and Head of the Department of Statistics, University of Pune.
4	2005-2006	Jointly (i) Dr. Manindra Nath Das, former Professor and Director, IARS, New Delhi (ii) Prof. Nikhilesh Bhattacharya, former Professor, ISI, Kolkata.
5	2007-2008	Prof. B.L.S. Prakasa Rao, Jawaharlal Nehru Chair Professor, University of Hyderabad.

Prof. C.R. Rao National Award in Statistics for Young Statisticians

S. No.	Year	Name of the Awardees/Recipients
1	2000-2001	Jointly (i) Dr. Rahul Mukherjee, Professor, IIM, Kolkata (ii) Dr. Rajeeva Laxman Karandikar, Professor, ISI, New Delhi
2	2002-2003	Professor Arup Bose, ISI, Kolkata.
3	2004-2005	Prof. Probal Choudhuri, ISI, Kolkata
4	2006-2007	Prof. Ayanendranath Basu, ISI, Kolkata

International Award in Memory of Professor P. C. Mahalanobis

S. No.	Year	Name of the Awardees/Recipients
1	2003	Prof. C. R. Rao, Former Director, Indian Statistical Institute, India.
2	2005	Prof. Ben Kiregyera, Professor, Makerere University, Uganda
3	2007	Prof. I.P. David, Former Manager, Statistics and Data System Division, ADB, Manila, Philippines.

Awards for "Essay Writing" on the occasion of Birth Anniversary of Prof. P. C. Mahalanobis

S. No.	Year	Name of the Awardees/Recipients	Prize
1	2005	Sh. Mathew Francis, St. Thomas College, Department of Statistics, Kottayam	First
2	2005	Ms. Sumi A. R., University of Kerala, Trivandrum	Second
3	2005	Ms. Prerana Bhasker Ail, Department of Post and Graduate Studies & Research in Statistics, Mangalore University	Third
4	2005	Sh. Mohd. Shahnawaz, Department of Statistics, Lucknow University, Lucknow	Third
5	2005	Sh. D. Satish, Acharya N. G. Ranga Agricultural University College of Agriculture, Hyderabad	Third
6	2006	Ms. Poonam Chandra, University of Madras, Chennai	First
7	2006	Ms. Nisha Malik, Ch. Charan Singh Agricultural University, Hissar, Haryana.	Second
8	2006	Ms. Jyothi Bodani, Acharya Nagarjuna University, Nagarjuna Nagar, Andhra Pradesh	Second
9	2007	Shri Anirvan Chakraborty, Indian Statistical Institute, New Delhi	First
10	2007	Ms. Ketaki Garg, Indian Statistical Institute, New Delhi	Second
11	2007	Ms. Nisha Malik, Chaudhry Charan Singh Haryana Agricultural University, Hisar	Second
12	2007	Ms. Jagrity Das, Guwahati University	Third
13	2007	Ms. Arshi Tahniyat Javed Iqbal Khan, Sant Gadge Baba Amrawati University, Amrawati	Third
14	2007	Shri Sarvadanand Barnwal, Delhi University	Third
15	2008	Ms. Tuhina Biswas, Indian Statistical Institute, New Delhi	First*
16	2008	Ms. Sumita Bose, Indian Statistical Institute, New Delhi	Second**
17	2008	Shri Rohit Patel, Indian Statistical Institute, New Delhi	Second**
18	2008	Ms. Subrat Kumari Behera, Indian Agricultural Statistics and Research Institute, New Delhi	Third**

*For writing an essay on "Impact of Industrial Development on Environment and Ecology and the Role of Statistics"

** For writing an essay on "Use of Statistics in Measurement of Economic and Social Development"



Statistics Day Function at Vigyan Bhawan, New Delhi



**Prof. C.R. Rao with the
First Prof. P.C.
Mahalanobis International
Award by the International
Statistical Institute in
recognition of lifetime
achievements in Statistics,
2003**



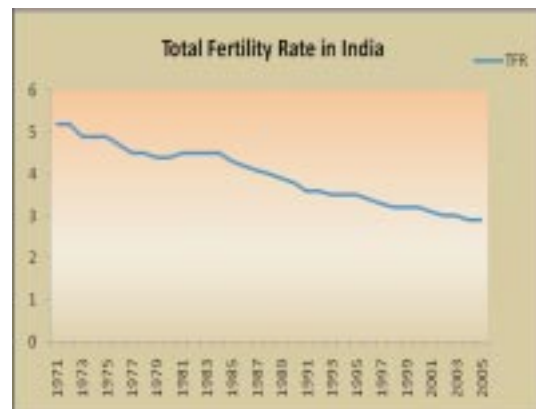
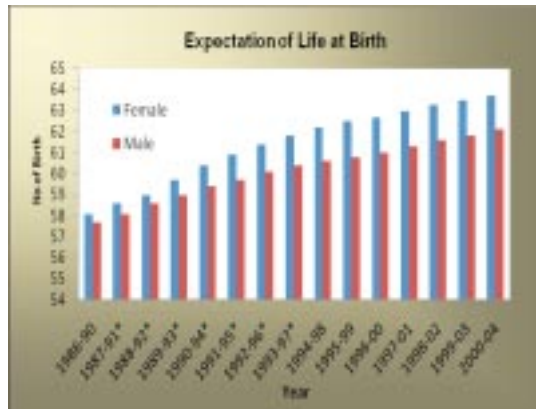
2005

**Second Prof. P.C.
Mahalanobis International
Award in Statistics was
presented to Prof. Ben
Kiregyera from Uganda for
his contribution to
development of statistics in
Uganda and other African
countries**

**Prof. I.P. David of
Philippines was awarded
the Third Prof. P.C.
Mahalanobis International
Award in Statistics in
recognition of his
contribution in Statistics,
particularly on issues of
poverty measurement**

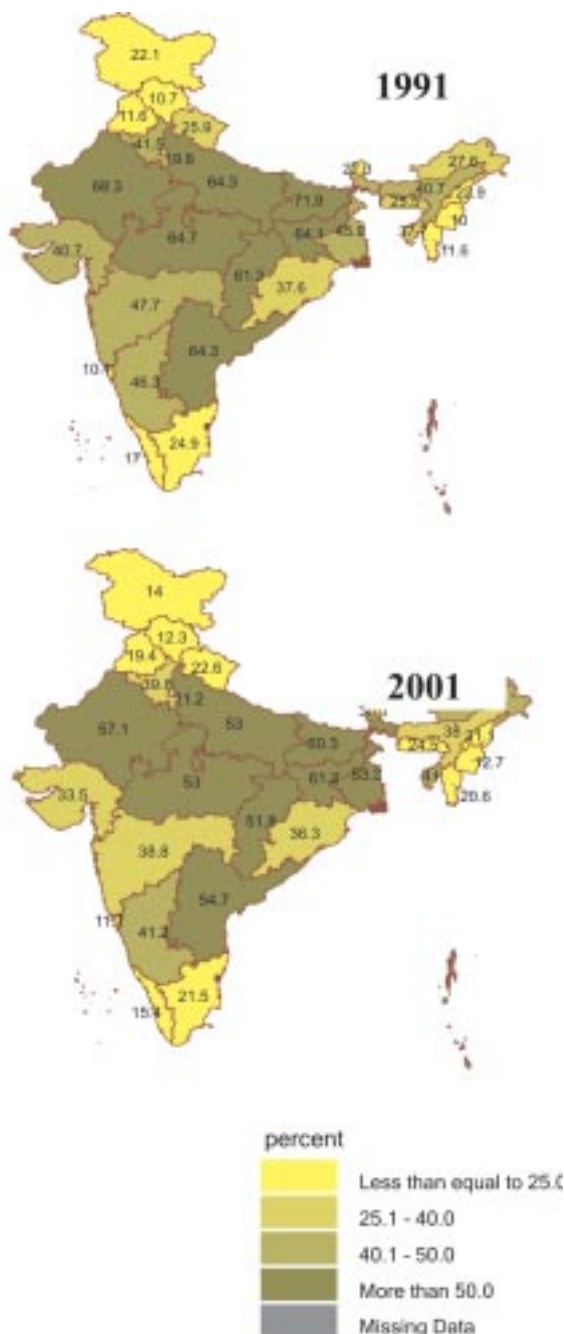
2007





सांख्यविद प्रो. मोहल्लवी
के जन्म दिवस को
'सांख्यिकी दिवस' के
रूप में मनाया

बरेली, 29 जून। विकास भवन
सभागार में महान सांख्यविद प्रो.
पी.सी. मोहल्लवी के जन्म दिवस
को 'सांख्यिकी दिवस' के रूप में
मनाया गया। इस अवसर पर
राष्ट्रीय प्रतिदर्श सर्वेक्षण संगठन के
संयुक्त निदेशक एस.पी. सिंह ने
प्रो. मोहल्लवी द्वारा सांख्यिकी के
लिए किये गये योगदान की जानकारी
दी। प्रो. मोहल्लवी द्वारा इंडियन
स्टैटिकल इंस्टीट्यूट की स्थापना
के साथ ही 1950 में राष्ट्रीय
प्रतिदर्श सर्वेक्षण की स्थापना के
संबंध में श्री सिंह ने जानकारी दी।
इस मौके पर उपनिदेशक रजनीश
माथुर सहित विभिन्न जिलों से
आये प्रतिनिधि मौजूद रहे।



Percentage of women aged 20-24 married by 18 years



Lakshadweep DES celebrating Statistics Day 2007



J & K, Statistical Bureau celebrating Statistics Day 2007



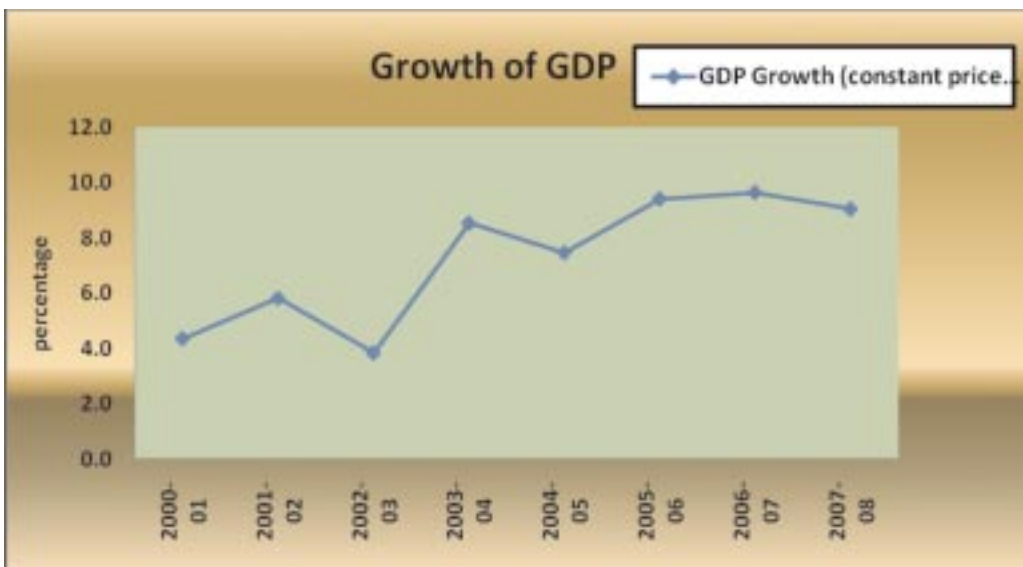
NSSO (FOD), Allahabad celebrating Statistics Day 2007

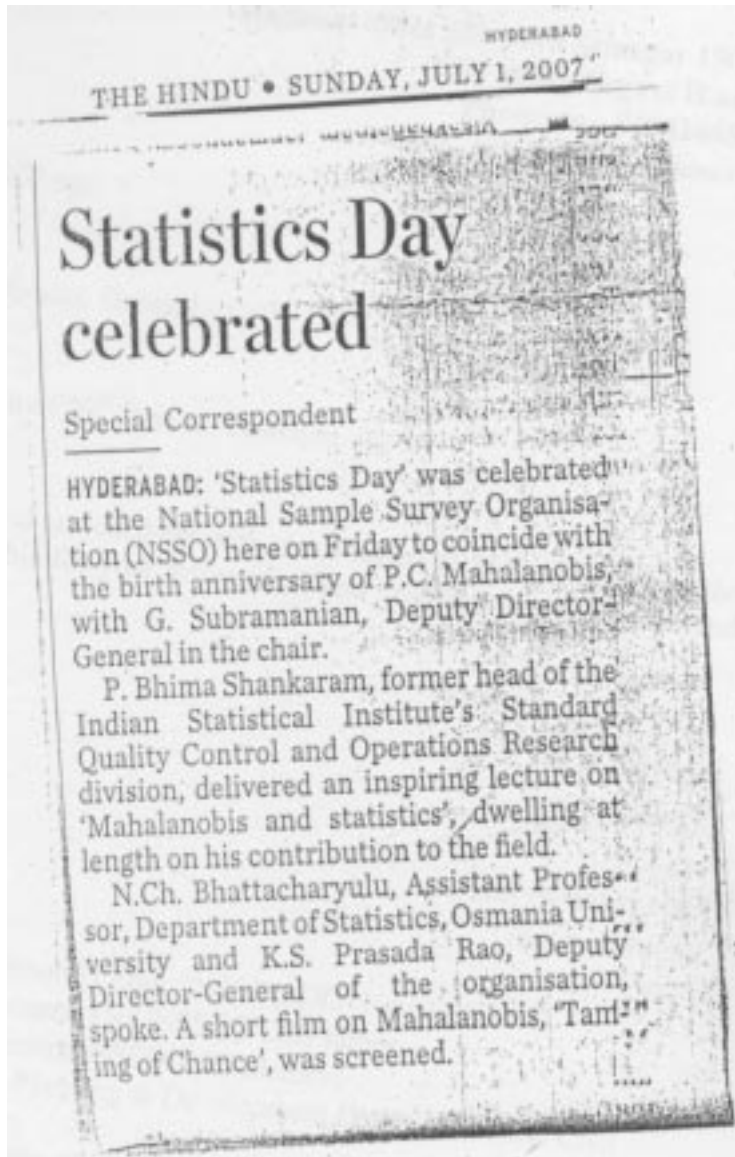


NSSO (FOD), Jammu celebrating Statistics Day 2007



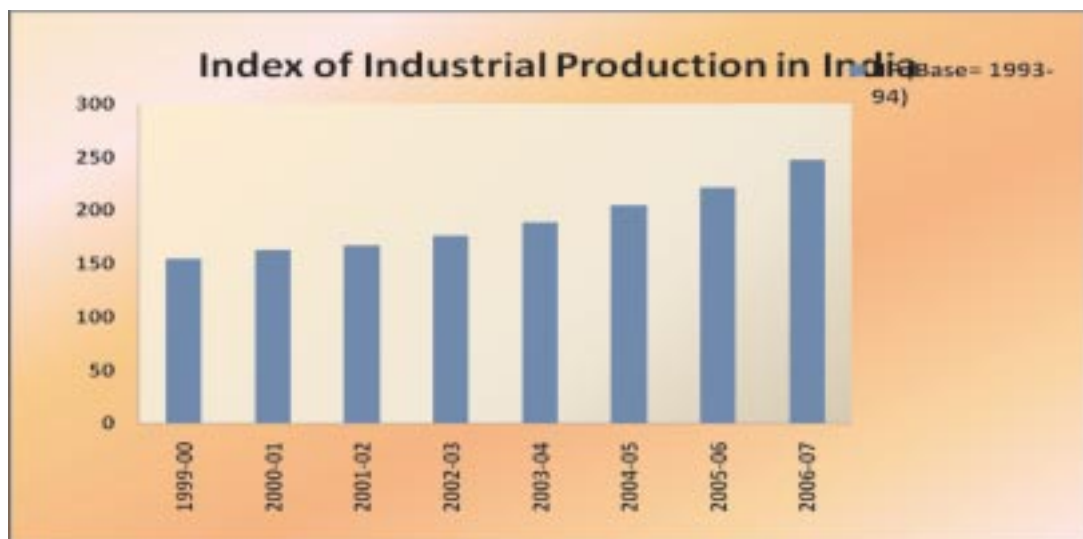
NSSO (FOD), Trivandrum celebrating Statistics Day 2007

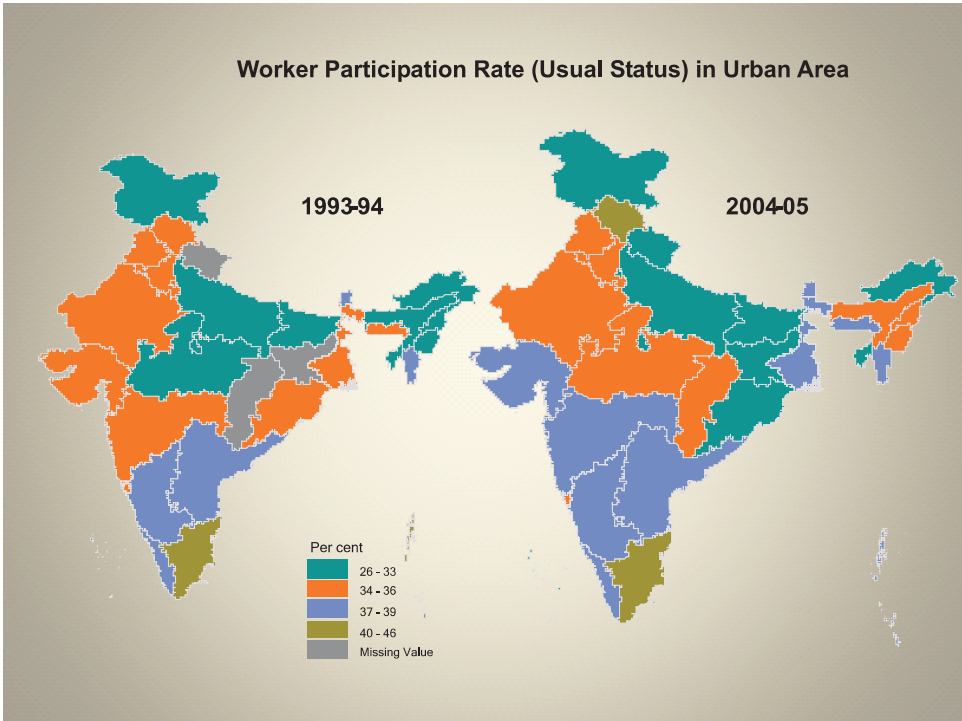




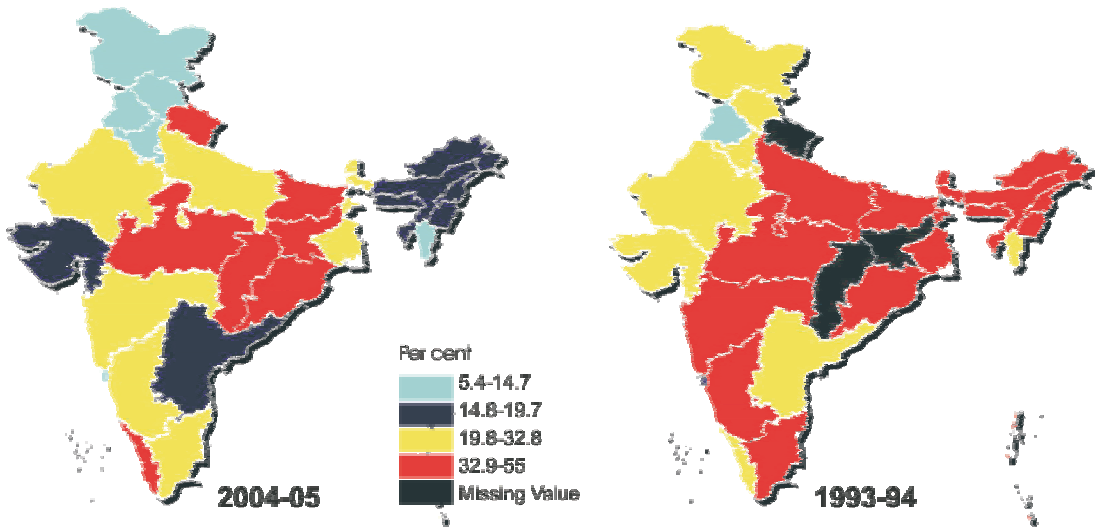


NSSO (FOD), Ahmedabad celebrating Statistics Day 2007

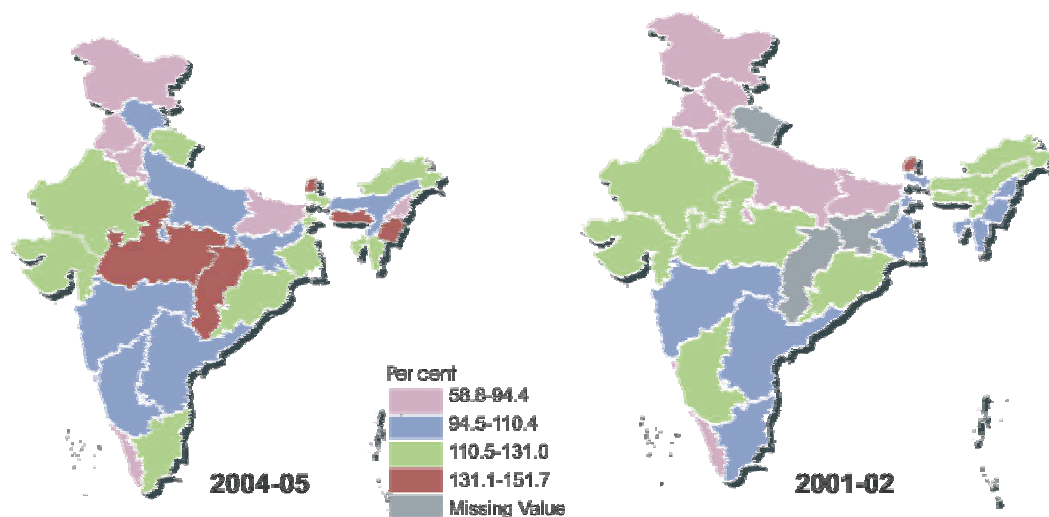




Proportion of Population Below Poverty Line

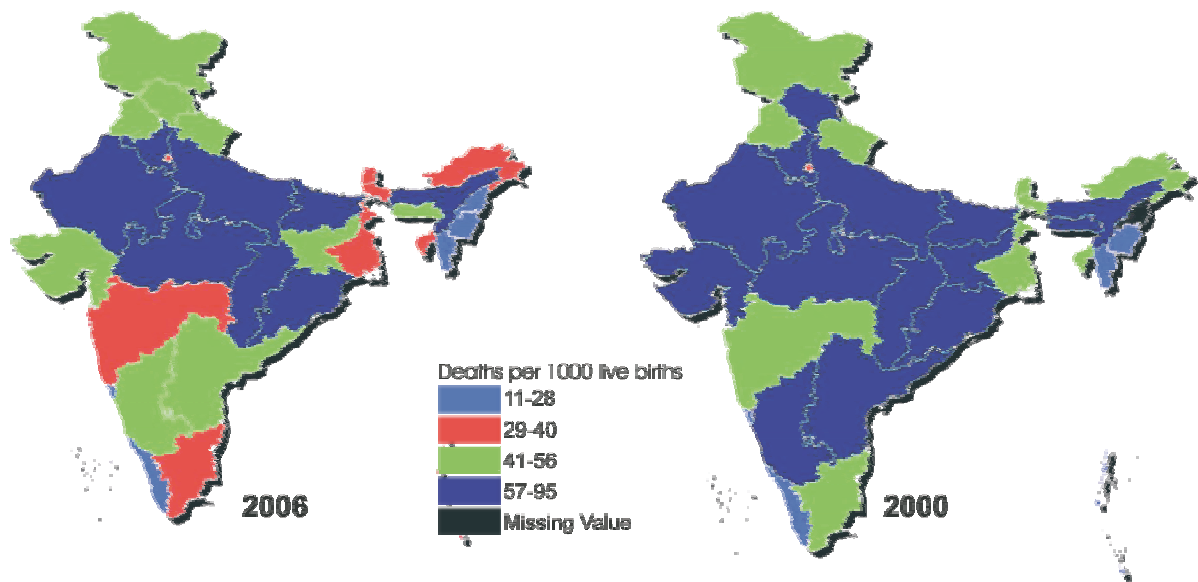


Gross Enrolment Ratio (Grade I-V)



National Academy of Administrative Statistics (NASA), Noida

Infant Mortality Rate



NASA, Officers' Quarter



NASA, Noida



NASA, Noida

Organisation of Statistics Day, 2008

Inspiration and Leadership:

Dr. Pronab Sen, Secretary, M/o Statistics & PI
Overall Direction and Programme Management:
Dr. S.K. Nath, Director General, CSO

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2. Shri M.R. Meena, DDG, CSO
3. Shri H. Borah, Director, CSO

Transport, Media and Publicity:

4. Shri S. Dhar, Director, CSO
5. Shri Inderjeet Singh, Director,CSO

Statistical Product Development:

6. Shri S. Chakrabarti, Director, CSO
7. Shri Sourav Chakraborty, Deputy Director, CSO

Award Management:

8. Shri R.C. Aggarwal, Director, CSO
9. Shri M.C. Sharma, PA, CSO
10. Shri R.G. Ram,CSO

Facilitating Panel Discussion:

11. Shri T.V. Raman, DDG, CSO

Statistical Quiz Competition:

12. Shri J.S. Venkateshwarlu, Joint Director, CSO
13. Shri Praveen Shulka, Joint Director, CSO
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