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The Intellectual Contributions of Bhartiya Statisticians: A Comprehensive Literature Survey

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Abstract:

This review attempts to portray the deep impact and contributions of Bhartiya (Indian) Statisticians on the world arena of statistical theory and practice in the applied areas of mathematics, economics, agriculture, medicine, and social sciences. This article traces the history of quantitative sciences from ancient to the present and focuses on the classical work of the Bhartiya statistician to underscore the long-standing tradition of quantitative science in Bharat. It also emphasizes the contributions of the leading Bhartiya statisticians such as Prasanta Chandra Mahalanobis, Calyampudi Radhakrishna Rao, Pandurang Vasudeo Sukhatme, V. S. Huzurbazar, Raj Chandra Bose, Debabrata Basu and Samarendra Nath Roy. Their pioneering contributions (including the Mahalanobis distance, the Cramér-Rao bound, design of experiments, etc) has had a monumental impact on the development of the statistical theory and methods of today. This article also discusses their effects on institutional growth, especially the creation of the India Statistical Institute (ISI), and the growth of statistics education and research in India. It also emphasises the pro-active role of Bhartiya statisticians in the international statistical organizations. This review ends by reflecting that Bhartiya statisticians have left behind a legacy with global footprint and expression, hoping that the future will stand on the shoulders of their past greats to bring even greater glory to our country and the world.

Keywords: Bhartiya statisticians, Indian Statistical Institute, Mahalanobis distance, Cramér-Rao bound, design of experiments, statistical education, and statistical research.

1. Introduction:

Statistics is indeed in demand these days, in every possible branch of science. From science to business, humanities to social sciences – everyone today is applying statistics to showcase what they're working on. In a sense we can say that statistics provides 'breath' to all fields. The contribution of Bharat's statisticians to the science of statistics can be traced back to

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ancient times. References can be identified in the works of Pythagoras and Panini, in the ancient collection of data related to agriculture and trade under the *Aryabhatiya*, and in the Sanskrit, records concerning state and district management as described in Kautilya's Arthashastra. The concept of the quantified individual is also evident in the Ayurvedic system of medicine, while the science of bodily measurement is found throughout ancient Hindu philosophy. The use of statistical data as an aid to state policy under the Buddhist king Hung-Chhung, reflected in stone inscriptions and Buddhist sculptures, and the detailed demographic studies of population balances presented in the Upanishads, further highlight the early role of statistics in India.

In more recent times, several eminent Bhartiya statisticians have made significant contributions not only to statistics itself but also to other disciplines such as agriculture, medicine, and computer science. They have advanced the field by developing new statistical methods and theories as well as by applying statistical techniques across a wide range of areas (Government of India, 2020).

2. Methodology:

The literature review in this paper draws from a thorough review of prior literature on Bhartiya statisticians. The sources reviewed include research articles, online content like Wikipedia, published content, print sources, and conference proceedings. This review also embraces interviews with eminent Indian statisticians to understand their life and their reflections on the global landscape.

3. Historical Evolution of Statistics in Bharat

3.1 Ancient Roots:

Vedic and Pre-Modern Contributions: The roots of statistical thinking in Bharat can be traced historically. During the Vedic period, elementary forms of data collection and classification were used in agriculture, astronomy, and administration. Texts like the *Rigveda* and *Arthashastra* show clear evidence of systematic record-keeping, census-type surveys, and economic planning. *Kautilya's Arthashastra* (circa 4th century BCE), a seminal treatise on statecraft and economics, is particularly notable for outlining principles of population estimation, land measurement, taxation systems, and revenue forecasting—elements deeply related to modern statistical practice (Thapar, 2002). In the pre-modern period, astronomers and mathematicians such as Aryabhata, Varahamihira, and Brahmagupta developed numerical techniques and models that indirectly contributed to the evolution of probability and numerical analysis, laying groundwork for statistical computation (Joseph, 2010; Sharma & Sharma 2024). Indian traditional educational systems, such as Gurukuls, emphasized holistic learning, which included mathematics and early forms of statistical thinking. This sets the stage for understanding the foundational environment from which Indian statisticians emerged (Tiwari,2024).

3.2 Colonial Period:

Foundations of Modern Statistical Thought: The formal establishment of statistics as a discipline in Bharat began under British colonial rule. The British administration required data to manage its empire effectively, especially for land revenue, population control, and trade policies. This led to the development of systematic census operations, with the first comprehensive Indian Census conducted in 1872, followed by decennial censuses from 1881 onward (Visaria & Visaria, 2004).

The Statistical Survey of Bharat, initiated in the 19th century, began gathering data on agricultural yields, rainfall, and population demographics. During this period, statistics primarily served colonial interests but laid the institutional and methodological foundation for later academic development. By the early 20th century, Bhartiya scholars such as P.C. Mahalanobis began to engage critically with statistical science. His work marked a shift from statistics as a tool of governance to statistics as a research-based and planning-oriented academic discipline. In 1931, Mahalanobis founded the Indian Statistical Institute (ISI) in Kolkata, which became the epicenter for statistical education and research in Bharat (Desai, 1991).

3.3 Historical path of Statistical Institutions after Independence:

Bharat prioritized the use of statistics for national development and planning after it achieved independence in 1947. Statistical inputs are regularly used in order to systematise and coordinate economic planning and social policy development. P.C. Mahalanobis became the government's statistical advisor in the early 1950s and used this to establish extensive data collection efforts in India, such as the National Sample Survey (NSS) in 1950 and the Central Statistical Organisation (CSO) in 1951. Of course, they were institutions that helped to institutionalize survey sampling, agricultural statistics, economic statistics, demography (Sengupta, 2002). There was also a boom in statistical education after independence with special departments in many of the leading universities in India and regional statistical training centres. The Indian Statistical Institute became known internationally and began to work on projects with international agencies such as the UN, FAO, and WHO. Distinguished statisticians such as C.R. Rao, R.C. Bose and S.N. Roy made extensive theoretical contributions in multivariate analysis, design of experiments and estimation theory that have international recognition

4. Bhartiya Statisticians & their Contribution in the Field of Statistics:

Bharat has contributed many generations of outstanding statisticians, whose pioneering research has influenced national and international policy, as well as the theoretical development of statistics. Some of the most prominent Bhartiya statisticians and their contributions are showcased in this section.

4.1 Prasanta Chandra Mahalanobis (1893-1972):

Prasanta Chandra Mahalanobis (1893–1972) Father of Indian Statistics, he had revolutionized the science of statistics in Bharat. He founded the Indian Statistical Institute (ISI) in 1931, which blossomed into a premier institution for advanced statistical research and training. As a confidant of the first Prime Minister of Bharat, Pt. Jawahar lal Nehru appointed him for the

Second five-year plan, Mahalanobis was the architect of large-scale sample surveys in the country and was pivotal in drawing up the 2nd Five-Year Plan, which relied extensively on statistics for economic planning and development. He is regarded as a pioneer in both theoretical and professional statistics. He developed the concept to measure the distance between the point and distribution. The Mahalanobis Distance (D^2), a multivariate distance measure, is his best-known theoretical work and has broad applications in pattern recognition, cluster analysis, and statistics (Desai, 1991).

4.2 Raj Chandra Bose (or Basu) (1901-1987):

R.C. Bose was an Bhartiya American mathematician and statistician; he contributed in the field of Design of Experiments and finite geometry. He invented the notion of partial geometry, the theory of error correcting codes, balanced incomplete block designs (BIBDs) and techniques which were responsible for much of the early development of combinatorial design theory.

4.3 Samarendra Nath Roy (1906-1964):

S.N. Roy (1906–1964) was a Bharat born American Mathematician and applied statistician, he is a known key figure in multivariate statistical analysis, mainly he contributed to the analysis of data from multivariate normal population. His development of Roy's Largest Root Test provided a statistical test used in multivariate hypothesis testing and MANOVA. As a close associate of P. C. Mahalanobis at ISI, he played a significant role in advancing statistical education in Bharat. He was instrumental in integrating matrix algebra into statistical methodology, thereby shaping the theoretical foundation of modern multivariate analysis (Rao, 1992).

4.4 Calyampudi Radhakrishna Rao (1920-2023):

Rao is one of the most globally renowned Indian statisticians. His name is associated with the Cramér–Rao inequality, Rao-Blackwellization, Rao-metric, Rao's U test, Multivariate analysis of variance (MANOVA) and orthogonal arrays, these techniques utilized in estimation theory that establishes a lower bound on the variance of unbiased estimators, improves the efficiency of estimators and used in designing products and producing goods of high quality respectively. Rao's work spans theoretical statistics, multivariate analysis, and geometry of statistical models. He assisted as director of ISI and held professorships at prestigious international universities, leaving a lasting global legacy (Rao, 1992,1997 & 2015).

4.5 J.B.S. Haldane (in the Bhartiya Context) (1892-1964):

He was British by origin (1892–1964), became a Bhartiya citizen and made substantial contributions to biostatistics and genetics in Bharat. At ISI and later in Odisha, he worked on population genetics, enzyme kinetics, and human biology, combining experimental biology with statistical modeling. His efforts helped institutionalize the application of statistical reasoning in biology and medicine in Bharat. Haldane's commitment to scientific rationalism and public science also made him a key figure in Bhartiya scientific culture (Kumar, 2010).

4.6 Vasant Shankar Huzurbazar (1919–1991):

V.S. Huzurbazar did some pioneering work in sequential analysis and theoretical statistics. He is best known for his work on the relationship between exponential family of distribution and sufficient statistics, he is an author of many popular textbooks which had the major influence in the development of statistics education in India. In addition to his academic contributions, he was instrumental in setting up the statistics departments in Bhartya universities, mainly contributing towards the institutional development of the discipline of Statistics (Vasant Shankar biography).

4.7 Debabrata Basu (1924–2001):

Basu was a famous statistician, who contributed significantly in the foundation of statistical theory which include sufficiency, ancillary and the likelihood principle, especially in fiducial inference and Bayesian methods. A student of C.R. Rao Basu was also a great advocate of the Neyman–Pearson approach and played an important role in the early foundations of philosophy of statistics. His contributions have served as a bridge between the classical and Bayesian schools of thought, and have had a lasting influence on the theoretical justification of statistical inference.

4.8 Pandurang Vasudeo Sukhatme (1911–1997):

P.V. Sukhatme made significant contributions to agricultural statistics, sample survey methodology, and nutrition statistics. As a leading statistician at the Food and Agriculture Organization (FAO) of the United Nations, he applied statistical methods to address real-world development challenges, particularly in the areas of food security and public health. His work had a lasting impact on global agricultural policy and nutritional planning (Sukhatme, 1984, FAO Report,1990).

These statisticians not only advanced the theoretical landscape of statistics but also institutionalized its use in planning, agriculture, genetics, and public health, making India a global contributor to the discipline.

Table 1: Highlights of Contributions and Research Domains of Eminent Indian Statisticians

S .N.	Name	Years	Key Contributions	Research Area
1	**P.C. Mahalanobis**	1893–1972	Mahalanobis Distance, large-scale sample surveys, ISI founder	Multivariate analysis, Planning statistics, Institutional development

2	**C.R. Rao**	1920–2023	Cramér–Rao Bound, Rao–Blackwell Theorem, multivariate analysis	Estimation theory, Multivariate analysis, Geometry of statistical models
3	**R.C. Bose**	1901–1987	Design of experiments, BIBDs, finite geometry	Combinatorics, Experimental design, Error-correcting codes
4	**S.N. Roy**	1906–1964	Multivariate analysis, Roy's Largest Root Test, matrix methods	Multivariate hypothesis testing, Matrix algebra, MANOVA
5	**J.B.S. Haldane**	1892–1964	Statistical genetics, biostatistics in India, population modeling	Biostatistics, Genetics, Evolutionary biology
6	**V.S. Huzurbazar**	1919–1991	Sequential analysis, theoretical statistics, academic development	Sequential analysis, Statistical education
7	**Debabrata Basu**	1924–2001	Fiducial inference, Bayesian methods, Neyman–Pearson framework	Statistical inference, Bayesian statistics, Foundations of statistics
8	**P.V. Sukhatme**	1911–1997	Agricultural statistics, nutrition studies, FAO contributions	Agricultural statistics, Nutrition, Development studies

Figure 1: Highlights of birth origin of Eminent Bhartiya Statistician

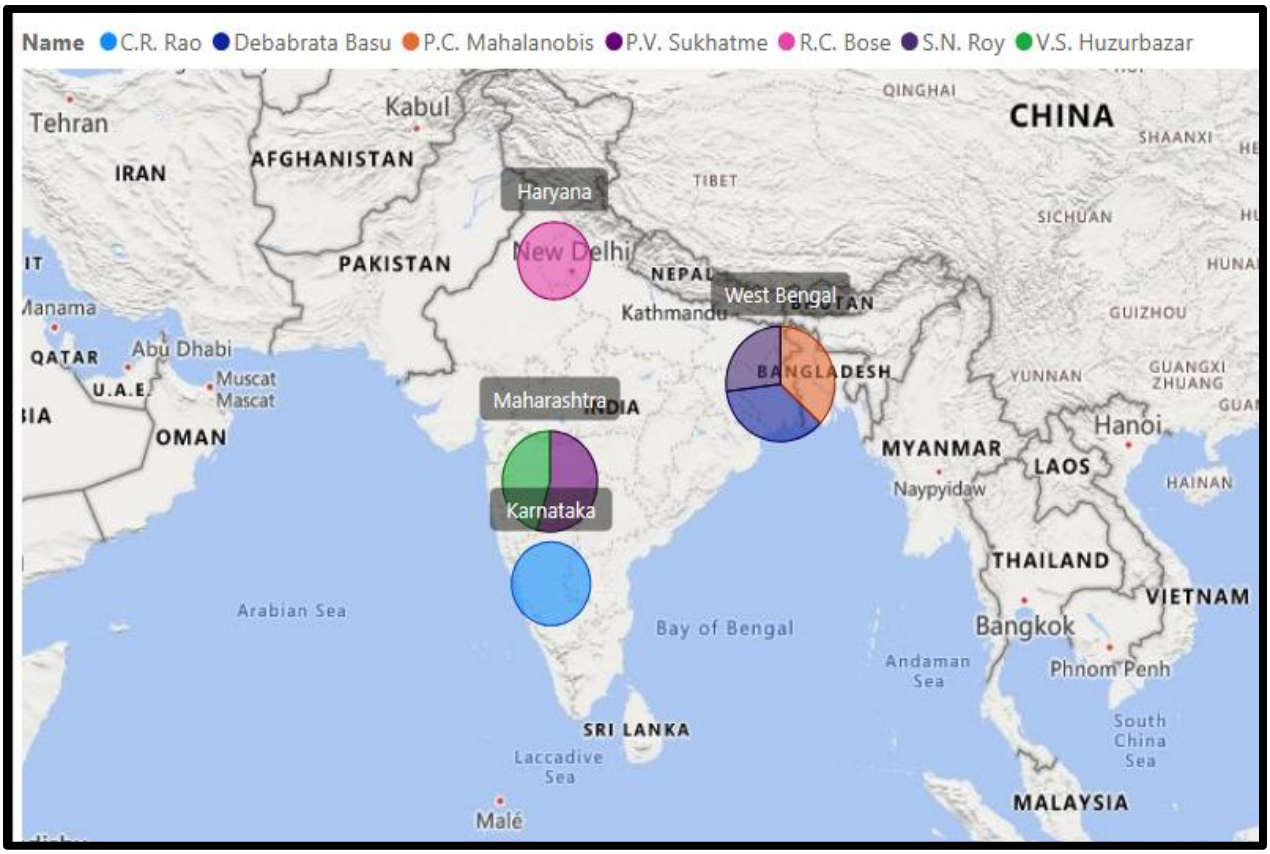

Table 1 and Figure 1 provide a concise summary—both in tabular and graphical formats of notable statisticians from the Bhartiya tradition along with details of their native states. The colored bubbles in Figure 1 indicate their states of birth, and it is noteworthy that South India has produced some eminent statisticians. P.C. Mahalanobis (1893–1972), born and brought up in West Bengal, lived for 79 years. C.R. Rao, one of the most internationally renowned statisticians, hailed from Karnataka and had a remarkable lifespan of 103 years (1920–2023). R.C. Bose, a native of Haryana and a towering figure in design theory, lived up to the age of 86. Another prominent academician from West Bengal, S.N. Roy, had a comparatively shorter life, passing away at the age of 58. A pioneer in Sequential Analysis, he lived for 72 years. Debabrata Basu, also from West Bengal, made seminal contributions to statistical inference during his 77 years. Finally, P.V. Sukhatme, an eminent authority in agricultural and nutritional statistics from Maharashtra, lived to the age of 86. This demographic portrait not only reflects the geographical diversity of these great minds but also underscores their lasting contributions to the field of statistics. The contribution of Bhartiya statisticians covers the entire gamut of statistical science. Their influence can be seen not only in theoretical developments but also in applied research, policy formation, institution-building and education. This section organizes these contributions under thematic headings in order to present a coherent view of the legacy of these contributions.

5. Legacy of Bhartiya Statistical Thought:

Bhartiya's contribution to the theory of statistics is immense, that is now called the Cramér–Rao Lower Bound and the Rao–Blackwell Theorem are known from C.R. Rao's work. Roy contributed to the development of multivariate statistical theory, particularly in the area of hypothesis testing. D. Basu contributed to the philosophical underpinning of statistical inference and Bayesian theory. Combinatorics, probability theory, Quantum statistics, Combinatorics (combinatorial mathematics) and Graph Theory, (quantum statistics), probability theory and Quantum were developed by C. Bose. These body of works have had giant impact in areas of estimation theory, testing of hypotheses, asymptotic theory, and decision theory which have placed India as one of the leaders in the world in statistics research

5.1 Contribution in the field of Agriculture, Health, Industry, etc. (Applied Statistics): Bhartiya statisticians have played a pivotal role in using statistical tools to address real-world problems. P.V. Sukhatme pioneered the application of statistics in agricultural research, particularly in crop yield estimation and nutrition studies, J.B.S. Haldane applied statistical genetics to public health and biology, Statistical models have been used in epidemiology, pharmaceutical trials, and population health by organizations like ICMR and AIIMS, influenced by early biostatistical work in Bharat, In industrial settings, ISI and the National Productivity Council developed quality control methods and process optimization models, influencing manufacturing standards.This focus on applied statistics bridged the gap between theory and practice, reinforcing the value of statistics in developmental planning and evidence-based decision-making.

5.2 Survey Sampling and National Planning:

Bharat became a global pioneer in sample survey methodology, largely due to the vision of P.C. Mahalanobis. He introduced stratified and pilot surveys, which became the foundation of the National Sample Survey (NSS) initiated in 1950. These techniques were instrumental in gathering data on employment, poverty, consumption, and rural development essential inputs for Five-Year Plans. Institutions like the Central Statistical Organization (CSO) and Directorate of Economics and Statistics in various states were developed to implement these methods on a large scale. The success of India's sampling techniques inspired similar models in countries across Asia, Africa, and Latin America, making India a leader in survey statistics for policy applications.

5.3 Experimental Design and Multivariate Methods:

Balanced Incomplete Block Design (BIBD) was launched by R.C. Bose who was known for error-correcting codes and finite geometry and S.N. Roy and C.R. Rao discovered fundamental results on canonical correlation, discriminant analysis, and principal components analysis. The ISI advocated the application of these methods in agriculture, medicine, and industrial experiments. Indian work in this area is still referred to in Machine Learning, climate modelling and bio-informatics—pointing towards the relevance of their foundational study.

6. **Global Influence:**

The statistical community in Bharat has made many contributions to global statistics, years of time have been spent with international development, policy and instructional modules. Torch bearers in the 1950s and for a few decades after, several pioneers took Bhartiya capability in agricultural statistics and nutrition to global heights, some of them working alongside FAO and UNSD. His original approaches to global hunger and undernutrition measurement formed the foundation for FAO's World Food Surveys and food distribution analysis methods.

The Indian Statistical Institute, established by P.C. Mahalanobis, has contributed significantly to worldwide Statistics. Mahalanobis's work was influenced by collaborations with statisticians such as Ronald Fisher and Harold Hotelling, which yielded development of new techniques in multivariate analysis and innovations in statistics such as the Mahalanobis distance. His works on large sample surveys and on recent development in economic planning have contributed significantly to the international statistical practice. C.R. Rao, a renowned statistician of Indian origin, has been widely acclaimed for his seminal contribution in statistical theory and multivariate analysis. He's received the U.S. National Medal of Science, the India Science Award and the International Prize in Statistics. Rao's memberships of the Royal Society and the US National Academy of Sciences are testament to his global significance. The Indian statisticians have also made important contributions to the global data movements such as World Bank's LSMS and OECD data projects to enhance international development agenda. The Academy trained faculty have been visiting scholars at institutions such as Harvard, Stanford and Cambridge and have actively participated in international conferences including UN's UNSD, FAO and ISI.

7. Enhancement of Statistical Education in Bharat:

Statistical education in Bharat, however, is running into difficulties which are preventing it from reaching that potential. Despite the modern technological world, many universities view statistics as a subset of mathematics, limiting students' lives at the applied (and interdisciplinary) university. All of this only highlights the need to revolutionize our education systems. Academia should embrace the need for practical skills such as data visualization, programming, ethical issues in artificial intelligence, and case studies from the industry. However, along with the upgrading of the curriculum, faculty development, innovating pedagogy and the upgrading of statistical laboratories and software tools are also the need of the hour for a modernised educational ecosystem. Promoting the growth of statistical literacy within fields in Bharat is an excellent way to harmonize the connections between academia and industry, and to promote innovation and societal development.

8. Modern Contribution:

The tradition of Indian statistical thinking based on the institutional and methodological edifices established by luminaries such as Mahalanobis, Sukhatme and C.R.Rao, It is sus̃tained by contemporary scholars and significantly extended in recent years by modern day researchers. Prajamitra Bhuyan, currently Assistant Professor in Statistics at IIM Calcutta, is known to have significantly contributed to the modern statistical theory and practice through his research in statistical data science, causal inference, and multiple-systems estimation. He is recipient of the prestigious 2025 Prof.C.R.Rao National Award for Statistics National Award

in Statistics. Bhuyan can be broadly categorized along different applications, for example, in causal modelling of transportation network systems (Bhuyan etal., 2021), advanced reliability and degradation model (Bhuyan & Sengupta, 2017), and multiple systems population size estimation and heterogeneous catchability (Bhuyan & Chatterjee, 2024; Bhuyan etal., 2023). Also, Professor Siva R. Athreya, a leading Indian probability theorist, has worked on fundamental problems related to measure-valued diffusions, interacting particle systems, stochastic processes from statistical physics and population biology and computational epidemiology. He is a winner of the Shanti Swarup Bhatnagar Prize in 2012 and his work is an anchor between classical probabilistic theory and modern-day applications pertaining to stochastic modeling and complex systems.

9. **Conclusion:**

This review has sketched the colorful development of statistics in Bharat, since ancient roots to its present developments. The country's statistical heritage is built by the great statisticians like P. C. Mahalanobis, C. R. Rao, R. C. Bose, Bhuyan and Athreya illustrate how contemporary Bhartiya statisticians are not only expanding the breadth of this nation's remarkable statistical armory in areas such as causal inference and data science, but also in the area of stochastic processes and computational modeling. Their impact from theory to applications, from surveys to education is deeply rooted in the national planning of Bharat and worldwide research.

10. **Bhartiya Statisticians – on Some Thoughts by Way of a Significant Bequest**:

Bhartiya statisticians have always had a mix of a very strong theoretical approach coupled with a very practical relevance, whether in theoretical discussions or in practical implementation in policy. Their impact is transcontinental and has influenced ways of doing, institutions and frameworks that are still pivotal to today's statistics. The history of ISI, NSSO and university departments still shapes current trends in data science, AI, and interdisciplinarity.

11. Limitation:

In the 21st century, Indian statistics is undergoing a dynamic transformation driven by emerging technologies, evolving academic priorities, and greater inclusivity. While rooted in the legacy of its pioneers, the discipline is adapting to the demands of a data-driven world. Bharat has a vibrant legacy in statistics but new challenges need attention for the country to maintain and expand its international standing. Indian research output is good despite the less global coverage of Bhartiya publications, which is because of considerable inadequacy of access to good journals and international collaboration. A biggest limitation of this article is the limited availability of information on other Bhartiya statisticians. As a result, We were only able to include eight eminent statisticians in this work, although many more are undoubtedly deserving of recognition.

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