

Preface

The book titled *Resources, Technology and Sustainability—An Analytical Perspective on Indian Agriculture* is the reflection of my research on agricultural economics for the last thirty years. Although I have research interest in diverse fields of economics, namely, economic growth, public economics, child labour, the major focus of my works has remained on natural resources, agriculture and sustainable growth. In the days of my student life in college and university in 1970s and 1980s, the low productivity, low capital investment and technological backwardness in agriculture were the subjects of major concern for farmers, agricultural sector and for the economy as a whole and this attracted me to be engaged in research on this field. The existing literature suggested that the productivity in traditional agriculture could not be increased without a technological breakthrough. At the beginning, I started my works with the objective of suggesting policies towards increasing productivity in agriculture. The frontline research in this field at that time published in renowned International Journals prompted me to undertake doctoral research on ‘Adoption of Modern Technology in Agriculture’. I started my work in late 1980s in the Department of Economics, University of Calcutta, under the supervision of my respected teacher, Prof. Asis Kumar Banerjee. Professor Banerjee, one of the finest teacher in economics, with commendable grip over economic theory and quantitative economics, advised me to keep in mind that a good research must be based on sound theoretical framework and I was trained and guided accordingly. Many works were going on in the same line in the Indian context but hardly any of them had any theoretical backup. I got the necessary help and guidance from my supervisor to analyse the problems in a very rigorous and scientific manner. The seminal works of Gershon Feder, David Zilberman, Richard E. Just, Rulon D. Pope, Joseph Stiglitz, Avishay Braverman, Amit Bhaduri, T.N. Srinivasan, Zvi Griliches, V.W. Ruttan, T.W. Schultz, John Mellor, C.H. Hanumantha Rao, K.N. Raj, Derek Byerlee, Barbara Harriss and many others helped me to a great extent in this matter. In my doctoral thesis I was able to show that the adoption of a new technology is decision-making under uncertainty. Since the production under a new technology is uncertain, the adoption of the technology

depends on the degree of risk and the risk preference of the farmers along with other factors. In the Indian context, the support measures of the government reduced the degree of risk and risk aversion of the farmers over time. So, many of the obstacles towards adoption of the new technology, known as high yielding variety (HYV) technology, were removed and the HYV technology was subsequently adopted on a wide scale. The adoption rate of the technology in small farms was found to be higher compared to the big farms. Irrigation, specially tube-well irrigation, played a vital role in the adoption of the new technology in Indian agriculture. The large-scale adoption of the HYV technology, extension of irrigation and use of chemical fertilisers resulted in remarkable increase in food grains production in India.

As a result of technological change and expansion of irrigation, Indian agriculture has achieved remarkable success in production. But at the same time it has caused huge stress on natural resources like land and water. Excessive depletion of ground water, soil degradation due to intensive cultivation and use of chemical inputs in increasing doses and loss of biodiversity are now posing a serious threat to sustainability of growth in the country. Now, issues like conservation of ground water, utilisation and proper management of surface water, soil health, crop diversification in favour of less water intensive crops, rain water harvest, efficient technology for irrigation, policy intervention for encouraging the use of resource friendly inputs, use of appropriate technology for resource conservation and sustainable growth have come into prominence. The focus of my research which was initially on technology adoption and productivity growth has now shifted towards conservation of resources and sustainable growth in agriculture policies. In fact, sustainable growth has now become a common agenda for research almost in all disciplines for the last three decades. By this time, Environmental and Resource Economics has become one of the prominent areas of research in Economics and in my post doctoral phase, I have joined this new line of research. The frontline research in this field published in Specialised Journals like *Journal of Environmental Economics and Management*, *Environment and Resource Economics*, *American Journal of Agricultural Economics*, *Oxford Economic Papers*, *Journal of Political Economy*, *Journal of Development Economics*, *Journal of Agricultural Economics*, *Quarterly Journal of International Agriculture* has enriched me to a great extent. Excellent works of the eminent scholars in this field provided the motivation to work on this field. During this phase, I have been immensely benefitted from my friend and renowned scholar, Prof. Sugata Marjit. Professor Marjit is a distinguished trade theorist but he has strong and deep insight in all branches of Economics. My long association and regular interaction with him has increased my interest in economic theory and improved my ability to deal with the problems in proper analytical structure. Since I got interested in growth oriented problems and resource use in dynamic perspective, the writings of Robert Solow, Joseph Stiglitz, Partha Dasgupta, K.G. Mäler, David Zilberman, Robert Barro, Kaushik Basu, Ronald Jones, Christopher Barrett, P.R. Agenor, J.A. Krautkraemer, Stephen Turnovsky provided the necessary skill and insights in formulating the research problems. One book that helped me a lot in pursuing my research in this

field is 'Elements of Dynamic Optimisation' by AC Chiang (McGraw Hill Inc.), 1992.

The three major issues that I have addressed in my book are technological change, conservation of natural resources and sustainable growth in agriculture. Technological change has increased productivity. The growth in productivity has caused resource degradation putting a threat to the sustainability of growth. Again for resource conservation and sustainable growth, appropriate technology is needed. All these are very relevant and much discussed issues in agriculture. But what I have wanted to do is to analyse these problems in an integrated and very comprehensive manner. The whole analysis is based on sound theoretical framework. The question of sustainability has been addressed in a very broader perspective encompassing geography, soil and agro-climatic conditions, rainfall, cropping pattern and technological innovations. The use and management of natural resources have externality problems. So, market failure is there in resource use. Sometimes, market distortions are created by support measures of the government. Nevertheless, public intervention is needed to popularise the use of resource friendly inputs and production techniques and discourage the use of polluting inputs through taxes, subsidies and incentive payments. Sufficient public investment is necessary for the development of new scientific knowledge and innovations. Natural resources are undervalued by private agents. As a result, excess depletion of resources takes place causing threat to sustainability of growth. Here comes the role of the Social Planner who can make proper valuation of costs and benefits of resource use. All these issues have been addressed in this book using appropriate theoretical framework. The theoretical propositions have been empirically verified by time series econometric analyses. The optimal control theory has been extensively used to build up theoretical models to determine optimal use of resources in agricultural growth in dynamic perspective. The techniques of time series analysis as outlined in Walter Enders (2004), John Wiley & Sons, have been applied to the Indian data to derive empirical results. In some chapters I have used the theory of decision-making under uncertainty, the structure of general equilibrium model of Ronald Jones (1965) and the Specific Factor Trade Model of Jones and Marjit (2003) for analysing the problems. All the contemporary issues of agricultural growth like excess depletion of ground water, soil degradation, harvest of rain water, crop diversification, use of organic manure in cultivation, alternative uses of land, food security, the role of the government in resource management and scientific innovations and the importance of the frontiers of technology in future growth of agriculture have been analysed in proper context. I hope, the book will be helpful to readers at Graduation and Master's levels and to researchers. The book could not cover many aspects of agricultural growth. It has basically adopted a supply-side approach in explaining growth. Due to non-availability of data many econometric exercises could not be done. The author admits these deficiencies. The deficiencies may be corrected and the suggestions from the readers may be accommodated in further editions of the book.

The list of persons the author is indebted to in writing this book is very long. First of all, I would like to convey my deep regards and indebtedness to Prof. Asis

Kumar Banerjee who has taught me and trained me for analytical research and has been guiding me in my works for more than three decades. I have got a lot of encouragement, appreciation and valuable help in writing this book. He has been kind enough to write a Foreword for this book. I am very grateful to him. I owe a very special debt to Prof. Sugata Marjit for his encouragement, spontaneous help and valuable guidance at every moment of my academic career. I have learnt many things of my subject from his writings and my interactions and joint works with him. His innovative ideas and clarity in thought and ability to build up beautiful theoretical models have greatly influenced me. He has remained very cordial with me and provided valuable guidance at every stage of writing this book. Apart from being a great scholar, he is also a great human being.

A sizable portion of my unpublished PhD Thesis has been included in this book. Professor Dipankar Coondoo of Indian Statistical Institute, Calcutta and Prof. Debasish Mondal of Vidyasagar University were very generous to extend very valuable help in my PhD work. I am very grateful to both of them. I have been largely benefitted from the interactions with Prof. Rabindranath Bhattacharya, Prof. Manas Ranjan Gupta, Prof. Abhirup Sarkar, Prof. Sarmila Banerjee, Prof. Soumyen Sikdar, Prof. Partha Sen, Prof. Rajat Acharya, Prof. Kausik Gupta, Prof. Ajitava Raychauduri, Dr. Saibal Kar and Prof. Tarun Kabiraj on different problems of my research at different points of time. I am indebted to all of them.

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I spent a long time in K.K. Das College under the University of Calcutta as a permanent teacher. I express my very sincere gratitude to Principal Sanjib Chandra Basu, my colleagues in the college and students for their encouragement and help in pursuing my research in the college. Presently I am in Vidyasagar University. Hon'ble Vice Chancellor of our University, Professor Ranjan Chakrabarti, is a great inspiration for me. He always encourages and provides all sorts of help for academic improvement. I respectfully acknowledge his cordial help and encouragement in writing this book. I also extend my gratitude to my colleagues and students in our Department in the University for their encouragement and cooperation in my academic pursuit.

I express my thanks to Oxford University Press for the permission of using two articles (one from *Oxford Economic Papers* and the other from *American Journal of Agricultural Economics*) partially in my book. I also like to extend my gratitude to

Sage Publication for giving permission to reproduce the modified version of my paper “Crop diversification for Conservation of Water Resource and Agricultural Growth: A Comparative Dynamic Analysis” originally published in *South Asian Journal of Macroeconomics and Public Finance*, Vol. 2, No. 2, Copyright © 2013 Sage Publications India, New Delhi, in my book.

I gratefully acknowledge that my two papers—one published in *Journal of Economics, Finance and Administrative Science* and the other in *Quarterly Journal of International Agriculture* jointly with Hans-Peter Weikard, have been partially used in modified and extended versions as theoretical backup for empirical exercises in my book. So, I convey my sincere thanks to the publishers of these two journals. I am deeply indebted to Springer for their interest in my book. I thankfully express my sincere gratitude to Sagarika Ghosh, Executive Editor, Springer, for her wholehearted cooperation and guidance at every stage in preparing the manuscript of this book.

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