Sustainable Agricultural Practices

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Sustainable Agricultural Practices: Economic and Environmental Implications

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INVESTOR IN PEOPLE

In memory of my teacher
Professor Rabindranath Bhattacharya

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List of Abbreviations

2SLS:	Two-stage least squares
ABP:	Anchor Borrowers' Programme
ADF:	Augmented Dickey–Fuller
AEC:	Architecture, engineering and construction
AGMARKNET:	Agricultural Marketing Information Network
AGS:	Agricultural production by sector
APMC:	Agricultural Produce & Livestock Market Committee
AR:	Auto-regression
ARCH:	Auto-regressive conditional heteroskedasticity
ARDL:	Auto-regressive distributive lag
ASI:	Agricultural Sustainability Index
BIMSTEC:	Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation
CBN:	Central Bank of Nigeria
CII:	Coppock's Instability Index
CO_2:	Carbon dioxide
CO_2 emission:	Carbon dioxide emission
CPI:	Consumer price index
CR:	Convergence rate
CRP:	Crop production
CV:	Coefficient of variation
CVM:	Contingent valuation method
DAP:	Di-ammonium phosphate
DBIE:	Database on Indian Economy
DC:	Dichotomous choice
DEA:	Data envelopment analysis
DEMATEL:	The decision-making trial and evaluation laboratory
DFS:	Dhaka Food System
DOLS:	Dynamic ordinary least square
DW:	Durbin Watson
ECSI:	Economic Sustainability Index
ECT:	Error correction term
EG:	Economic globalization
EKC:	Environmental Kuznets curve
ENSUB:	Environmental sustainability
ESI:	Environmental Sustainability Index

FAO:	Food and Agriculture Organization of the United Nations
FDI:	Foreign direct investment
FFW:	Food for work
FMOLS:	Fully modified ordinary least square
FW:	Food waste
FY:	Fiscal year
GAIN:	Global Alliance for Improved Nutrition
GARCH:	Generalized auto-regressive conditional heteroskedasticity
GDP:	Gross domestic product
GFCF:	Gross fixed capital formation
GHGs:	Greenhouse gases
GIB:	Green innovation business
GJR:	Glosten–Jagannathan–Runkle
GMA:	Gross margin analysis
GMM:	Generalized method of moments
GVA:	Gross value added
GXA:	Total government expenditure
HL:	Half-life of convergence
IFPRI:	International Food Policy Research Institute
IMR:	Infant mortality rate
IPCC:	Intergovernmental Panel on Climate Change
IPM:	Integrated pest management
IPS:	Im, Pesaran, and Shin
IRF:	Impulse response function
LAB:	Population growth
LLC:	Levin, Lin, and Chu
LRI:	Live Rice Index
LSP:	Livestock production
MC:	Marginal cost
MLE:	Maximum likelihood estimates
MSC:	Marginal social cost
M-TAR:	Momentum-threshold auto-regressive
NABARD:	National Bank for Agriculture and Rural Development
NCA:	Necessary condition analysis
NCRMP:	National Cyclone Risk Mitigation Project
NGO:	Non-governmental organization
NTFPs:	Non-timber forest products
OECD:	Organization for Economic Co-operation and Development
OLS:	Ordinary least square
OMS:	Open market sale
PCA:	Principal component analysis
PCAGDP:	Per capita agricultural GDP
PCFW:	Per capita food waste
PCGDP:	Per capita GDP
PGDP:	GDP per capita
POCAA:	Platform of Community Action and Architecture

PRSSP:	Policy Research and Strategy Support Programme
RBI:	Reserve Bank of India
RCA:	Revealed comparative advantage
RRB:	Regional Rural Bank
RUM:	United Nations Educational, Scientific and Cultural Organization
SCBs:	Schedule commercial banks
SDG:	Sustainable development goals
SFR:	Stochastic frontier regression
SLR:	Sea-level rise
SPS:	Sanitary and phytosanitary standard
SSI:	Social Sustainability Index
SWOT:	Strengths, weaknesses, opportunities and threats
TAP:	Total agricultural production
TE:	Technical efficiency
UA:	Urban agriculture
UN SDGs:	United Nations Sustainability Development Goals
UN:	United Nations
UNDP:	United Nations Development Programme
VAR:	Vector auto regression
VECM:	Vector error correction mechanism
VGF:	Vulnerable group feeding
VIF:	Variance inflationary factor
WDI:	World Bank Development Indicator
WFP:	World Food Programme
WTO:	World Trade Organisation
WTP:	Willingness to pay

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Foreword

In the face of growing global challenges such as climate change, population growth and food insecurity, sustainable agricultural practices emerge not only as a choice but also as an imperative. The present book titled *Sustainable Agricultural Practices: Economic and Environmental Implications* stands as a beacon in the international landscape, offering profound insights into the intersection of economics, environment and agriculture. Moreover, the interdisciplinary nature of the contributions underscores the interconnectedness of economic, environmental and social dimensions in agriculture. By integrating perspectives from fields such as economics, environmental science and agriculture, this book fosters a holistic understanding of the challenges and opportunities facing agricultural sustainability.

In this meticulously curated anthology, scholars from diverse backgrounds and regions converge to dissect the many dimensions of sustainable agriculture. Divided into two sections, the book navigates through the economic and environmental implications of agricultural practices, providing a comprehensive understanding of the contemporary agricultural landscape.

The first section, 'Economic Implications of Agricultural Practices in Countries and Groups', delves into the economic complexities that characterize agricultural systems around the world. From examining productivity changes in cereal crops in BIMSTEC countries to examining the role of institutional credit in the development of India's agricultural sector, each chapter offers a nuanced perspective on the economic forces driving agricultural dynamics. In addition, the section illustrates how modern agricultural techniques and entrepreneurial models can catalyse agricultural transformation, as shown in studies from Mexico to Nigeria.

In the second section, 'Environmental Insinuations of Agricultural Practices Across Countries and Groups', the focus shifts to the environmental impacts of agricultural activities. Through empirical investigations and theoretical frameworks, contributions clarify strategies to mitigate greenhouse gas emissions, address environmental degradation and promote sustainable agricultural exercises. From Turkey to Bangladesh, chapters emphasize the global relevance of sustainable agricultural practices to safeguard environmental health and ensure food security.

The breadth and depth of topics covered in this volume underscore the interdisciplinary nature of sustainable agriculture. Scholars from economics, environmental science, agriculture and related fields converge to provide a holistic understanding of the challenges and opportunities facing modern agriculture.

Moreover, by highlighting case studies from diverse geographic contexts, the book underscores the universality of the imperatives of sustainable agriculture and the need for context-specific solutions.

Finally, this book is not only an excellent scientific compendium but also a call to action. It invites policymakers, practitioners, researchers and students to engage in dialogue, innovation and collaboration to forge a more sustainable agricultural future. By integrating economic viability with environmental protection, we can achieve agricultural systems that nourish both people and the planet.

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Preface

The need for food has increased in tandem with the growth in the world's population. In addition to causing environmental harm, the agricultural sectors of the majority of nations have now adopted modern technologies that yield high yield rates. Thus, modern farming methods have both positive and negative effects on the economy and the environment. A number of contaminants combined with agricultural output cast doubt on the sustainability issue's effectiveness. Large-scale agricultural production can release additional greenhouse gases and more hazardous pollutants. Once again, these emissions may have an impact on weather variability, increase the likelihood of climate change and increase the rate of global warming. This may have a greater detrimental impact on the dairy cow feeding industry than on other agriculture-related businesses. Consequently, when the likelihood of a disaster increases, so too may the vulnerability of livelihoods depending on agriculture. But there isn't a reliable and solid model that can calculate the social costs associated with these emissions. Therefore, reducing the dangers of pollution and environmental degradation as well as adapting to climate change and weather unpredictability should not only make farming systems more resilient but also stabilize farmers' output and revenue.

Under the ambiance, the present edited book titled *Sustainable Agricultural Practices: Economic and Environmental Implications* pitches light upon accumulating studies related to economic and environmental aspects of agricultural practices over the years across countries and groups of the world.

The book has compiled of 16 chapters which are divided into two broad sections. Section A covers up the Economic Implications of Agricultural Practices in Countries and Groups containing nine chapters including this introductory chapter and Section B covers up the studies related to the Environmental Insinuations of Agricultural Practices Across Countries and Groups casing seven remaining chapters.

The summary observations are that the countries have experienced rising growth of agricultural sector leading to the improvements in the overall economic activities. There are so many institutional supports from banks, several borrowing programmes and entrepreneurship developments, among others, which have worked as the catalyst for the additional growth progress in the agricultural sector. It has also been observed that the developed countries with high per capita income and relatively low dependence on agriculture sector do waste more food due to their preferences over good quality foods compared to the so-called low income countries. Besides the magnificent achievements in growth front,

the activities in the sector have led to the environmental degradation although a list of studies has focussed on recommending the climate change issues. Zero budgeting towards inorganic fertilizers usage and full budgeting towards organic farming practices is also recommended. Thus, as the concluding observation, the entire book has revealed the spectacular growth of the agriculture sector during the modern times with some sort of negative externalities in terms of environmental degradation. Both developed and less developed economies should focus upon sustainable agricultural practices, as has been recommended by the listed research on the topic to have a better future so that inter-generational equities can be maintained.

The contents of the book may provide thought-provoking solutions to the existing problems – economic and environmental aspects of agricultural practices in order to achieve sustainable development in true sense. The readers and policymakers will be immensely benefitted from the contents of the book.

While executing the book project, the editor got marvellous support from different angles of the academic and social world. The editor acknowledges the support of the entire Emerald Team, the contributing authors and the Foreword writer. Moreover, the editor is beholden to his parents, wife, daughter and other members of the family for their sacrifice and cooperation to divulge the volume. Though, the editor is exclusively accountable for any error that still remains in the book.

Ramesh Chandra Das

Section A

Economic Implications of Agricultural Practices in Countries and Groups

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Chapter 1

Economic and Environmental Implications to Sustainable Agricultural Practices: Insights from the Covered Studies

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Abstract

With the rise in the global population size there has been a parallel increase in the food demand. The agricultural sector in most of the countries has now come up with the uses in the modern technologies resulting into high yield rates besides environmental damage. The new agricultural practices of today have thus both economic positivity and environmental negativity. The present book intends to investigate the growth of agricultural sector and its implications to national output and environmental sustainability. It covers up economic and environmental implications of the agricultural practices in the modern world across the nations and groups of nations. The summary output of the coverage of the entire book shows that modern agricultural practices have led to high growth of the agricultural sector but environment has lost its in situ feature leading to sustainability problems. The recommendations are offered in terms of environmentally sustainable agricultural practices which can mitigate the challenges of climate change.

Keywords: Agricultural practices; productivity; climate change; food waste; zero budgeting; entrepreneurship; food waste; sustainability

Introduction

The world now is with a population load of around 800 crore and a giant share of this belongs to the Asia and African continents. With the rise in the population size there has been a parallel increase in the food demand. The agricultural

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sector in most of the countries has now come up with the uses in the modern technologies with chemical fertilizers, pesticides and insecticides. There has been application of crop insurance against agricultural credit which leads to secured production leading to increase in supply chains involving exports and imports of agricultural produces. The countries' gross domestic product (GDP) in the head of agriculture sector is going up over the years, although the share of the agricultural sector in total GDP in most of the countries are going down (Čolović & Petrović, 2014; Das, 2023; Das et al., 2018; Duxbury, 2001; Enjolras et al., 2012; Gangopadhyay, 2004).

Amalgamation of several pollutants, particularly the methane emission, with agriculture production creates doubt over the efficacy of sustainability issue. Massive agriculture production can emit more vulnerable pollutants along with other greenhouse gases. Again, such methane emissions may affect weather variability and multiply climate change risks and the magnitude of global warming. This can affect dairy cattle feeding sector along with other agriculture-based activities more severely. As a consequence, the vulnerability of agriculture-based livelihoods may increase with induced disaster risks. However, there is no definite and robust model which can estimate social costs from such emissions. Hence, by minimizing environmental degradation and pollution risks along with adaptation to climate and weather variability risks should not only increase resilience of farmers' production systems but also stabilize their output and income. Identification and reduction of above-stated uncertainties and risk factors in terms of anticipatory adaptation may raise the potentiality of sustainability paradigm (Das & Mukherjee, 2020; Haddad, 2005; Hope, 2008; Volenzo, 2019). Therefore, climate change adaptation policies in the agricultural sector along with adaptation to control methane emissions are to be implemented for getting sustainable development.

In some parts of the world, the agricultural transformation from the low-productive natural sources to high-productive technology-based sources is known as the 'green revolution' which has made a vast part of the world, particularly of the Asia and African zones, food-secured. It is not that the cent per cent population is now out of the poverty network. Though a vast part of the world is food-secured, the technology-based modern agricultural practices have contributed a huge number of pollutants (such as carbon emission, methane, nitrogen, etc.) to the ambient environment making the growth and development process unsustainable.

Objectives of the Book

It is in this juncture, this book titled *Sustainable Agricultural Practices: Economic and Environmental Implications* aims to emphasize upon the economic and environmental aspects of agricultural practices over the years across countries and groups of the world. The readers from the disciplines such as Pure Economics, Agricultural Economics and Agricultural Science and Environmental Science are expected to be the main beneficiaries of the contents of the book.

Outcomes of the Chapters and Their Analysis

The book has the assembling of 16 chapters that are divided into two broad sections. Section I covers up the Economic Implications of Agricultural Practices in Countries and Groups containing nine chapters including this introductory chapter, and Section II covers up the studies related to the Environmental Insinuations of Agricultural Practices across Countries and Groups casing seven remaining chapters. The brief sketch of all the chapters is outlined below.

Chapter 2 attempts to analyse the change in productivity and cropping pattern among the Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation (BIMSTEC) countries that comprises with Bangladesh, Bhutan, India, Myanmar, Nepal, Sri Lanka and Thailand. The study also examines the performance of BIMSTEC countries in exporting the agricultural products. For the empirical investigations the study uses co-efficient of variation, Coppock's instability index and Balassa's index. The study reveals that productivity and cropping pattern of the cereal production have been changing gradually over time in all BIMSTEC countries which shows the importance of products substitution. It also reveals that the development cooperation among the BIMSTEC countries through promotion of exports and imports is required to meet their needs.

Chapter 3 has attempted to relate the socio-economic aspects to the valuation of two most used as well as popular natural resources on which people of Sundarbans largely depend for survival – agriculture and fishery applying the very popular and appropriate methodology for valuation of natural resources – contingent valuation method – to get an idea about the valuation of these two resources by the stakeholders of the region. It is observed that people of Sundarbans are not only steadily reliant upon the use of these two resources for livelihood generation but they are very much eager to protect and sustainably use these resources as well, obviously except the problem of 'illegal bottom trawling'.

Chapter 4 investigates the fluctuations and instability of the two crops, paddy and wheat, in the states of India for the period 2006–2023 using coefficient of variation (CV), Cuddy-Della Valle index and Coppock's index. Then it estimates volatility by GARCH framework. It is observed that the average standard deviation of prices across mandis for paddy in a given month is 0.18 and for wheat it is 0.22. Both for paddy and wheat Punjab has the maximum instability among the three states if we consider CV and Coppock's index. But if we consider the Cuddy-Della Valle index, Madhya Pradesh has the maximum instability for wheat. The observed volatility in the price series of paddy revealed that the value of ARCH term has significant term and value of GARCH term is also significant for all the price series.

Chapter 5 investigates the evolving dynamics of India's agricultural sector, particularly the shift from reliance on informal money lenders to a more prominent role of institutional credit in recent decades employing the Vector Autoregressive methodology on data spanning from 1990 to 2022. To address the issue, researchers used direct institutional credit and the share of gross value-added (GVA) of agriculture and allied sectors at current prices, finding that neither of them causes

the other. Further analysis concludes that in the future, the contribution of credit will have some impact on development.

Chapter 6 aims to examine the market of fertilizers in México during the pandemic crisis using the analytical-descriptive and the critical reflexive based on the quantitative data which points out that the consumption of fertilizers has undergone a change in the structure in favour of consumers with the highest concentration and diversification. To take advantage of the opportunities arising from the crisis, it analysed the functioning of an integral model of entrepreneurship in green innovation business (GIB) that is currently emerging and in the process of internationalization. With respect to the GIB and eco-efficient company through the comprehensive method of entrepreneurship, it is observed that just as the company has some advantages in the product, it is also with many threats that are the large companies that are already positioned and that also compete with competitive prices.

Chapter 7 examines whether the countries having high agriculture as well as per capita incomes are responsible for food waste or not using the data on food waste out of export and import channels across the world's selected 20 countries having about 70 per cent contribution to food waste for the period 1971–2019. It finds that food waste is associated with agriculture as well as per capita incomes of the developing and developed countries (DCs), positive for majorly developing countries and negative for majorly DCs. The time series analysis involving food waste, per capita agriculture income and per capita income as the indicators, the study finds that there are long-run relations among them across many countries implying countries having high incomes are responsible for food waste in most cases due to their food preference, although having good infrastructural facilities for preservation of foods.

Chapter 8 inspects the improvement of rice production in Nigeria through the government's policy of the Anchor Borrowers' Programme (ABP) using a cross-sectional survey research design to measure rice production and ABP in Ebonyi State, Nigeria. Applying regression technique, the study reveals the need for the ABP, banks and other lending agencies/programmes to train farmers. It shows that modern farming contributes to rice production in Ebonyi State.

Chapter 9 attempts to explore how a shift toward zero-budget farming from inorganic farming can improve the access of agricultural goods, as predominant component of their export basket, to the markets in DCs, given the rising stringency of sanitary and phytosanitary and environmental standards, as well, coming disproportionately against the exports from developing and less-developed countries (LDCs), including India. With reference to Balassa's the measure of Revealed Comparative Advantage, the chapter points to the dwindling competitive advantage of India's agriculture in global market during the last decade. Given the stringent environment standard facing, disproportionately, the exports from LDCs, zero-budget farming can improve the access of agricultural goods, as predominant component of their export basket, to the markets in DCs.

Chapter 10 mentions that agriculture plays an important role in human life, contributing to the national economy. Though its biggest problems lying in the carbon gas emission during production through fertilizing activities, etc., the

study is aimed to determine the most appropriate strategy for carbon emission in this study. As a result of the DEMATEL analysis, it was seen that the most appropriate strategy was effective regulations and auditing.

Chapter 11 points out that sustainable agriculture comprising with environmentally friendly farming methods allows crops to be produced without harming natural systems and preventing adverse impacts on soil, water, biodiversity as well as surrounding or downstream resources and analyses all issues related to mitigating environmental degradation through agricultural sustainability. It helps to take necessary measures for designing and its actual execution. The study constructed a composite index of agricultural sustainability by applying the principal component analysis method where significant differences in agricultural sustainability were found among the states in India. It is also to mention that agricultural sustainability has improved for all states in 2019 compared to 2016.

Chapter 12 aims to examine the interrelationships between crop production, livestock production, transport services and CO_2 emissions from 1998 to 2019. To achieve this goal, the study begins by conducting stationary tests to determine the order of integration for the variables under consideration. Following this, panel unit root tests are employed, and subsequently, panel cointegration tests are conducted to identify any long-term relationships among the selected variables. The findings reveal a significant long-term relationship among crop production, livestock production, transport services and CO_2 emissions.

Chapter 13 investigates agricultural production by sector, convergence and environmental sustainability using West African countries as a case study for the period 2000–2022 using system dynamic panel-data estimation. Based on the findings, it is concluded that there is a divergence effect of agricultural production by sector. The agricultural growth levels of economies are diverging, at a rate of 0.03%, 0.02% and 0.02%, respectively, for the crops subsector, livestock subsector and total agricultural production.

Chapter 14 focuses on the importance of undergraduate and graduate curriculums of future architecture, engineering and construction (AEC) industry professionals to equip them with the skills and knowledge of sustainable agricultural practices and technologies integrated greenhouses, built environment and indoor environment and interior design. For this reason, agricultural policies need to cover food security-related interdisciplinary education and training (e.g. renewable energy-based agriculture integrated built environment) of AEC industry professionals. The study recommends that agricultural policies need to be designed with the contribution of, and considering, AEC industry professionals as they are among the main stakeholders of food security and renewable energy-based agriculture-integrated built environment and how it makes compliance with United Nations Sustainable Development Goals and countries sustainable and resilient development plans can contribute to food security and sustainability.

Chapter 15 examines the technical efficiency of small pond fishery using the stochastic frontier model in the northern region of the state of West Bengal in India taking the data from field surveys in Uttar Dinajpur and Dakshin Dinajpur districts for three months (i.e. from May to June) in the year 2022. The estimated stochastic frontier model revealed that investment in labour, organic fertilizers,

fish fingerling and land area could increase the return from fish production. The result shows that technical efficiency ranges from 83 to 100 per cent with a mean efficiency of 94 per cent implying that average fish farmers in the study area are performing below the maximum possible production level by a shortfall of about 6 per cent, though with the issue of sustainability.

The final chapter, that is, Chapter 16, explores Bangladesh's vulnerability to environmental stressors and climate change impacts which significantly affect food availability and agricultural productivity highlighting the pervasive issue of food safety in the country, identifying contaminants such as pesticide residues as a major threat to public health and food security. Then it focuses on the country's huge potential to ensure technology-driven agriculture production that may further strengthen food security and the economy with a special focus on the governance and environmental issues in ensuring sustainable agriculture. It recommends that the Government of Bangladesh needs to adopt a policy that will ensure the national interest and the safety of the citizens inside the country which will help to avoid any devastating food crisis during emergencies and international disputes.

Summary

The studies so far covered up in the book have mainly aimed at examining the economic and environmental implications of agricultural practices in countries and groups. The summary observations are that the countries have experienced rising growth of agricultural sector leading to the improvements in the overall economic activities. There are so many institutional supports from banks, several borrowing programmes, entrepreneurship developments, among others, which have worked as the catalyst for the additional growth progress in the agricultural sector. It has also been observed that the DCs with high per capita income and relatively low dependence on agriculture sector do waste more food due to their preferences over good quality foods compared to the so-called low income countries. Beside the magnificent achievements in growth front, the activities in the sector have led to the environmental degradation although a list of studies have focused on recommending the climate changing issues. Zero budgeting toward inorganic fertilizers usage and full budgeting toward organic farming practices is also recommended. Thus, as the concluding observation, the entire book has revealed the spectacular growth of the agriculture sector during the modern times with some sort of negative externalities in terms of environmental degradation. Both developed and less-developed economies should focus upon sustainable agricultural practices, as has been recommended by the listed research on the topic to have a better future so that inter-generational equities can be maintained.