

ISBN: 978-93-94174-05-4

Recent Trends in Bioresource Management for Greener Environment

Editors

Dr. Mani Jayakumar

Dr. Natchimuthu Karmegam



Excellent Publishers



Recent Trends in Bioresource Management for Greener Environment

Editor(s)

Dr. Mani Jayakumar

Assistant Professor of Chemical Engineering, and Chair Process Engineering, Haramaya Institute of Technology,
Haramaya University, P.O. Box 138,
Dire Dawa, Ethiopia

Dr. Natchimuthu Karmegam

Assistant Professor, PG and Research Department of Botany,
Government Arts College (Autonomous), Salem-7, Tamil Nadu,
India

ISBN: 978-93-94174-05-4

<https://doi.org/10.20546/978-93-94174-05-4>



Excellent Publishers



Excellent Publishers

Kancheepuram, India

www.excellentpublishers.com

email id: excellentpublishers2013@gmail.com

Copyright © 2022 Excellent Publishers. All rights reserved.

Publisher: Excellent Publishers

Editors: Dr. Mani Jayakumar and Dr. Natchimuthu Karmegam

ISBN: 978-93-94174-05-4

DOI: <https://doi.org/10.20546/978-93-94174-05-4>

Note: No part of this publication may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopying, recording, or any information storage and retrieval system, without permission in writing from the publisher.

Table of Contents

Contents		Page No.
Chapter-1 Study of Reduction in Greenhouse Effect using Biochar on Wetlands <i>P. K. Sindhu , K. Aneesh, G. Abirami, M. Suganthi and K. Ashok Kumar</i>		1-12
1.1	Introduction	2
1.2	Fast pyrolysis	4
1.3	Advantages of using Biochar (Ippolito et al., 2012)	4
1.4	Limitations of biochar	5
1.5	Biochar in agriculture	5
1.6	Effect of biochar on greenhouse gases	6
1.7	Conclusions	9
	References	9
Chapter-2 Black Gold - A New Era of Fertilizers <i>P. Akila Vaishnavi, M. Jayanthi and M. Thenmozhi</i>		13-31
2.1	Introduction	15
2.2	Darwin's studies on earthworms	15
2.3	Morphology of earthworms	16
2.4	Biology of earthworms	16
2.5	Types of earthworms	18
2.6	Characteristics of earthworms	20
2.7	Substrate source	20
2.8	Vermicomposting	21
2.9	Vermicasts	24
2.10	Vermiculture	24
2.11	Vermiwash	25
2.12	Precautions during the Process	26
2.13	Advantages of vermicompost	27
2.14	Conclusion	28
	References	28
Chapter-3 Banana Waste: An Efficient Substrate for Eco-Friendly Vermitechnology <i>R. Subalakshmi, M. Vishnu Priyan, Jayanthi Malaiyandi and K. Ashok Kumar</i>		32-47
3.1	Introduction	33
3.2	Vermicompost	34
3.3	Musa paradisiacal and its constituent	36

3.4	Banana waste as manure	38
3.5	Vermitechnology using banana waste	40
3.6	Application	41
3.7	Conclusion	42
	References	43
	<p style="text-align: center;">Chapter-4 Earthworms and Vermicomposting: Nature's offering of Organic Waste Valorization <i>Joys Selva Mary Albert</i></p>	48-63
4.1	Introduction	49
4.2	Earthworm	50
4.3	Anatomical characteristics of earthworms	50
4.3.1	Bilateral Symmetry	50
4.3.2	Locomotion	50
4.3.3	Respiratory System	51
4.3.4	Circulatory System	51
4.3.5	Brain & nervous system	51
4.3.6	Reproductive system	51
4.4	Earthworms species	52
4.5	Types of earthworms	53
4.5.1	Epigeics	53
4.5.2	Endogeics	54
4.5.3	Anecics	54
4.6	Ecological role and Economic importance of Earthworms	55
4.7	Vermiculture – definition, scope and importance	55
4.7.1	Vermiculture	55
4.7.2	Vermitechnology	55
4.7.3	Vermicompost	56
4.7.4	Vermicomposting – applications, future perspectives	56
4.7.5	Vermicompost preparation	57
4.7.6	Favourable conditions of earth worms in the composting material	57
4.7.7	Procedure	57
4.7.8	Precautions	58
4.8	Transportation of live worms	58
4.9	Application rate	59
4.10	Harvesting of the vermicompost from the pit	59
4.11	Advantage of Vermicompost	59
4.12	Potentials for vermiculture in India	60
4.13	Vermiwash	60
4.13.1	Method of preparation	61
4.14	Application of vermiwash	61

4.15	Conclusions	62
	References	62
	<p style="text-align: center;">Chapter-5 Aerobic and Anaerobic Digestion: Opportunities for Safe Biowaste Disposal <i>C. Siluvai Kirubagari Aneeshia</i></p>	64-83
5.1	Introduction	64
5.2	Aerobic digestion	65
5.3	Phases of composting	66
5.3.1	Mesophilic phase	66
5.3.2	Thermophilic phase	67
5.3.3	Maturation phase	67
5.4	Composting technologies	67
5.4.1	In-vessel composting	67
5.4.2	Aerated static pile composting	68
5.4.3	Windrow composting	69
5.5	Advantages	70
5.6	Disadvantages	70
5.7	Anaerobic digestion	70
5.8	Process	71
5.9	Process stages	71
5.9.1	Hydrolysis	71
5.9.2	Acidogenesis	72
5.9.3	Acetogenesis	72
5.9.4	Methanogenesis	72
5.10	Applications	72
5.11	Products	73
5.11.1	Biogas	73
5.11.2	Digestate	73
5.11.3	Wastewater	74
5.11.4	Factors affecting anaerobic digestion	74
5.11.5	pH value range	74
5.11.6	Operating temperature	75
5.11.7	Loading rate	75
5.11.8	Retention time	76
5.11.9	Composition of the food waste	76
5.12	Reactors	76
5.12.1	Categories of Digesters	76
5.12.2	Passive Systems	77
5.12.3	Low Rate Systems	77
5.12.4	High Rate Systems	77
5.12.5	Passive Systems	77

5.12.6	Covered lagoon	77
5.12.7	Low Rate Systems	78
5.12.8	Complete Mix Digester	78
5.12.9	Plug Flow Digester	79
5.12.10	Mixed Plug Flow Digester	79
5.12.11	High Rate Systems	79
5.12.12	Solids Recycling	79
5.12.13	Fixed Film Digester	80
5.12.14	Suspended Media Digesters	81
5.12.15	Sequencing Batch Reactor	82
6	Conclusions	82
	References	82
	Chapter-6	
	Bioremediation of Plastics by Microbes <i>Murugesan Srimathi, Krishna Kumar Ashok Kumar, Muthusamy Suganthi, Malayandi Jayanthi and Gopalakrishnan Abirami</i>	84-95
6.1	Introduction	85
6.2	Plastics Types and Composition	85
6.3	Common plastics	85
6.4	SPI Code of 1	86
6.5	SPI Code of 2	86
6.6	SPI Code of 3	86
6.7	SPI Code of 4	86
6.8	SPI Code of 5	86
6.9	SPI Code of 6	87
6.10	SPI Code of 7	87
6.11	Thermoplastics	87
6.12	Thermosetting polymers	87
6.13	Adverse Effect of Plastics	88
6.14	Hazards of Plastics	88
6.15	Treating Plastics with Chemicals for Degradation	88
6.16	Biodegradation of Plastics	89
6.17	Plastic Degradation by Enzymes	89
6.18	Esterases	90
6.19	Polyestrerases	90
6.20	Cutinases	90
6.21	Lipases	90
6.22	Laccases	90
6.23	Enzymatic Hydrolysis	91
7	Conclusions	93
	References	93

	Chapter-7 Heavy Metals (HMs) Dynamics During Vermicomposting of Organic Wastes: Current Understanding and Future Prospects <i>Tridip Boruah and Hemen Deka</i>	96-113
7.1	Introduction	97
7.2	Heavy metals as pollutants	98
7.3	Quantification methods of HMs in vermicompost	100
7.3.1	Inductively Coupled Plasma Emission Spectroscopy	100
7.3.2	Graphite furnace atomic absorption spectrophotometry	100
7.3.3	Atomic Absorption Spectroscopy	101
7.3.4	Spectrophotometric analysis	101
7.3.5	Microprocessor-controlled voltammetry	102
7.4	The fate of heavy metals in vermicomposting	102
7.4.1	Role of earthworms in bioaccumulation of heavy metals	102
7.4.2	Role of microbes in degradation of heavy metals	104
7.5	Pros and cons of heavy metal degradation through vermicomposting	105
7.6	International and National regulations for heavy metals	107
7.7	Conclusion and future directions	108
	References	109
	Chapter-8 Phytochemistry, Pharmacology and Biological Activities of <i>Phyllanthus</i> spp.: A Promising Bioresource for Medical Applications <i>V. Soundarya, M. Prakash and N. Karmegam</i>	114-161
8.1	Introduction	115
8.2	Taxonomic Position	115
8.3	Morphological Description	116
8.4	Phytochemical components of <i>Phyllanthus</i> spp.	117
8.5	Biological and Pharmacological Activities of <i>Phyllanthus</i> spp.	140
8.5.1	Anti-inflammatory Activity	141
8.5.2	Antimicrobial activity	141
8.5.3	Antidiabetic Activity	141
8.5.4	Anticancer Activity	142
8.5.5	Antioxidant Activity	142
8.5.6	Anti-fibromyalgic Activity	142
8.5.7	Anti-fertility Activity	142
8.5.8	Mosquito Larvicidal Activity	142
8.5.9	Antinociceptive Activity	143
8.5.10	Hepatoprotective Activity	143
8.5.11	Immunosuppressive Activity	143
8.5.12	Antiallergic Activity	143

8.6	Antimicrobial Activity of Nanoparticles Synthesized Using <i>Phyllanthus</i> spp.	143
8.7	Conclusions	144
	References	144
	<p style="text-align: center;">Chapter-9 Weeds as Bioresources for Vermifertilizer Production: Present Scenario and Prospects <i>V. Soundarya, M. Prakash and N. Karmegam</i></p>	162-180
9	Introduction	163
9.1	Weed biomass availability	163
9.2	Indiscriminate disposal of weed biomass	163
9.3	Different composting methods of weed utilization	163
9.4	Earthworms and vermicomposting	163
9.5	Weed biomass utilization in vermicomposting	164
9.6	Characteristics of vermicompost	164
9.6.1	Physico- chemical characteristics of vermicompost obtained from weed biomass	164
9.6.2	Enzymes and microfloral activity in weed biomass derived vermicompost	164
9.7	Nutrient enhancement of vermicomposting	164
9.8	Prospects and challenges of weed biomass vermicomposting	165
9.11	Conclusions	174
	References	174
	<p style="text-align: center;">Chapter-10 Nanomaterials for Green Environment: Sources, Synthesis, Characterization, Applications, Prospects and Challenges <i>Abas Siraj Hamda, Melkiyas Diriba Muleta, Lata Deso Abo, Mani Jayakumar</i></p>	181-200
10.1	Introduction	182
10.2	Sources of nanomaterials	182
10.3	Classification of nanomaterials	184
10.3.1	Inorganic-based nanomaterials	184
10.3.1.1	Silica-based nanomaterials	185
10.3.2	Organic-based nanomaterials	185
10.3.3	Carbon-based nanomaterials	186
10.3.4	Composite-based nanomaterials	186
10.4	Synthesis of nanomaterials	186
10.4.1	Top-down approaches to nanomaterial synthesis	187
10.4.1.1	Mechanically-synthetic methods	188
10.4.1.2	Sputtering	188
10.4.1.3	Lithographic methods	188
10.4.2	Bottom-up approaches to nanomaterial synthesis	189

10.4.2.1	Sol-gel method	189
10.4.2.2	Solvothermal synthesis	189
10.5	Characterization of nanomaterials	189
10.5.1	Mechanical properties of nanomaterials	190
10.5.2	Chemical properties of nanomaterials	191
10.6	Applications of nanomaterials	191
10.6.1	Medical applications	192
10.6.2	Environmental applications	193
10.6.3	Agricultural applications	193
10.6.4	Catalytic applications	194
10.6.5	Electronic applications	194
10.7	Prospects	195
10.8	Challenges	195
10.9	Conclusions	195
	References	196
	Chapter-11 Effects of Abiotic Stress Components on Wheat Grass <i>Indrani Chandra, Pintu Singh Sardar and Sushobhan Sen</i>	201-210
11.1	Introduction	201
11.2	Application of wheat grass juice	204
11.3	Impact of biotic & abiotic stress on plant system	204
11.4	Effect of elicitor on plant secondary metabolism	205
11.5	Ascorbate glutathione pathway	206
11.6	Conclusion	207
	References	207
	Chapter-12 Deforestation and Rainfall in East Kalimantan <i>Akas Pinaringan Sujalu*, Zuhdi Yahya, Ismail, Zikri Azham, Legowo Kamarubayana, Maya Preva Biantary, Heni Emawati, Jumani, Marisi Napitupulu, Noor Jannah, Taufan Tirkaamiana, Hery Sutejo, Puji Astuti, Helda Syahfari, Abdul Patah, Abdul Rahmi and Sri Endayani</i>	211-219
12.1	Introduction	211
12.2	Results and Discussion	212
12.2.1	Climate in Lokus	212
12.2.2	Discussion	213
	References	218
	Chapter-13 Formulation and Evaluation of Novel Herbal Gel of Mimosa pudica Linn., fruits extract <i>R. Bhramaramba*, V. Anitha Kumari, V. Mrudula Raj</i>	220-227
13.1	Introduction	212
13.2	Materials and Methods	212

13.2.1	Plant Materials	212
13.2.2	Chemicals	213
13.2.3	Animals	213
13.2.4	Preparation of Topical Gel	213
13.2.4.1	Method for Preparation of Gel Containing Extract	213
13.2.4.2	Formulation	213
13.2.5	Evaluation of Topical Gel Formulation	214
13.2.5.1	Physical Evaluation	214
13.2.5.2	Measurement of pH	214
13.2.5.3	Spreadability	214
13.2.5.4	Stability Study	214
13.2.5.5	Extrudability	214
13.2.5.6	Viscosity	215
13.2.6	Application of Herbal Gel and Skin Irritation Study	215
13.3	Results and Discussion	215
13.4	Conclusion	217
13.5	Acknowledgements	217
13.6	References	217
	<p style="text-align: center;">Chapter-14 Applications of Industry 4.0 & its Impact on Economic Growth and the Agriculture Sector <i>Chandra Prakash Dewangan</i></p>	228-236
14.1	Introduction	228
14.2	Objective and Method	229
14.3	The Importance of the Agricultural Sector In Terms of Economic Growth	230
14.3.1	Contribution to Poverty Reduction	230
14.3.2	Market Contribution	230
14.3.3	Contribution as a Production Factor	231
14.3.4	Contribution to Foreign Exchange	231
14.4	Problems in Agricultural Production and the Causes of Insufficient Product Supply to Meet Demand	232
14.5	Industry 4.0 and the Digital Transformation of the Agriculture Sector	233
14.6	Industry 4.0 Applications in Agriculture	233
14.7	Agricultural Robots and Agricultural Production Worldwide	234
14.8	The Impacts of Industry 4.0 Applications in Agriculture on Economic Growth	236
14.8.1	Negative Effects	236
14.8.2	Positive Effects	237
14.8.2.1	Environmental Impacts	237
14.8.2.2	Cost Reduction	237

14.8.2.3	Increased Production	237
14.8.2.4	Poverty Reduction	238
14.9	Discussion and Conclusion	238
14.10	References	240
	Chapter-15 The Role of Paper Mills in India's Agronomy: Integrating Agro Industry with Sustainable Agriculture <i>Amit Sharma</i>	237-250
15.1	Introduction	238
15.2	Agro-Residue Availability and Utilization Gaps	239
15.3	Regional Resource Hotspots	240
15.4	Barriers to Greater Utilization	240
15.5.2	Soil Health and Microbial Activity	241
15.5.3	Crop Diversification and Strengthened Market Linkages	241
15.5.4	Rural Employment and Ancillary Economic Benefits	242
15.6	Feedback Loop: Paper Mills Supporting Agronomy	242
15.6.1	Contract Farming and Buy-Back Arrangements	242
15.6.2	Capacity Building and Training Initiatives	242
15.6.3	Infrastructure Development and Rural Market Strengthening	243
15.6.4	Enhancing Agronomic Resilience and Sustainability	243
15.7	Environmental and Soil Health Considerations	243
15.7.1	Striking the Balance: Residue Removal vs. Soil Organic Matter	243
15.7.2	Soil Degradation & Policy Linkages	244
15.7.3	Wider Environmental Co-benefits	244
15.8	Policy Support and Future Prospects	244
15.8.1	National Policy Framework	244
15.8.2	Emerging Policy Enhancements	245
15.8.3	Future Outlook and Scaling Potential	245
15.8.4	Paper Types Produced by Indian Mills and Production Breakdown	246
15.10	Agro-Residue's Role in Decarbonizing the Paper, Printing, Packaging & Publishing Ecosystem	247
15.10.1	Reduced Carbon Footprint of Raw Material Sourcing	247
15.10.2	Circular Economy Integration in Print and Publishing	247
15.10.3	Sustainability in Packaging	247
15.10.4	Certifications and Market Perception	247
15.11	Conclusion	248
	References	249

Preface

Bioresources (animals, microorganisms, plants) and their usage have been increasing rapidly, due to their era and administration hone towards making a cleaner environment. Biowaste transfer takes after the developing worldwide human populace has commended the chase to certain strategies economically for the biowaste administration to overpower the environmental issues, provoked by implications of the collection of such squandered materials. The bioconversion handles of the different biowaste into tall esteem included items appears to be practicable in different scenes in terms of an innovative and budgetary bolster.

This book, “Recent Trends in Bioresource Management for Greener Environment” covers the latest developments in biomass resources, biomass conversion, aerobic and anaerobic digestion, waste valorization, biofuels, biorefinery, and circular economy, vermicomposting advances in composting, heavy metal elimination, hazardous pollutants and treatment methods, water and wastewater management approaches for the production of various value-added products and bioenergy by the utilization of various solid and liquid renewable feedstocks.

Recent Trends in Bioresource Management for Greener Environment is a hands-on reference for faculty members, researchers, scientists, and practicing engineers working on various fields of biomass resources, biomass conversion, aerobic and anaerobic digestion, waste valorization, biofuels, biorefinery and circular economy, phytoresources for human and environmental well-being, vermicomposting, advances in composting, heavy metal elimination, hazardous pollutants and treatment methods, water, and wastewater management.

This book is a good source of information addressing industrial problems relevant to undergraduate, postgraduate, and research students under different academic departments such as agricultural engineering, biotechnology, bioenergy engineering, chemical engineering, energy engineering, environmental engineering, food technology, microbiology, and process engineering in various colleges, universities, research institutes, and higher education academic institutions.

Dr. Mani Jayakumar
Assistant Professor of Chemical Engineering, and Chair
Process Engineering, Haramaya Institute of Technology,
Haramaya University, Ethiopia

Dr. Natchimuthu Karmegam
PG and Research Department of Botany,
Government Arts and Science College (Autonomous),
Salem -7

About the Editors



Dr. Mani Jayakumar received Doctoral Degree in Faculty of Engineering and Technology with Biotechnology specialization from Vinayaka Missions University in 2011. He is having 18 years of teaching and research experience in Engineering. He qualified his UG and PG degrees in Chemical Engineering from University of Madras (2003), and Industrial Biotechnology from the Faculty of Engineering and Technology, Annamalai University (2005), respectively. At present, he is servicing in the Department of Chemical Engineering as Assistant Professor cum Organizing Chair for PG-Process Engineering Program at Haramaya University, Ethiopia since October 2015. He had engaged with various positions in different Engineering Institutions (as Principal at Sri Ramana Maharishi College of Engineering, Tamil Nadu, India; as Head In charge cum Assistant Professor at Dept. of Chemical Engineering and Biotechnology, Arulmigu Meenakshi Amman College of Engineering, Tamil Nadu, India; as Lecturer in Biotechnology Department at Vinayaka Missions University, Tamil Nadu, India, and as Department in-charge in Chemical Engineering at Thirumalai Engineering College, Tamil Nadu, India).

He has potential research outcomes on the different Chemical Engineering themes, such as Biochemical Engineering, Bioenergy Engineering, Solid Waste Management, Wastewater Treatment, and Hybrid and Nanomaterials. He published 49 reputed impacted journal articles and 19 chapters with research citations, 866; h-index, 14 and i10 index, 20. As co-curricular activities, he is acting as Editorial Board Member for “International Journal of Current Microbiology and Applied Sciences” journal. He is also the potential reviewer of several journals such as Chemosphere, Environmental Pollution, Environmental Research, Fuel, Materials Letters, Science of the Total Environment, Urban Climate, Environmental Science and Pollution Research, Biomass Conversion and Biorefinery, Plos One, Science and Education Publishing, etc. He has undertaken to advice couple of PhD scholars under pursuing and couple of PhD scholars have completed. So far, he has been invited as resources key person & given talks and tutorials in numerous conferences, seminars, faculty development workshops and training programmes, and also acted as examiner, chairman, judge, panel member and reviewer in examination, conference, proposal review workshop, seminars and so forth.



Dr. N. Karmegam is an Assistant Professor of Botany, Government Arts College (Autonomous), Salem-7, Tamil Nadu, India. He obtained his PG and Ph.D., degrees from The Gandhigram Rural Institute (Deemed University), Gandhigram. He is having more than twenty years of teaching and research experience. His research interest includes medicinal and aromatic plants, phytochemistry, biomass valorization, waste management, vermitechnology and environmental remediation. His guidance has led to the award of 15 M. Phil., and 9 Ph.D., degrees. He is a recipient of Young Scientist and Best Researcher awards and he has published over 90 scientific articles in reputed Scopus indexed journals with a cumulative impact factor >600 and contributed 15 book chapters.

As a Guest Editor, he has compiled the following special issues/books:

- (1) *Vermitechnology I* (2009), GSB, Japan.
- (2) *Vermitechnology II* (2010), GSB, Japan.
- (3) *Vermitechnology III* (2012), GSB, Japan.
- (4) *Status, Trends, and Advances in Earthworm Research and Vermitechnology* (2010), Hindawi Publications, UK.

Presently, he is serving as a Guest Editor for the Special Issues:

- (1) Aerobic and Anaerobic Digestion of Agro-Industrial and Livestock Wastes: A Green and Sustainable Way toward the Future (2021) – Journal: *Agronomy* (MDPI).
- (2) Environmentally safe management strategies for biowaste and emerging pollutants (2022) – Journal: *Environmental Research* (Elsevier).

Dr. N. Karmegam is currently serving as Editor for two international journals and Review Editor for six different disciplines of *Frontiers Journals* (*Microbiology, Energy Research, Water, Chemical Engineering, Soil Science and Waste Management*).

Recent Trends in Bioresource Management for Greener Environment

Edited by Dr. Mani Jayakumar, Dr. Natchimuthu Karmegam

Dr. Mani Jayakumar

Assistant Professor of Chemical Engineering, and
Chair Process Engineering, Haramaya Institute of Technology,
Haramaya University, P.O. Box 138,
Dire Dawa, Ethiopia

Dr. Natchimuthu Karmegam

Assistant Professor, PG and Research Department of Botany,
Government Arts College (Autonomous), Salem-7,
Tamil Nadu, India



Published by
Excellent Publishers

No.:38/48, Second Street, Ellappanagar, Kancheepuram, Tamilnadu, India
www.excellentpublishers.com e.mail: excellentpublishers2013@gmail.com
Mobile No.: +91-9842641794