

## CONTENTS

---

<b>Executive Summary .....</b>	xxvii-lx
<b>Abbreviations.....</b>	lxi- lxxvi

### SECTION -1

#### **THE BIOLOGY AND AGRICULTURE OF SUGARCANE**

1.1 History .....	1
1.2 National and Global Status .....	7
1.2.1 Sugarcane .....	7
1.2.2 Sugar Industry .....	16
1.2.3 Sugarcane Economics .....	21
1.3 Taxonomy of Sugarcane ( <i>S. Officinarum</i> ) .....	26
1.3.1 <i>Saccharum spontaneum</i> .....	30
1.4 Inflorescence .....	31
1.5 Leaf.....	32
1.6 Root.....	35
1.7 Stem.....	36
1.8 Physiology and Nutrition .....	40
1.9 Flowering, Fruiting and Seed germination .....	59
1.10 Planting, Agriculture and Seed Certification .....	61
1.10.1 Cultivation practices .....	68
1.10.2 Planting Methods .....	70
1.10.3 Germination .....	75
1.10.4 Mechanization in managing Sugarcane Plantations .....	76
1.10.5 Ratoon Management.....	82
1.10.6 Some Implements used in Sugarcane Cultivation.....	84
1.10.7 Production Constraints .....	84
1.11 Products and Bye Products .....	85
1.11.1 General .....	85
1.11.2 Whole Cane.....	85
1.11.3 Raw Sugar .....	87
1.11.4 Sugarcane Juice .....	88
1.11.5 Gur or Jaggery .....	90
1.11.6 Potable Alcohol and Ethanol.....	91
1.11.7 Bagasse.....	93
1.11.8 Energy Cane .....	96
1.11.9 Molasses .....	96
1.11.10 Other Products .....	98
1.12 Irrigation and Water Stress.....	101
1.12.1 Methods of Irrigation .....	106
1.12.2 Micro irrigation .....	118

---

1.12.3	Suitability of Irrigation methods and Irrigation Schedule .....	119
1.13	Sugarcane Ripening, Harvesting and Post Harvesting Management .....	121
1.14	Trash Management .....	126
1.14.1	Integrated Sugarcane Trash Management .....	132
1.15	Chemical and Organic Fertilizers .....	134
1.15.1	Nitrogen.....	134
1.15.2	Phosphorous .....	134
1.15.3	Potassium .....	134
1.15.4	Calcium .....	134
1.15.5	Magnesium.....	135
1.15.6	Green Manure.....	135
1.15.7	Sugarcane Trash .....	135
1.15.8	Filter Press Mud .....	135
1.15.9	Biofertilizers .....	136
1.16	Integrated Nutrient Management .....	136
1.17	Climatic Factors and Sugarcane .....	139
1.17.1	Climate Change and Impact on Environment, Sustainability and Management of Green House Gas emissions.....	141
1.17.2	Sugarcane and Climate Change .....	143
1.18	Biotic Factors and Sugarcane .....	145
1.19	Edaphic Factors and Sugarcane .....	152
1.20	Environmental Allergens, Health and Safety .....	156
1.21	Disease Management .....	159
1.21.1	Some Sugarcane Diseases, Transmission and Control .....	160
1.21.2	Global Distribution of Major Pathogen Related Diseases. ....	170
1.21.3	Distribution of Pathogen Related Diseases in India .....	173
1.21.4	Important Diseases of Sugarcane. Symptoms and Management ...	174
1.21.5	Integrated Disease Management .....	179
1.22	Pests and their Control .....	188
1.22.1	Major Invertebrate Pests .....	190
1.22.2	Distribution of Insect Pest infestations in India. ....	193
1.22.3	Important insect pests of Sugarcane, Routes and infestations and Chemical and Biological Control. ....	195
1.22.4	Insect Pests, Symptoms and Integrated Management. ....	201
1.22.5	Pest and Disease Resistant Cultivars. ....	207
1.23	Stage wise Integrated Pest, Disease and Weed Management. ....	211
1.24	Weeds and Their Control .....	220
1.24.1	Weed Management.....	222
1.25	Hybrids, Cultivars and Their Management .....	223

*Contents* XV

---

1.26	Genetically Modified Cane .....	245
1.27	Policy .....	246
1.27.1	Macro Management of Agricultural Schemes in India. ....	248
1.27.2	Sustainable Development of Sugarcane. ....	248
1.27.3	Sugar and Sugar Development Fund .....	250
1.27.4	Ethanol Blending Program .....	251
1.27.5	Recommendations of Task Force (Niti Aayog 2020).....	251
1.27.6	Sugar as an Export Commodity .....	255
1.27.7	Payment of Buffer Subsidy. ....	256
1.28	Pricing of Sugarcane .....	256
1.28.1	Fair and Remunerative Price (FRP) .....	257
1.28.2	Price Policy .....	259
1.28.3	Major Recommendations of the Task Force (Niti Aayog) .....	259
1.28.4	Future Strategy .....	260
1.28.5	Ethanol Blended Petrol Program and remunerative pricing for Ethanol .....	261
1.29	Sustainable Sugar Initiatives .....	262

**SECTION -2**  
**SUGAR-THE PRODUCT**

2.1	Overview of Sugar Industry .....	265
2.2	State of Sugar Industry in India .....	267
2.3	Policy and Pricing .....	269
2.4	Types of Sugar .....	270
2.5	By Products of Cane Sugar Manufacture .....	271
2.5.1	Bagasse and Press Mud.....	272
2.5.2	Molasses, Sugarcane Juice and Ethanol.....	272
2.5.3	Muscle and Skin Care.....	273
2.5.4	Biochar and Soil Amendment .....	273
2.5.5	Bio Oil.....	275
2.5.6	Second Generation Bio-fuel from Bagasse .....	276
2.6	Sugar, Ethanol and Distilleries .....	277
2.6.1	Ethanol Blending and Policy .....	277
2.6.2	Ethanol Manufacturing Process .....	283
2.6.3	Water use in Distillery Process .....	288
2.6.4	Distillery Waste Waters .....	288
2.7	Bagasse as Fuel .....	300
2.8	Molasses and its Storage .....	301
2.9	Sugarcane Constituents .....	304

---

2.10	Categories of Sugar Mills .....	306
2.11	Use of Water in Sugar Processing .....	306
2.12	Cane Harvesting and Transfer to Mill .....	312
2.13	Cane Preparation .....	313
2.14	Cane Crushing .....	314
2.15	Diffusion .....	317
2.16	Clarification .....	321
2.16.1	Clarification Process in Raw Sugar Manufacturing .....	325
2.16.2	Clarification (The Defecation Process) .....	327
2.16.3	Clarification (Carbonation) .....	329
2.16.4	Clarification (Sulphitation).....	331
2.16.5	Clarification (Other Processes) .....	336
2.17	Evaporation .....	337
2.17.1	Scaling.....	342
2.17.2	Sucrose Losses .....	344
2.17.3	Vapor Economy .....	345
2.17.4	Evaporation (Vacuum Systems) .....	346
2.17.5	Evaporation (Syrup Treatment) .....	349
2.18	Crystallization .....	350
2.18.1	Graining .....	356
2.18.2	Crystallization (Centrifugal Separation).....	359
2.19	Steam Generation .....	363
2.20	Steam Consumption .....	364
2.20.1	Station wise Measures for Steam Economy .....	364
2.21	Boiler Feed Water Treatment.....	367
2.22	Sugar Refinery .....	368
2.22.1	Affination .....	369
2.22.2	Melting .....	370
2.22.3	Clarification .....	370
2.22.4	Secondary Decolorization .....	370
2.22.5	Crystallization and Centrifuging .....	371
2.22.6	High Pressure Absorbents .....	371
2.23	Process Automation .....	371
2.24	Sustainable Sugar Initiatives .....	372
2.24.1	Sugar Industry and Clean Production .....	376
2.24.2	New Sustainable uses for Sugar Crop Extraneous Matter .....	377
2.24.3	Energy Cane .....	378
2.24.4	Sugar and Sugar Bio Product Industries .....	379
2.24.5	Sustainability of Cane .....	381

---

2.24.6 Other Agro Industrial Residues .....	383
2.24.7 Charter on Corporate Responsibility for Environmental Protection .....	384
2.24.8 Additional Recommendations for Sugar Industry (IL&FS 2010)..	396
2.25 Power Co-generation .....	396
2.25.1 General .....	396
2.25.2 Process and Steam Generation .....	399
2.25.3 Possible Performances Issues of the Co-generation Unit.....	401
2.25.4 The Process in a Steam Turbine Co-generation System .....	402
2.25.5 Climate Change .....	414
2.26 Energy Conservation .....	415
2.27 Air Pollution and Control .....	419
2.27.1 Air Emissions from Sugar Making Process .....	419
2.27.2 Co-generation and Circular Economy.....	425
2.27.3 Emission Standards and Environmental Impacts .....	429
2.27.4 Air Emission Control .....	432
2.28 Water Pollution Control .....	433

### **SECTION -3 LAWS AND PROCEDURES**

3.1 The Essential Commodities Act 1955 .....	442
3.2 The Essential Commodities Act- The Sugarcane Control Order 1966.....	451
3.3 The Essential Commodities Act- The Sugar Control Order 1966..	461
3.4 The Essential Commodities Act- Sugar Price (Control) Order 2018.....	463
3.5 Levy Sugar .....	464
3.6 Sugar Development Fund Act, 1982 .....	467
3.7 Export of Sugar- The Sugar Export Promotion Act, 1958 .....	468
3.8 The Sugar (Regulation and Production) Act, 1961 .....	471
3.9 The Sugar Cess Act 1982 .....	472
3.10 The U.P. Sugarcane (Regulation, Supply and Purchase) Act 1953 .....	472
3.11 The Uttar Pradesh Sheera Niyantran Adhiniyam, 1964 .....	478
3.12 Packaging of Sugar .....	481
3.13 Corporate Social Responsibility- The Company Act, 2013 .....	484
3.14 The Boilers Act, 1923 .....	490
3.15 The Factories Act, 1948 .....	497
3.16 The Forest Conservation Act 1980.....	513
3.17 The Wild Life Protection Act of 1972.....	524

---

3.18	The Public Liability Insurance Act 1991.....	527
3.19	Environment and Pollution Control Laws.....	528
3.20	The Water (Prevention and Control of Pollution) Act 1974 .....	529
3.21	The Water (Prevention and Control of Pollution) Cess Act 1977..	546
3.22	The Air (Prevention and Control of Pollution) Act 1981.....	547
3.23	The Environment Protection Act, 1986.....	561
3.24	The Environment Impact Assessment Notification of 2006 (As Amended up to May 2022).....	568
3.25	The Hazardous and Other Wastes (Management and Transboundary . Movement) Rules 2016 and the Manufacture, Storage and Import of. Hazardous Chemical Rules, 1989. ....	583
3.26	The Plastic Waste Management Rules 2016 as amended up to March 2018 including E.P.R.....	590
3.27	The Construction and Demolition Waste Management Rules 2016. ....	609
3.28	The E-Waste (Management) Rules, 2016 .....	610
3.29	The Bio Medical Waste Management Rules 2016 .....	614
3.30	The Central Ground Water Authority and Ground Water Clearances .....	614
3.31	The National Green Tribunal Act 2010. ....	624

**SECTION -4****ENVIRONMENT AND POLLUTION CONTROL**

4.1	Water and Quality Concerns .....	627
4.2	Sugar Mill Water Balance and Water Conservation .....	628
4.3	Sugar Mill Effluents .....	635
4.4	Sugar Mill Waste Water Treatment .....	641
4.5	Operation and Maintenance of Sugar E.T.P. .....	674
4.5.1	Primary Sedimentation .....	674
4.5.2	The Activated Sludge Process .....	676
4.5.3	Secondary Settling Tanks .....	677
4.5.4	Anaerobic Digester.....	677
4.6	Performance Evaluation of Effluent Treatment Plant .....	678
4.7	Good Operating Practices .....	691
4.8	Air Emission from Sugar Mills and Air Emission Standards .....	695
4.9	Air Pollution Control Systems. ....	697
	<b>Some Updates.....</b>	714
	<b>Bibliography .....</b>	719