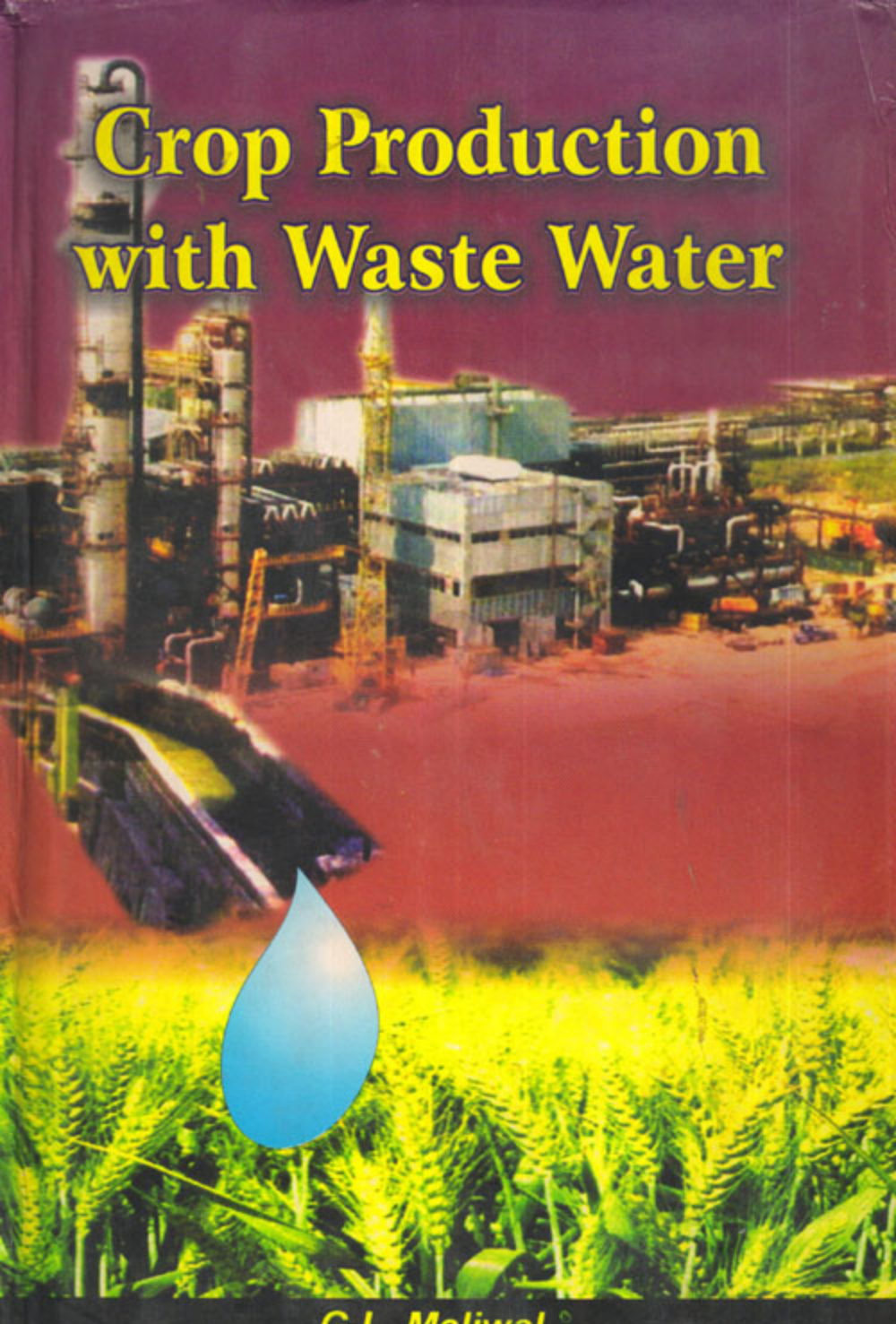
Crop Production with Waste Water



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CROP PRODUCTION WITH WASTE WATER

THE BOOK

Good quality water is becoming more and more scarce on global basis due to expanding urbanization and industrialization and attempts have been made to use and reuse the huge quantities of waste water generated daily by human and industrial activities without causing any adverse effect on the environment. However, disposal of pollutant contaminated waste waters on land causes soil pollution and deterioration in the quality of crop produce, edible portions of vegetables, fruits and fodders grown on such pollutant contaminated soils besides irrigation with pollutant contaminated waste water. This polluted water - soil - plant - food - chain system results in enhanced risks for consumer's (animal and human) health.

This book on crop production with waste water provides a systematic information on the origin of air, water and soil pollutants, and their effect on environment, pollution through fertilizer and pesticides used in agriculture, characteristics and quality requirement of waste water reuse, effects of waste water use on soils and crops and their use in forestry are emphasized. Due importance has been given to land and crop management for waste water irrigation describing crop management, irrigation, chemical and physical management.

This book also contain waste water treatment including Chemical processes and Engineering aspects. However as the biological method of waste water treatment is the most effective and economical method of treatment of organic and certain inorganic pollutants due emphasis has been given to this area.

Data pertaining to Indian conditions has been given to help the reader gain an insight into India's own pollution problem.

In short, this book will be of immense value to students of environmental sciences, researchers and decision makers associated with waste water management, soil and water pollution, sewage water irrigation, forestry and environment management.

PREFACE

Water is life; and purer the water, better the life is of all livng creatures. The demand of water for various purposes like domestic, commercial, industrial and for agricultural is increasing significantly all over the world. Growing urbanization and industrialization has further aggravated the situation and generating huge quantities of wastewater of different physical, chemical and biological characteristics. Such variedly waste waters either through the process of recycling or as a means of irrigation in areas where no other source of good quality water is available, are disposed on land. Under all situations the land resources are more and more contaminated by polluted waters leading to complete deterioration in soil health.

Waste water reuse for agriculture presents not only a low cost appropriate disposal medium but also an opportunity to manage wastes with minimum adverse environmental effects as the treatment requirements prior to land application are less rigid than those for disposal into water bodies. Application of sewage sludge and domestic wastewater on land has been practiced since time immemorial. The challange is to utilize the chemical, physical and biological properties of soil as an acceptors with minimum adverse effects on crops to be grown, soil characteristics and ground and surface water quality.

Crop plants and trees grown on contaminated soils are likely to reflect the poor quality in the produce and may be unsuitable for human and animal consumption if they contain toxins beyond permissible limits. Number of soil-water-plant-food chain processes are working under contaminated systems. These are not only complex in nature but are multi-components with widely varying conditions. Hence the laws and predictive approaches meant for single component systems are not usually operative in contaminated system.

This book is written with an objective to cover most important issues in utilizing wastewater for crop-production. The book has in total thirteen

chapters including one case study. The book begins with wastewater availability and problem associated in waste water use. The chapter 2 through 5 deal with environment and pollution - classification of pollutants, air, soil and water pollution, environmental issues; pollution through fertilizer and pesticides including weedicides, characteristics of domestic wastewater, industrial waste water and surface and ground water pollution. Water quality criteria/evaluation is taken up in detail under chapter 6. Physico-chemical and biological parameters of significance for soil as well as for human health are covered in detail in chapter 7. A Chapter 8 is devoted on effeect of waste water irrigation on crops-includes growth response at germination and early stages, yield and critical limits for metals have been described. The chapter also includes plant composition with phytotoxicity limits of different metals for different crops. The chapter 9 deals the utilization of waste water for forestry and chapter 10 is devoted to land and crop management–Crop management, Irrigation management includes waste water irrigation systems, Chemical and Physical management.

Other important topic in the book is : Waste Water Treatment - Chemical and Engineering processes and as the biological method of waste water treatment is the most effective and economical method of treatment of organic and inorganic pollutants, more emphasis on Phyto and Bio-Remediation are given and discussed in detail.

A chapter on Socio-Cultural Issues of Waste Water Reuse for crop production has been included (chapter 12) and case study on the impact of industrial waste water irrigation practices at Vadodara on soil, crops and underground waters as well as Socio-Economic Impact has been extensively covered in this book. At the last (Chapter 13), Economic, Institutional, Environmental Protection Laws and Standards have been included.

The book also covered Waste Water Discharge Standard for release of effluents from different industries to land/water bodies as laidout by Central Pollution Control Board as Appendix.

Data dealing with conditions in India are given wherever possible to help the reader gain an insight into the country's problems on use of waste water for crop production.

The major portion of the material/presented in this book has been compiled from the works of others. Authors may only be given credit for the compilation of all the available information in one volume. It is expected that this book will help to students of Environmental Sciences, Soil Science, Agronomy, Ecology and Teachers, decision makers associated with waste water management, soil and water pollution and sewage irrigation.

The author is grateful to all the scientists whose contribution has made this book complete and meaningful. The author acknowledge the assistance received from all of the sources books and journals. While every attempt has been made to acknowledge all the sources of information, I appologise in advance for any inadvertant omission in this connection. The author is also thankful to the Central Pollution Control Board to use their data on prescribed standards for discharge of effluent of different industries. M/s Agrotech Publishing Academy gladly accepted the proposal to print this book for readers. The author thank them.

Great appreciation should also be given to Mrs. Maliwal for their patience in bearing with the situation when author was more than fully occupied during the preparation of this work.

Vadodara, 2004

G.L. Maliwal

ABBREVIATIONS

AICRP	:	All India Coordinated Research Project
ADI	:	Acceptable Daily Intake
Adj. SAR	:	Adjusted Sodium Adsorption Ratio
BIS	:	Bureau of Indian Standards
BOD	:	Biological Oxygen Demand
BAW	:	Best Available Water
BARC	:	Bhabha Atomic Research Station
CWL	:	Constructed Wet Lands
CEC	:	Cation Exchange Capacity
cc	:	Cubic Centimeter
Cm	:	Centimetre
CSSRI	:	Central Soil Salinity Research Institute
CPCB	:	Central Pollution Control Board
^{o}C	:	Degree centigrade
COD	:	Chemical Oxygen Demand
DO	:	Dissolved Oxygen
dSm^{-1}	:	deci Siemens per meter
DAP	:	Di Ammonium Phosphate
ET	:	Evapotranspiration
$EC_{2.5}$	:	Electrical Conductivity in 1:2.5 Soil : Water Ratio
EC_2	:	Electrical Conductivity in 1:2 soil : Water Ratio
ECe	:	Electrical Conductivity in Saturation Extract
EC_{iw}	:	Electrical Conductivity of Irrigation Water
EU	:	European Union
ESP	:	Exchangeable Sodium Percent
EC	:	Electrical Conductivity
FAI	:	Fertilizer Association of India
FAO	:	Food Agricultural Organization
GAU	:	Gujarat Agricultural University

GEMS	:	Global Environmental Monitoring System
g ml^{-1}	:	Gram per milliliter
g/pot	:	gram per pot
GDP	:	Gross Domestic Product
GPCB	:	Gujarat Pollution Control Board
ha	:	hectare
HAU	:	Haryana Agricultural University
Kld	:	Kilo liter per day
Kg	:	Kilogram.
LR	:	Leaching Requirement
LF	:	Leaching Fraction
md Sm^{-1}	:	Millideci Siemens per meter
MLD	:	Million liters per day
mgL^{-1}	:	milligram per litre
Mg ha^{-1}	:	Megagram per hectare
mg kg^{-1}	:	Milligram per kilo-gram
Mg / m^3	:	Megagram per cubic meter
MPC	:	Maximum permissible concentration
m	:	meter
mmol L^{-1}	:	millimole per litre
MINAR	:	Monitoring of Indian National Aquatic Resources
MINAS	:	Minimal National Standards
ng/m^3	:	microgram per cubic meter
NS	:	Non significant
ng/l (μgL^{-1})	:	microgram per litre.
NO_3-N_2 L^{-1}	:	Nitrate Nitrogen per litre
NATP	:	National Agricultural Technology Project
NEERI	:	National Environmental Engineering Research Institute
ppb	:	Parts per billion
ppm	:	Parts per million
%	:	per cent