RC-NAEB/AFC

RC-48

SPECIES SELECTION FOR POLLUTION ABATEMENT

IN

UTTAR PRADESH, RAJASTHAN, HARYANA AND DELHI

Station, Kanpur

- Parag Dairy,

- Parag Dairy,

Rajasthan)

- Example for

er (Rajasthan).

tion Ltd
058

PROCEEDINGS OF WORKSHOP
HELD AT DELHI, Oct 28-30, 1996

REGIONAL CENTRE
NATIONAL AFFORESTATION AND ECO-DEVELOPMENT BOARD

AGRICULTURAL FINANCE CORPORATION LTD., MUMBAI
NRO, NEW DELHI
1997

PREFACE

Pollution has been increasingly affecting the quality of land, water and air in the States of Uttar Pradesh, Rajasthan, Haryana and Delhi. As a result the sustainability of the systems providing essential facilities to human society like water supply, food, fodder, fuelwood, etc. is remaining elusive, while the safety of roads, buildings and monuments is being threatened. Finally, the health of the human beings is being seriously affected.

In India, perennial vegetation and trees have been known to provide a natural defence or deterrent to various degradation processes leading to deterioration in the systems that provide many goods and services. However, due to faster pace of developmental activities in the post-Independence era the significance and the traditional values of trees vis-a-vis these distortions have been relegated to the background. But in the recent two decades there has been increasing consciousness particularly among the scientific and professional communities about the far reaching adverse effect on the society and therefore, a number of pioneering activities were undertaken.

The workshop was thus, to provide a forum where exchange of experience, perception and perspective of the professionals, scientists, policy makers and managers could take place effectively. In the same forum the Regional Centre for the National Afforestation and Eco-development Board, functioning in the Northern Regional Office of Agricultural Finance Corporation Ltd., New Delhi also provided its experiences gathered from various assignments entrusted by NAEB and the options available to counter pollution due to mining, discharge of sewage water, dumping of garbage, etc.

The workshop which was structured in four technical sessions and a panel discussion brought out the fact that information obtained by the research institutes and experiences gathered by the developmental agencies offer considerable potential for using plants as deterrent as well as ameliorator of the polluted natural resources base.

In order to provide some basic information about the problems, technology and specific plants vis-a-vis different types of pollution, data and results presented at the workshop have been collated and included in this publication. It is hoped that this publication will be a useful ready reference to the practising professionals in the area of forest, land and water management.

Vijay Kumar

VIJAY KUMAR
General Manager &
Coordinator, RC-NAEB

June, 1997
New Delhi

CORE GROUP

Vijay Kumar	Coordinator
R.D. Gupta	Team Leader and Senior Consultant (Forestry)
D.C. Das	Senior Consultant (Watershed Management/ Eco-development)

Compilation and editing of technical papers, writing and printing of the proceedings

D.C. Das	Senior Consultant
D.V. Nithyanand	Project Officer

CONTENTS

* **PREFACE**

* **HIGHLIGHTS**

1.	INTRODUCTION	1-3
2.	WHY AND HOW TO MEET THE CHALLENGE	4-10
3.	POLLUTION PROBLEMS AND NATURAL RESOURCES OF THE REGION	11-28
4.	POLLUTION INDICATOR, ACCUMULATOR AND PROMOTER PLANTS	29-35
5.	TOLERANT AND POLLUTION SPECIFIC PLANT SPECIES	36-41
6.	VALUE OF PLANTS FOR POLLUTION ABATEMENT	42-47
7.	PROGRAMMES AND FUTURE PERSPECTIVES	48-57
8.	ISSUES AND ACTION POINTS	58-62
	ANNEXURES	63-72
	REFERENCES	73-74
	LIST OF RC:NAEB PUBLICATIONS	75-76

ABBREVIATION

AC	Assimilating Capacity
ACC	Associated Cement Company
ACF	Asstt. Conservator of Forests
AFC	Agricultural Finance Corporation
AFRI	Arid Zone Forestry Research Institute
APTI	Air Pollution Tolerance Index
BARC	Bhaba Atomic Research Commission
BOD	Biological Oxygen Demand
CAZRI	Central Arid Zone Research Institute
CCGI	Climatic Crop Growth Index
CCF	Chief Conservator of Forests
CES	Centre for Science and Environment
CF	Conservator of Forests
COD	Chemical Oxygen Demand
CPCB	Central Pollution Control Board
DCF/DFO	Dy. Conservator of Forests/Divisional Forest Officer
DDA	Delhi Development Authority
FMDI	Fertiliser Marketing Development Institute
GGC	Green Guard Cadre
FRI,UP	Forestry Research Institute; Uttar Pradesh
ICFRE	Indian Council for Forestry Research and Education
IFFCO	Indian Farmers Fertiliser Cooperatives
IGFRI	Indian Grassland and Fodder Research Institute
IGNP	Indira Gandhi Nahar Pariyojna
JNU	Jawaharlal Nehru University
KVIC	Khadi and Village Industries Commission
MCD	Municipal Corporation of Delhi
MOEF	Ministry of Environment and Forest

NAEB	National Afforestation and Eco-development Board
NBRI	National Botanical Research Institute
NCR	National Capital Region
NCT	National Capital Territory
NDMC	New Delhi Municipal Corporation
NEERI	National Environmental Engineering Institute
NGO	Non - Governmental Organisation
NIH	National Institute of Hydrology
NRO	Northern Regional Office
PWD	Public Works Department
RC	Regional Centre
RO	Range Officer
RPM	Respirable Suspended Particulate Matter
SC	Supporting Capacity
SOFEM	Society for Forest and Environment Management
SPM	Suspended Particulate Matter
TERI	Tata Energy Research Institute
WWF	World Wide Fund

1. The
problem sp
vulnerabl

2. The

i) Hov
For

ii) Wh
age
con

iii) Ho
con
me
con

iv) Ho
cor

v) Ho
pro
cor

3. Th

i) Gr
pol

ii) Im
tra
im

iii) In
qu

iv) Sit
tak
sh
de

v) Si
N
ex

HIGHLIGHTS

1. The existing green areas should be protected and rehabilitated while a site and problem specific strategy and action plan should be prepared for other affected or vulnerable areas.

2. The issues need to be addressed immediately are :

i) How pollution abatement can become a priority activity of the Department of Forests of the four States of this region?

ii) What could be the mechanism to put raising plants for pollution control on the agenda of the Forest Department and of other agencies who are responsible to contain pollution and to draw appropriate programme for implementation?

iii) How to get the plant accepted by the policy makers and planners as a means to control and abate pollution for the conservancy of cities and towns including metropolis of Delhi which are beset with air, water and land pollution concurrently?

iv) How to mobilise necessary funds from various sources such as public sector, corporate bodies, private sectors etc.?

v) How to gather information, document and disseminate the same to the professional and functionaries as well as people of different walks who are concerned with pollution hazards and their abatement?

3. The major action points are :

i) **Greening with a purpose** should be a necessity to counter different types of pollution hazards in the region and an urgent one for NCT of Delhi.

ii) Immediate steps should be taken to document existing information, both from traditional and modern sources, to offer best possible set of plant species for immediate inclusion in the field projects.

iii) In order to have better problem identification and clear determination of gaps, quantitative assessment of different type situations should be undertaken.

iv) Site and problem specific investigations and research programme should be taken up to bridge these gaps and provide answers to many questions. This should be a joint activity by research bodies and development departments/agencies concerned.

v) Similarly pilot projects could be started jointly by the Deptts, Communities or NGOs or Institutions with available research results and other established experiences. These projects should run at least for a period between 5-10 years.

vi) Participatory Forest Management, with a distinct perceptions and mechanism from those, which are being followed in JFM, will be a pre-requisite specially in NCT of Delhi. This is required for formulating, implementing and monitoring greening activities as deterrent to the pollution. This is because of demographic diversity as well as scattered sites of varied sizes over extensive area.

vii) Forest Deptt. should equip itself and function as a think tank to help find right path ways. It should have a greater role in the net working and monitoring progress of various greening activities vis-a-vis agreed objectives.

viii) Infrastructural development in the area of communication, mobility, updating professional skill vis-a-vis pollution abatement through plantations are immediate needs for the department to act with speed and in collaboration with other agencies involved.

ix) Department of Forest, NCT of Delhi, thus requires to be strengthened and should have two streams viz. (a) one to deal with reserved and protected forests as well as Asola Game Sanctuary and (b) the second to deal with community, agro/farm forestry, sanctified green areas, round-abouts, road side and nala side plantations in the city and rural settlement areas, residential complexes etc.

x) NGOs should be effectively involved and professionally updated for awareness generation activity, facilitating community participation in investigation, organising operational or field trials, monitoring and even in raising fund from non-governmental sectors.

xi) For planting and after caring of trees and other plants in settlements (rural and urban) at scattered and generally on a small area basis could be effectively done by raising a Green Guard Cadre (GGC).

xii) There should be specially designed refreshing and reorientation courses on pollution abatement through greening for the personnels of the Department of Forests, PWDs, Horticulture, MCD/NDMC, DDA, and similar Civic authorities and Corporate bodies and other agencies.

xiii) Economic viability of the considerable investment that the projects on pollution abatement through plantations will need, can be tested only when the value environmental/ecological goods and services are assessed and considered. Immediate steps should be taken to obtain better tools and methodology to this effect. Meanwhile available ones should be used.

xiv) Funds should specially be provided for these activities in the Central and State Plans. Besides considerable contributions should also come from industries, Corporate bodies, Civic authorities and individuals as well.

1.1 BACK

Pollution affe
urban and ru
Delhi. Pollut
of settlemen
traffic, indu
livestock ma
sewage and
emission of
quality of na
for various
Likewise the
status of Nat

The major r
the Aravalli
land areas a
forests to at
shrinking. C

Natural defe
perennial ve
therefore, b
denuded or
and related
perception,
assessment
in a norm
pollutants w

CHAPTER - I

INTRODUCTION

1.1 BACKGROUND

Pollution affecting the quality of land, water and air is steadily increasing both in the urban and rural areas of the States of Uttar Pradesh, Rajasthan, Haryana and NCT of Delhi. Pollution is caused variously by transformation of landscape through emergence of settlements bringing in the overall development like roads, railways, vehicular traffic, industries, intensification of primary production systems like cultivation, livestock management, mining of all kinds, etc. The typical adverse fall outs are sewage and garbage, industrial wastes & effluents, mine spoils, voids & overburdens, emission of unfavourable gases and particulates to air, dust and noise. Consequently the quality of natural resources, like land, water and immediate above ground environment for various life forms including human being, is likely to get severely deteriorated. Likewise the facilities like water supply, roads, buildings, and even monuments of the status of National heritage are threatened.

The major river systems like Ganga-Yamuna, Sutlej-Beas and west flowing rivers from the Aravallis are adversely affected in terms of volume and quality of flow. Sizeable land areas are continuously slipping into lower productivity classes while ability of forests to absorb and consume CO_2 and release O_2 as a continuing natural process is shrinking. Consequently quality of life is fast deteriorating.

Natural defences or deterrent to the pollution hazards are built in an eco-system where perennial vegetation along with various life forms, play a dominant role. There has, therefore, been an increasing conviction that this natural defence, which has been denuded or lost variously, need to be rebuilt over extensive areas through afforestation and related package concerning land and water. However, there is a difference in the perception, strategy and technology package, follow up management schedules, assessment of effectiveness, etc. of such activities vis-a-vis those which are envisaged in a normal afforestation programme. Specific species for combating different pollutants will have be worked out.

1.2 BACK-UP AVAILABLE AND GAPS

The potential of the plants had been known to the Indian communities. Trees and plants have come down through generations as symbols of purity and source to alleviate sufferings and heal the ailments. With the fast pace of development there had been conscious attempts to understand the role of plants and means of raising these to tackle many problems arising from the various social and economic development activities.

Quite a few number of Universities, Research institutes, Philanthropic agencies and NGOs have been working in this area. However, the action programmes to use plants as a deterrent to pollution has yet to be accepted in a policy strategy and implemented in terms of specific projects at representative sites over extensive areas of these four States.

National Afforestation and Eco-Development Board (NAEB) of the Ministry of Environment and Forests, Govt. of India, had thus been concerned with this expanding problem. NAEB had thus approved the organising of a Workshop to get the experts, managers, NGOs together and to share views, experiences and information available with different agencies

1.3 OBJECTIVES

The main objectives of the workshop were :

- to obtain and compile base line information on technology packages to counter adverse effects of pollution on ecosystem specially on land, water and life forms including human beings;
- to share experiences on the performance of plants in combating the pollution hazards;
- to identify site and problem specific plant species;
- to determine a few important policy issues; and
- to prepare a list of action points.

1.4 PAI

There were
Pradesh (8
is given in
ICFRE, M
Universitie
like Vatava

Age
State G
Central
Researc
NGOs
Interna
Industi
Others

1.5 F

There we
Wrap up
Delhi. T

1.4 PARTICIPANTS

There were 65 participants in all from the States of Delhi (45), Haryana (8), Uttar Pradesh (8), Rajasthan (2) and West Bengal (2). The agency & expertise wise breakup is given in Box-1.4. Participants from Research Institutes were from IGFRI, AFRI, ICFRE, Ministry of Environment & Forests, and TERI. There were experts from the Universities of JNU (Delhi) and Jadavpur (Calcutta) WWF (Delhi) and local NGOs. like Vatavaran, Sristhi etc. The list is at Annexure 1.1.

Box - 1.4 Break up of Participants

Agency wise		Expertise wise	
State Govt. Deptts.	18	Forestry Experts & functionaries	22
Central Govt.	6	Scientists (ICAR, ICFRE & Universities)	21
Research Bodies	10	Policy Makers/Administrative Manager	10
NGOs	14		
International Body	3	Economists, Computer Experts, Sociologist, etc.	3
Industries	1	Others - Industries & other Depts.	9
Others- AFC etc.	13		
Total	65	Total	65

1.5 FRAME WORK

There were four Technical sessions, a Panel Discussion in addition to the Inaugural and Wrap up sessions. Besides, a field trip was also organised to Asola Game Sanctuary of Delhi. The detailed programme is given in Annexure 1.2.

CHAPTER - 2

WHY AND HOW TO MEET THE CHALLENGE

2.1 THE TASK

Delhi has been ranked by World Health Organisation as the fourth most-polluted city in the world. But Shri Sahib Singh, the Chief Minister, who also holds the charge of Environment and Forests, expressed his serious apprehension that Delhi may soon top the list. While inaugurating the three day Workshop in last October in Delhi, Shri Singh observed that the NCT practically is beset with all types of pollution hazards. These are affecting entire life support system comprising land, water and air. Immediate need, though is to protect and rehabilitate existing green areas, it is not enough. There must be a strategy and an approach to tackle this complex and all-pervading problem of pollution. The traditions provide us enough confidence to go at a more purposeful manner to use plants in abating the pollution hazards and this must be done at the earliest.

Outlining the course of actions Shri Singh observed that the programme should have scientific back up. As scientific information is not completely lacking and more are coming every day, he called upon experts and scientists to provide basis for :

: Reformulation of problem and site specific approaches and strategies.

: Setting effective norms and objectives for formulating plans and preparing projects alongwith ways and means to assess the impact of project implementation.

: Giving parameters for selecting carefully the plant species for different sites and for varying problem intensities;

: Bringing forth the attributes and rationales available for many traditions so that indigenous species could be preferred on merit.

: Involving people of all walks of life and NGOs to make it a mass programme.

Shri Singh further emphasised that the changes in the level of pollution of air, water and land vis-a-vis living conditions should be monitored on a continuing basis at representative sites of N.C.T. region.

2.2 PRIORITIES

In his keynote address, Dr. D.K. Biswas, Chairman, Central Board of Pollution Control (CBPC), Min. of Environment and Forests, provided some latest facts to testify the increasing severity of the pollution hazards. It is time, he stressed that some concrete steps are taken on ground.

Plants and of appropriate types if planted can tolerate some type of pollution and also can reduce the hazards. It is so because plants can create micro and macro environment which can absorb and/or neutralise the adverse effects of pollution. However, it is still a debatable issue if plants alone can control pollution. Nevertheless it is absolutely necessary to protect green areas and restore those areas which have been degraded already. Main constraint to achieve this objective seems to be the lack of coordination amongst different line departments.

Further segment specific plants need be chosen and raised to achieve greater success. Simple and clear guidelines are needed to this effect.

2.3 POTENTIAL AND CONSTRAINT

Shri Alok Jain, Joint Secretary, Min. of Environment and Forests, observed that wherever trees are raised to tackle such and similar problem areas, these have given very encouraging results. Pollution abatement through plantation alone and more in association with any other activity, could be most cost-effective.

He, however, felt discouraged by the fact that outlay for forestry sector is generally low and does not permit this sector to do something significant.

Further, the challenge cannot be met by the Central and State Government alone. There must be maximum involvement of NGOs, women and communities to make the activity a mass movement.

Earlier, Shri Vijay Kumar, General Manager and Coordinator of the Regional Centre welcomed the Hon'ble Chief Minister and guests. He opined to the fact that the R.C. while conducting studies on assignments has come across serious problems of pollution through emission from vehicular traffic, thermal plants, industries, mining, discharge of domestic sewage and industrial effluents in the four States of its service jurisdiction. Various study teams and the workshop deliberations have also been able to identify plants and practices to fight and reverse the trends as well as document in one place some integrated package of treatment which were useful to the States of the region.

2.4 RELEASE OF PUBLICATION OF RC : NAEB IN AFC, NEW DELHI

Shri Sahib Singh, Hon'ble Chief Minister of Delhi and the Chief Guest released the following two publications brought out by the Regional Centre (RC) of National Afforestation and Eco-development Board (NAEB) in Agricultural Finance Corporation, NRO, New Delhi. Shri R D Gupta briefly outlined the important conclusions highlighted in the publications and their relevance to pollution abatement activities with plants.

2.4.1 Afforestation of Areas affected by Canal Waterlogging, salts and wastes (AFC:NAEB/RC-40)

The publication puts together on data available technology and future needs for restoring the land and water polluted or degraded through waterlogging, salt affiliation, discharge of industrial effluents and sewage dumping of garbage, etc. through afforestation. The important points that emerged are as under :

i. The problems of water logging particularly due to irrigation canals, sodic soils and the areas affected by discharge and dumping of sewage and industrial waste water are quite serious and extensive in the States of Haryana, Rajasthan, Uttar Pradesh and NCT of Delhi.

ii. These processes of degradation are closely linked with disruption in hydrological balance which finally deteriorate the physical, chemical and biological balance of the soil body and, therefore, affects the productivity as well as quality of plants.

iii. Therefo
capacity
urgently

iv. The pr
effectiv
therefor
tackling

v. Among
very vi

vi. Agricu
hands
attribu

vii. Practic
of the
effecti

viii. The a
develc
treatm
bio-fe

ix. Brack
know
resear
deter
availa

x. Garb
plant
sites
from

iii. Therefore, combating these processes for restoring and sustaining the production capacity of the soils and combinations of appropriate measures in these areas are urgently called for.

iv. The presentations and deliberations have revealed that most lasting and cost effective measures are basically based on plants and their attributes. It is, therefore, necessary to identify, locate, establish and upgrade their ability in tackling these problems.

v. Among the attributes of the plants, root system and canopy development play very vital role.

vi. Agricultural scientists, forestry professionals and plant scientists should join hands to study genetics and physiology of such plants and identify natural attributes that regulate these capacities.

vii. Practical and economic means could then be obtained for further improvement of the capacities. This should help gain greater technical as well as cost effectiveness.

viii. The available technology packages for saline soils and alkali soils are fairly developed. There is, however, scope for further improvement in the land treatment measures as well as drainage system while the potential of applying bio-fertilisers and vermicomposts should be tested and operationalised.

ix. Brackish water should be considered as an asset and should be used with the known technology in combination with fresh water. There should be more research as well as operational trials under different site specific conditions to determine wider application potential of brackish water and for improving the available technology package.

x. Garbage, sewage and industrial waste water should be viewed as a rich store of plant nutrients and critical input water. These should be preferred at appropriate sites to substitute the capital intensive chemical and irrigation water obtainable from external sources.

xi. Recognising the threat of toxicity and contamination which may ultimately affect the health, preference should be given to use these resources for afforestation and greening programme and raise those plants which do not give produce that enters into food chain.

xii. Waste resources are being extensively used for yielding biomass for consumption of goods of human beings and domestic animals, in pursuance of the strong market forces. Therefore, the application of these wastes for afforestation and greening programme will have to be competitive both environmentally and socio-economically. It will be desirable to find and demonstrate the critical and promotional role of wastefed plants in ushering compatible and profitable combination of primary production system.

2.4.2 Afforestation and Eco-development of IGNP Command Area (AFC:NAEB/RC-41)

The Publication systematically collated the facts gathered and on the spot inter actions which had taken place during the Travelling Workshop organised on the subject during Feb - 26 to March - 1, 1996 through Bikaner-Jaisalmer-Jodhpur. The important points which emerged are as under :

i. The Travelling Workshop covering Bikaner-Jaisalmer-Jodhpur offered valuable opportunities to acquaint with harsh conditions of western Rajasthan and the visible transformation being brought by irrigation in general and irrigated desert plantations in particular.

There were in all 54 participants coming from development departments mainly Forests, Engineering, CAD & Agriculture and scientists from Rajasthan Agricultural University, Arid Forest Research Institute and Central Arid Zone Research Institute, Jodhpur and Regional Centre NAEB, AFC, Delhi. In addition, senior decision makers and managers from Government of Rajasthan and CAD, Bikaner as well as a representative from the Overseas Economic Cooperation Fund of Japan also participated.

ii. The varied background of the participants helped in having an access to different perceptions on impact assessment. This was finally helpful to identify the main issues for consideration and future action.

iii. Availabl
planted
were tr

iv. All the
and a t
differer
Stabilis
etc.

v. The su
The gr
quite s

vi. IGNP
terrain
of the

vii. This v
indica
farmir
irrigat
The a
econo
shoul
a tacit
peren
landu

viii. The
becor
visibl
there

ix. It is,
wate
may
imm

iii. Available information indicated that an area of about 1.14 lakh hectare was planted both in Stage-I and Stage-II under IGNP programme, while 20,000 ha were treated under DPAP, DDP and other schemes.

iv. All the three districts covered, are also part of Desert Development Programme and a total area of 2.11 lakh ha. was afforested in 11 desert districts, under different schemes and various types of plantations such as Sand dune Stabilisation, Silvi-pasture, Village fuelwood plantation, Road side plantations, etc.

v. The survival percentage of the irrigated plantations have been more than 95. The growth performance of almost all species under different types have been quite satisfactory and in certain cases the growth has been exceptionally good.

vi. IGNP is one of the largest irrigation projects. But due to its complexity of terrain, its irrigation command is not a large contiguous one and a vast portion of the gross command area continues to be rainfed.

vii. This very fact and time tested land husbandry based on livestock management indicate that the areas in Stage II command is particularly suitable for mixed farming and, therefore, land use management should be a combination of irrigated agriculture, plantations and also silvi-pastoral system mostly rainfed. The animal/livestock demography and the set of crops and thus produce for economic growth are likely to change. Therefore afforestation programme should anticipate such shifts and identify appropriate source of fodder to provide a tacit direction of eco-friendly mixed land use package and establish the role of perennials for sustaining natural resources base and the productivity from all landuses in vogue.

viii. The water, which was meant for agriculture and settlement requirements, has become available and in reasonable quantity for afforestation activities. This has visibly made afforestation a success. However, with the settlements catching up there will be competitive demand on the availability of water.

ix. It is, therefore, necessary to anticipate the difficulties in continued supply of water for plantation of trees etc. and identify the appropriate plant species which may be demanding less water and offering greater return in future, for immediate trial for further screening.

x. The selection of plant-species also could keep in mind important supporting attributes of the tree species in the form of wind brake, shelter belts and also means for organic enrichment to agriculture fields.

xi. The problem of water logging and secondary salinisation is a real one and exists over extensive areas. The Eucalyptus, particularly seems to have succeeded in lowering the water table and reclaiming the water-logged areas over the years.

xii. There is however, a necessity to work out and standardise the technical details and also locate other plant species which may be more comfortable or economically profitable and achieve the same ecological purpose.

xiii. On the technical packages there should be more scientific inputs need in the design of shelter belts specially to provide understoreys that can intercept bulk of the moving sands through process of saltation. Similarly the geometry of species and their combination call for reassessment.

xiv. For effective control of road side plantations, a front line vegetation should be of grass and bushes, so that moving sands can be held back which generally filter through the trees as there is not much of under-storeys.

POLLUTION

3.1 NATU

Three natural
direct concern

Air is unlim
Gangetic plai
except some
regions like I
Delhi and ir
pre-requisite
Uttar Pradesl
the small St
population is
is lying wast

Thus, it will
these three
Haryana, Ra

3.2 AIR

3.2.1 Over

Concern for
even though
and 1990. (
being inhale
that he drin
remaining u
shrunk. Bu

CHAPTER - 3

POLLUTION PROBLEMS AND NATURAL RESOURCES OF THE REGION

3.1 NATURAL RESOURCES OF THE REGION

Three natural resources namely, air, water and land are being considered here as of direct concern to sustainable land management and health of human beings.

Air is unlimited in all parts of the year. Water for the year adequate or plenty in Gangetic plain and in mountains. It is, however, extremely scarce in most of Rajasthan except some parts of eastern Rajasthan and in greater part of Haryana as well. The regions like Bundelkhand and areas bordering Haryana, Rajasthan as well as in NCT of Delhi and in Uttar Pradesh, water shortage is severe. Land, which is a physical pre-requisite for the existence of the society, is very limited. Even in the large State of Uttar Pradesh it is scarce because it also has the largest population. On the other hand, the small States like Haryana and NCT of Delhi has very small area while the population is growing fast. In Rajasthan vast expanse of land is available but most of it is lying waste for various reasons.

Thus, it will be interesting to take an over-view of the problem of pollution vis-a-vis these three vital resources in the region's constituent States namely NCT of Delhi, Haryana, Rajasthan and Uttar Pradesh.

3.2 AIR POLLUTION

3.2.1 Overall Status

Concern for air pollution seems to have intensified only in recent two to three decades even though there were more than a dozen major disasters in the world between 1980 and 1990. One of this had occurred in Bhopal, India. The fact, that a normal human being inhales O_2 about 10 times by weight that of food he consumes and water 6 times that he drinks, does not prevent him to quickly get alarmed for food or water while remaining unconcerned to matters relating to air. This is because in quantity it has not shrunk. But what we take in is of poor quality and consequences come following a

variable time lag. There is nothing so similar in it on day to day basis to the choking thirst for water and acute hunger pang for food. Air is said to have been polluted when it has been loaded with its usual constituents in excess of the amount found in a normal air or it has gathered new and harmful entrants into its composition. It happens due to emissions into atmosphere through various means. The major sources (Atri, 1996) are (i) automobiles, (ii) thermal power plants, (iii) fertiliser factories, (iv) textile mills, tanneries, dairies, distillaries etc, (v) stone quarrying, mining and related processing, (vi) industries related to chemicals, medicines etc. and those based on diesel and petrol. Break-up of air pollution according to sources are given in Table 3.2.1.

Table 3.2.1. Percentage of Air Pollution from three major sources at three decades in NCT of Delhi

(Fig. in Percentage)

Sl. No.	Source of Pollution	Reporting year		
		1970-71	1980-81	1990-91
1.	Industrial	26.0	40.0	29.0
2.	Vehicular	23.0	42.0	63.0
3.	Domestic	21.0	18.0	8.0

Air pollution due to industries increased between 1970-71 and 1980-81 by 14 percent and came down by 11.0 percent during the next decade. This was possibly due to adoption of safety treatment measures. Contribution of domestic segment declined by 62 percent over 20 years and was possibly because of adoption of LPG and electricity as the energy for cooking at home. But pollution due to vehicles jumped by 83 percent in first decade and by 174 percent by the close of second decade. During this period, as pointed out by Shri R. K. Goel (1996), the vehicular population increased by about 800 times while number of vehicles per km of road increased from 31 (1975) to 89 (1990). An estimate puts total emission into Delhi's air at 2200 MT per day. Nearly 73 percent of it comes from vehicles, 16 percent from three power stations and 11 percent from 9800 industrial units.

3.2.2 Relative Intensity of Air Pollution

A comparative 'State of Affairs' for a few cities can be visualised from the table 3.2.2.

Tabl

City
Ahmedaba
Bombay
Calcutta
Delhi
Hyderaba
Jaipur
Kochi
Kanpur
Madras
Nagpur

Source : N

Figures within

Delhi, Kanpu
given in table

3.2.3 **Air Po**

Delhi has con
higher than th
hazards are ve

The magnitud
visualised fro
serious threat

Table 3.2.2 Ambient Air Quality (Annual Average) of Selected Cities In India (1992-93)

City	Level of Pollutants (Micrograms/m^3)			
	SO_2 (60)	NO_2 (60)	SPM (140)	RPM (60)
Ahmedabad	16	07	285	122
Bombay	27 33*	26 40*	226 204*	91
Calcutta	62 24*	39 20*	394 266*	180
Delhi	33 40*	46 60*	543 589*	204
Hyderabad	10	19	156	56
Jaipur	08	14	338	108
Kochi	11	10	115	58
Kanpur	07	13	380	135
Madras	08	13	101	67
Nagpur	09	09	173	82

Source : NEERI Report 1996. * Quoted from Atri, 1996

Figures within bracket indicate National Air Ambient Air Quality Standards.

Delhi, Kanpur and Jaipur are the three cities of the region amongst 10 major cities given in table 3.2.2.

3.2.3 Air Pollution in NCT of Delhi

Delhi has concentrations of three out of four pollutants i.e. NO_2, SPM and RPM/RSPM higher than the National Standards fixed by CPCB. In respect of SPM and RPM, the hazards are very serious.

The magnitude of the air pollution hazards in various segments of NCT of Delhi can be visualised from Table 3.2.3. The data revealed that almost all parts of Delhi are under serious threat of air pollution and the trend is rising (Atri, 1996).

Table 3.2.3 Average Ambient Air Quality Parameters at Different Segments of NCT of Delhi on three seasons. (Mg/m^3)

Location	Winter			Summer			Monsoon		
	SO_2	NO_2	SPM	SO_2	NO_2	SPM	SO_2	NO_2	SPM
Nizamuddin	9.2	26.5	332	12.8	30.8	289	18.2	15.1	206
Ashok Vihar	16.3	32.3	271	14.4	27.5	271	16.7	35.9	238
Shazda	17.7	22.1	389	5.6	29.9	577	11.0	18.1	204
Shahdra	13.2	22.0	261	22.2	24.5	386	15.3	25.3	194
Janak Puri	17.2	33.0	345	13.6	34.9	475	12.3	30.1	360
Sri Fort	8.9	20.7	239	5.1	25.0	309	9.6	23.3	204
Netaji Nagar	36.5	49.2	452	25.4	39.2	476	12.0	31.1	274
ESI Dispensary Najafgarh Road	37.2	53.0	498	34.2	39.0	624	11.5	31.5	410
Town Hall	90.3	82.3	843	51.9	71.0	640	20.6	41.8	388
Escorts Med. Centre	23.4	9.5	263	39.0	11.2	268	23.7	7.2	146
Air Quality Std. C.P.CB									
Residential	60	60	140	60	60	140	60	60	140
Industrial	80	80	200	80	80	200	80	80	200

Source : NERI, 1993.

All sections exceeded the safely standard values of SPM in all seasons. The standard values for residential areas of SO_2 and NO_2 have been crossed at Town Hall in non-monsoon season. Dust and emissions from vehicles, power plants and industries are the main causes.(Table 3.2.3)

The particulates of lead in ambient air of Delhi are present in high concentrations. The relative hazards at different segments of the NCT Delhi are illustrated in Table 3.2.3(a). Lead is a serious contaminating metal. Average lead content in petrol sold in the four metros of Delhi, Bombay, Calcutta and Madras prior to June 1994 was 0.56 gm/1. After June 1994 it has been lowered to 0.15 gm/1.

Table 3.2.3(

Monitor
Ashok V
Shahzad
Siri Fo
Janak P
Nizamud
Shahdar
ITO
Average
Total l Emissio

Source :

Whereas ann

The rising tr and adoption taken as sign

3.2.4 Cost

The loss due 6000 crores about Rs. 1(Agra was ab vis-a-vis size for total mag

Table 3.2.3(a)Status and Trend of Particulate Lead in milligrams per cubic metre in Ambient Air of National Capital Territory of Delhi

(Mg/m^3)

Monitoring Site	1992-93 (APR-MAR)	1993-94 (APR-MAR)	1994-95 (APR-MAR)
Ashok Vihar (R)	212	260	118
Shahzada Bagh (I)	110	176	88
Siri Fort (R)	188	166	112
Janak Puri (R)	230	222	105
Nizamuddin (R & S)	198	126	62
Shahdara (I)	678	213	177
ITO	444	303	415
Average	294	209	154
Total lead Emission (MT)	198	203	86

Source : NEERI, 1996 Quoted from Atri, 1996

Whereas annual Average Limits of particulate Lead has been prescribed as under

Industrial Area (I)	:	1000 mg/m^3
Residential & Mixed Use (R)	:	750 mg/m^3
Sensitive Area (S)	:	500 mg/m^3

The rising trend has been reversed possibly due to the introduction of lead free petrol and adoption of other remedial measures. However, at ITO the reduction could not be taken as significant.

3.2.4 Cost of Air Pollution

The loss due to premature death caused by air pollution for Delhi alone is about Rs. 6000 crores and for three cities of U.P. i.e. Kanpur, Varanasi and Agra, it comes to about Rs. 105 crores while per capita healthcost for 2 U.P. cities i.e. Varanasi and Agra was about 40 percent more than that of Delhi and Kanpur. The danger and effect vis-a-vis size of cities are indicative of the fact that all needs immediate attention either for total magnitude or for severe effect or individuals (CES, 1996).

3.3 NOISE POLLUTION

Noise levels beyond 80 decibels cause severe health problems and loss of hearing. The standard noise levels range from 40 to 70 dBA by night and 50 to 75 by day. While the average day-night levels should be between 45 and 72.5. However, the data from a number of areas of U.P. and Haryana forming part of NCR crosses significantly these levels in all types of campuses vide Table 3.3. The hazard has crossed lower limits in all towns even in the silence zones. Sector wise the most affected areas are those having large concentration of industries and commercial establishment. But the violations could be viewed as the most serious for the silence zones and then for the residential areas.

Table 3.3 Noise Levels in DMA and Priority Towns of NCR

Town/Area Core	Noise Levels (Leq), dBA			
	A	B	C	D
DMA TOWNS				
Ghaziabad	77	64	68	60
Faridabad	71	62	50	65
Gurgaon	74	72	60	60
NOIDA	72	72	61	60
PRIORITY TOWNS				
Bulandshahar	74	65	63	50
Palwal	58	68	62	56
Panipat	62	56	46	52
Rewari	76	66	54	53
Rohtak	70	58	46	64
Meerut	74	74	55	71

Source : NEERI's Report for 1993.

Area Code : A - Industrial; B - Commercial; C - Residential; and D - Silence Zone
DMA - Delhi Metropoliton Area

3.4 WA

3.4.1 Nat

Water is th
form. Alm
quality dete
about 59 p
availability
Haryana, D
the year as
Haryana wl
and water s
getting stre
deteriorating
vegetation a
pollution. V
(organic, ch
form. In the

3.4.2 Grou

The water st
The scenario
be seen from

3.4 WATER POLLUTION

3.4.1 Natural Source

Water is the critical input that decides on survival, growth and development of a life form. Almost all surface water in India is unfit for human consumption today. Water quality deterioration accounts for Rs 19950 crore worth of health cost every year. It is about 59 percent of all environmental degradation cost (CES, 1997). Naturally its availability in quantity is highly variable over different parts of the region covering Haryana, Delhi, Rajasthan and Uttar Pradesh and widely fluctuating over time within the year as well as over the years. The greater part of Rajasthan, NCT of Delhi and Haryana while western and Bundelkhand area of Uttar Pradesh are subject to drought and water stress problems of varying intensity. Consequently ground water sources are getting stretched or diminished in their capacities. On top of it much of these are deteriorating in qualities. The first set of hazards is due to extensive loss of perennial vegetation and land degradation. While the hazards of quality deterioration is through pollution. Water pollution can be viewed as the presence of any foreign substance (organic, chemical and biological) in water. It can be in suspended solid or dissolved form. In the region these hazards are high and spreading very fast over larger areas.

3.4.2 Ground Water Balance

The water stress situations are overcome largely through withdrawal of ground water. The scenario of the States in respect of ground water status is not a pleasing one as will be seen from the details given in Table 3.4.2.

Table 3.4.2 Ground Water Status in Some Districts of the States.

Parameters	States Annual Figures - Million ha-m/yr.			
	Haryana	Delhi	Rajasthan	U.P.
For States				
Total replenishable G.W. Resources.	0.852	0.050	1.622	8.045
Net Draft	0.508	0.029	0.493	2.495
Balance available for exploitation	0.216	0.014	0.836	9.344
No. of districts covered	12 Shivalik,Aravalli Plains, Desert		27 Aravalli, Desert, Vindhyan scrp.	50 Plains, Bundelkhand Himalayan foothills
Out of total district covered	DPAP-1 (Mohindergarh)	----	DPAP-13 (includes Udaipur, Chittorgarh Bhilwara & Bharatpur of Aravalli	DPAP-16 (includes Vindhyan, Bundel khand, Distt. of Jhansi, Mirzapur, Hamirpur Lalitpur
	DDP-4 Hissar, Bhiwani Rohtak, Sirsa		DDP-11	DDP- Nil

Source : Compiled from Ground Water Statistics publication by MOWR (1991).

However, quality analysis of districts revealed that greater portion are of brakish or of poor quality. Polluted rivers like Luni, Bundi and Jojri in western Rajasthan carry toxic substances from textile industries varying from 6 tonnes (Jojri-Jodhpur) to 90 tonnes (Bundi in Pali) of toxic substances. The industrial water with such load of pollutants percolates through the river bed and contaminate the ground water. At Jetpura village near Jodhpur 25 percent of wells have become polluted. (Arrawatia, 1996)

3.5 SURF

3.5.1 Status

Information o
percent of the
Moran and Ba
be micro sto
irrigate 31.5
command bel
irrigated com
areas of this
rainfall is low
natural vegeta

Besides fluctu
crops, is freq
while desert a
has the most
besides for th
rainfall revea
Micro level a
week to wee
receiving rela
weeks and da
quite often m

Thus ultimat
between the
extraction ca
Growth Inde
germination,
The rainfall
emergence o
growth and c
the absence
moisture by

es.

U.P.

8.045

2.495

9.344

50
Plains,
Bundelkhand
Himalayan
foothills

DPAP-16
(includes
Vindhyan,
Bundel khand,
Distt. of Jhansi,
Mirzapur,
Hamirpur
Lalitpur

DDP- Nil

akish or of
carry toxic
90 tonnes
pollutants
ura village

3.5 SURFACE WATER

3.5.1 Status in Aravallis

Information on Aravalli region reveal that a total water of 3797.6 mill. m^3 or 78 percent of the total flow through five major southern rivers, i.e. Mahi, Som, Jakhan, Moran and Banas have already been utilised. The major source for irrigation appears to be micro storages (Tanks below 400 ha. command). These tanks numbering 995 irrigate 31.5 percent of the total command of 2.36 lakh ha. Minor storages (with command between 400 and 1000 ha) number 90 and account for 16 percent of total irrigated commands. These have special significance for helping recharge over large areas of this difficult terrain and thus achieve a degree of drought proofing. Because rainfall is low and erractic to support any sustainable land management system except natural vegetation represented by climax forests. (AFC, 1994)

Besides fluctuation of rainfall over seasons, specially growing period of plants and crops, is frequent. Both Aravalli and Vindhyan receive low to moderate annual rainfall while desert areas of Rajasthan and Haryana receive very low rainfall. Thus the region has the most difficult period of moisture deficits in growing weeks, months, seasons besides for the whole year. Excess deficit analysis of the daily, weekly and monthly rainfall revealed that in almost all the areas the deficits was in June, July and August. Micro level analysis have revealed that carry over effect of rainfall from day to day and week to week had been beneficial both in years receiving low rainfall and those receiving relatively higher rainfall. This is because rainfall distribution in the months, weeks and days within a year has been observed to be very erratic. Dry spells could be quite often more than 15 days and could stretch to 21 or even 35 days in a year.

Thus ultimate potential of plant/crop performance was assessed from the balance between the forces of evapo-transpiration and gravity vs. soil suction plus plant root extraction capacity. This is reflected through a composite index called Climatic Crop Growth Index (CCGI). This index is again variable with crop growth stages i.e. germination, restricted growth, satisfactory growth, sufficient and abundant growth. The rainfall data revealed frequent failures or inadequacy of rainfall to permit even emergence of plant and their survival and persistent inadequacy to promote desired growth and development in the peak growing weeks. This shows that notwithstanding the absence of large and sustainable sources to encourage irrigation, augmentation of moisture by other means for desired plant performance is a critical need. (AFC, 1994)

On the other hand the same rainfall records have established the fact that the areas receive quite often abnormally high daily rainfall or heavy cumulative rainfall over 2 to 4 consecutive days. The high and severe flash floods have, therefore, been visiting the area not quite infrequently.

It is not surprising to find quite a few traditional techniques in vogue to overcome both these extremes to a reasonable extent. There has been successful attempts to buttress the tradition by incorporating modern technology to match site conditions.

In Haryana Aravallis there are rivers like Sahibi, Kasawati, Indori etc. In addition there is a large (20 Km^2) surface lake call Kotla lake. These, besides, innumerable depressions and inter-dunal basin help voluminous recharge. The resources however, are inadequate for domestic requirements as well as for cultivation. Thus the tradition has been to conserve and harness rain and run off water for recycling to agriculture and other land management systems. Large number of percolation embankments, ponds, silt detention dams, other small structures have been constructed, under the programmes of catchment treatments, rainfed watershed development, eco-development, afforestation of degraded areas etc. These small structures collectively have been able to hold and re-use large quantum of water. Consequently, greenery could be recreated and cultivation could be given stability. All these generated larger employment and higher income (AFC, 1994).

3.5.2 Status in the Vindhyans

In Vindhyan Region of Uttar Pradesh, stretching from Mirzapur to Jhansi and then to Indore in Malawa plateau of M.P., there are good rivers like Betwa, Sone, Rehand and others. As a whole the average quantity of water that flows through these rivers could be considered fair. But in parts, such as Bundelkhand area, the Region is subject to fluctuations and failure in rainfall distribution and other climatic aberration. Thus harnessing and reusing seasonally available rain water through 'Ahars', bundhies, ponds and other means have been in practise since ancient time. In last two decades such structural support has been able to improve hydrologic regimes. Consequently afforestation to regenerate the non-cultivated areas and profitable cultivation of cropland with higher cropping intensity could become a sustainable proposition.

3.5.3 Status of Indo-Gangetic plains in Haryana, Delhi & UP

Haryana plains area, now gets reasonable quantity of water. Though for intensive agriculture as the State has become used to, more water would be desirable. For U.P. plains rainfall and river water are good. The limitations is in soil quality, population etc.

3.6 LOSS OF AVAILABLE MEAGRE WATER

The delicate situations due to scarcity of fresh water affecting biological processes, as explained in preceding para, further gets deteriorated through the continuous loss of quality of both surface and ground water sources. This deterioration is due to excessive pollution by various developmental and economic activities.

3.6.1 Industrial Effluents Polluting Water Sources

3.6.1.1 Regional Problem

Ground water quality monitoring programme for the country has identified 22 problem areas in sixteen States. The list includes Najafgarh drainage basin of NCT of Delhi, Pali and Jodhpur in Rajasthan and Singrauli of Uttar Pradesh. All these areas revealed serious bacteriological contamination (MOEF, 1995-96). While the list of Grossly Polluting Industries (GPI) which have been discharging effluents into water course include the following in this region is as under

	State	No. of GPI identified
1	Haryana	128
2	NCT Delhi	7
3	Rajasthan	14
4	Uttar Pradesh	372
		521

These represent 34 percent of the total of 1532 GPIs identified in 25 States and 5 UTs in the country.

3.6.1.2Problems in Aravallis

In the Aravallis in Rajasthan, Haryana and Delhi there are 5580 industrial units. The industries concerning textiles, leather, chemicals and smelting, cement making and others are causing serious water pollution. In areas where Zinc industries predominant, ground water has been polluted within a radius of 5 to 19 kms. in Rajasthan. While Faridabad and Gurgaon in Haryana are worst affected districts by industrial wastes (AFC, 1994).

3.6.1.3Problems in Rajasthan

There are 125 large scale and 149 medium scale industries. So far surveys have established that 88 large scale industries and 47 medium scale industries are water polluting ones. On the basis of water pollution, 27 districts have been grouped in three categories vide Box 3.6.1.3 (Arrawatia, 1996).

Box 3.6.1.3 Districts of Rajasthan in three categories of water pollution

S.N.	High A Category	Medium B Category	Low C Category
1.	Pali	Jhunjhunu	Banswara
2.	Jodhpur	Sawai Madhopur	Jhalwar
3.	Barmer	Bharatpur	Jalore
4.	Kota	Bundi	Dholpur
5.	Alwar	Chittorgarh	Nagaur
6.	Udaipur	Tonk	Durgapur
7.	Jaipur	Bikaner	Jaisalmer
8.	Bhilwara	Sriganganagar	Sikar
9.	Ajmer	Sirohi	Churu

Trade and industries generate effluents to the tune of 2.93 lakh m^3. The important districtwise break up is as under :

Kota	45 percent
Udaipur	11 percent
Alwar, Jaipur Jodhpur and Pali each @3 percent	12 percent
Rest 21 districts	31 percent

The textile and metal rolling mills generate maximum quantity of polluted water. The former is coloured rich by chloride and sulphates with high COD, BOD and pH While the latter is of light green to red and alkaline. These effluents contain high Na CO_3, Zn and residual sodium carbonate.

3.6.1.4**Problems in NCT Delhi**

Consequent to the discharge of industrial effluents in the rivers/streams which carry high concentration of toxic substances, surface water in river flow gets polluted alarmingly. The pesticides and chemical fertilizers applied to agricultural fields of Haryana send highly polluted water to the boundary of Delhi. While Delhi multiplies the load several times of the undesirable pollutants in Yamuna which is dreadful for cities like Agra and Mathura (CES, 1997). In large and perennial rivers there is a feasibility of washing down of the pollutants during high rainfall years. In case of non-perennial rivers situation deteriorates further and fast. The danger could be perceived from the data for 3 rivers of western Rajasthan (Table 3.6.1.4):

Table 3.6.1.4 Industrial Effluents and pollutant load in three Rivers of Western Rajasthan

Sl. No.	River at Town	Volume of Industrial effluents m.l.d	Pollutant load Tonnes/day
1.	Luni at Barmer	4	45-50
2.	Bundi at Pali	10	90
3.	Jojri at Jodhpur	7	6

The polluted water percolates through bed and bank and contaminates with groundwater. At Salawar village, Jodhpur through pollution almost all wells are contaminated and yield has declined at least by 25 percent of the original. Effluents

breach the sand bund and swamp the crop land and thus cause almost complete loss of yield for one to two year (Arrawatia, 1996).

3.6.1.5Problems in U.P. and Haryana Plains

Nearly 113 rivers out of all major river systems, have 85 percent of drainage basin, 85 percent of surface flow and have 80 percent of the country's population in these plains. Many of these also remain dry during summer and a few mighty ones carry highly polluted water. The river Ganga is found polluted in a stretch of 480 km out of its full length of 2035 Km and Yamuna 522 Km out of its total length of 1044 Km. These polluted stretches passes through the plains area of Haryana and the cities like Delhi, Calcutta, Agra, Mathura, Kanpur down to Varanasi and Allahabad (NIH, 1992).

Tannery effluents at Kanpur contains over 23 times total solids and 3 times total volatile solids that are carried by waste water of Calcutta. Similarly BOD from tannery at Kanpur is four times as that of in Calcutta waste water (Chaturvedi A.N. quoted from Das & Kaul 1992). Problems in the Ganga also along its course are alarming and main sources have been industries and application of agro-chemicals to agricultural fields.

3.7 SEWAGE AND WASTE WATER

3.7.1 Quantity Generated

Fifty cities of Haryana, Rajasthan, Uttar Pradesh and Delhi generate waste water including sewage to the tune of 4377 M.L.D. and only about a quarter of it is collected while only one-fifth is treated (Table 3.7.1). Percentage of waste water and sewage collected varies from a high of 50 for Delhi to only 12 for Rajasthan. Treatment is given to 100 percent that is collected in case of Delhi and only 63 percent or 160 MLD out of 255 MLD collected from a few U.P. cities. An assessment made by CPCB reveals that domestic sewage contributes to 90 percent of waste water generation. While out of 10 percent, 7 percent by medium sector industries and 3 percent by small and collaze industries. (quoted from NIH, 1992)

Table 3.7.1

Ste
Har
Raj
Utt
NCT

Sourc
*

3.7.2 Disp

The sewage
in 37 cities

Table 3.7.2

State
Haryan
Rajast
U.P.
Delhi
Total

Source :
* Fig

Table 3.7.1 Problem of Sewage/Waste Water Generated in four States of the Region

State	No. of cities	Waste Water (MLD)		Waste Water Treatment Capacity	
		Generated	Collected	Primary	Primary & Secondary
Haryana	9	130	38.5 (29.6)	0	0
Rajasthan	11	318	38.2 (12.0)	---	---
Uttar Pradesh	29	1449	255 (17.6)	---	160
NCT of Delhi	1	1480	745 (50.3)	0	745
Total :	50	4377	1076.7 (24.6)*	0	905 (20.7)

Source : Das and Kaul, 1992

* Figures in parenthesis are percentage of total

3.7.2 Disposal of Waste Water and sewage Generated

The sewage and waste water generated in the region are discharged on agricultural land in 37 cities (64%) out of the total 50 cities under discussion. (Table 3.7.2).

Table 3.7.2 Disposal/Discharge of Waste Water from the cities of four States.

State	No. of cities	No. of cities disposing on		
		Agrl. Land	River	River & Agrl. Land
Haryana	9	3	1	5
Rajasthan	11	10	-	1
U.P.	29	19	4	6
Delhi	1	--	--	1
Total	50	32 (64.0)	5 (10.0)	13 (26.0)

Source : Das and Kaul, 1992

* Figures in parenthesis are percentage of total.

In case of another 13 cities (Table 3.7.2) or 26.0 percent of the samples these are discharged both on agricultural land as well as in rivers, ponds and reservoirs. Only 10.0 percent of cities or 5 out of 50 are draining exclusively into rivers. The waste water generated in the present day contain a varieties of toxic minerals and heavy metals. The list for the region includes Zn, Fe, Cu, Mn, Pb and Ni. In addition a large quantity of pathogenes, bacteria etc. are present in the sewage which poses a serious threat to the human health. Thus the threat of contamination of water is very serious and extensive. The ultimate effect of such contamination could be fatal and cause deaths. The dangerous prospect was demonstrated convincingly by Dr. D. Chakravarty (1996) School of Environment, Jadavpur University, Calcutta through data from the calamities brought in West Bengal by the arsenic contaminated ground water.

3.8 LAND DEGRADATION THROUGH POLLUTION

3.8.1 The Process of toxicity and contamination

By definition land degradation refers to loss of its production potential due to physical, chemical and biological damages inflicted on it and hydrologic deterioration brought about. Land or soil productivity is due to favourable (i) solid-liquid-air ratio; (ii) chemical environment (iii) communities of micro organisms, (iv) hydrologic responsiveness. Discharge of sewage or industrial effluents and land fills of various kinds subsequently induce seepage of minerals and metals. This promotes emergence growth and multiplication of a host of micro-organisms and insects. Many of these are set in operation in a varieties of processes which are injurious to cultivated plants and other life forms. Many of these are not yet studied while a few studies have revealed some alarming facts. The total solids, total volatile solids, loads of toxic and contaminating substances in sewage and waste water finally find there ways into soil body. The limited data have shown that there had been accumulation of toxic substances on land, beds of fish ponds and rivers. On the other hand application of sewage and effluents for irrigation and fertility enrichment helped produce a varieties of consumable biomass on a very remunerative basis notwithstanding the hazards stated above.

3.8.2 Garbage Dumps

Garbage from settlements has been becoming a serious threat to the health of land water and air. In cities like Delhi, Kanpur, Jaipur or Ambala/Hissar, it is common to see garbages get piled up at road sections, on depressions and at the road junction. For

days these
elsewhere
surface and
dengu has
tonnes of g
times that
that produc
Precise inf
what is exte

The magnit
(Malik, 19

i.	Amou
ii.	No.
iii	No.
	are
-	Mid
-	Jhu
iv.	No.
	last
v.	Break
1.	Resi
2.	Baza
3.	Indu
4.	Rail
5.	Hosp
6.	Rest

Source : M

days these remain to rot and decay, and to get pulverised, scattered and carried elsewhere by animals and rag pickers. In the process pollutants spread out on land surface and through drains and air reach other areas too. Recent mass infection like dengu has been largely attributed to such situations. Delhi generates a staggering 7880 tonnes of garbage/day and is over 2.2 times the garbage generated in Calcutta and 1.34 times that of Bombay. Lucknow generates 1500 tonnes/day which is only 70 percent of that produced by emerging fifth metropolis of India i.e. Bangalore (Malik, 1996). Precise information from cities of Rajasthan and Haryana is not available. But from what is extensively visible in these towns and cities, the situations are no less alarming.

The magnitude of the problem can be visualised from some figures obtained for Delhi (Malik, 1996) and given in Box 3.8.2.

Box 3.8.2 Garbage Hazards of Delhi

i.	Amount of garbage produced per day			7880 tonnes
ii.	No. of Community Collection Centres			1804
iii	No. of Communities where Garbage bins are absent:			
-	Middle income level colonies			508
-	Jhuggi clusters			1020
iv.	No. of dumps not cleared for the last five years			9
v.	Break-up of Garbage producing sectors is as under :			
		Tonnes/day	Biodegradable	Recyclable
1.	Residential areas	3200	60%	35%
2.	Bazars/Markets	2040	50%	27%
3.	Industrial areas	1080	10%	80%
4.	Railway stations	640	50%	48%
5.	Hospitals	550	---	6%
6.	Rest	370		
	Total	7880		

Source : Malik. Iqbal, 1996

There are evidences of cadmium pollution in Naraina and Mayapuri areas. While Shakur Basti suffers from heavy products dumps. Further Mandoli and Suraspur's agricultural soils have become toxic due to lead smelting there. Impact on human health due to bazar sector garbages range from skin rashes from caustic soda to heart attack and mis-carriages through trichlora ethane.

3.8.3 Flyash

Fly ash dumps on land have caused serious changes in physico-chemical properties of soil. A few important ones (Srivastava et al, 1996) are

- Being predominantly sandy - the texture degrades;
- Being lack of clay and organic-particles, which are fine sand, are highly succesptible to wind erosion.
- As the particles reflect light, surface temperature rises.
- Deficient in major plant nutrients and has high Al_2O_3 and Fe_2O_3. Lack micronutrients too. Thus lowers fertility of soil.
- Reduces microbial population

3.9 CONCLUSIONS

The pollution of land, water and air is not only extensive in the region but also alarming. These are contaminating soil and water that produce foodgrains and other items while degrades air quality. These adverse effects are set to deteriorate vital organic functioning of human beings. All these are mainly due to the fact that socio-economic growths have over taken the carrying capacity of natural resources base. These growths have disrupted the balance between land-water-plant (permanent vegetation) interms of Supporting Capacity (SC) as well as Assimilating Capacity (AC) as has already been explained in detail for the fragile Aravallis (AFC, 1994).

POLLUTIC

4.1 W

Pollutant
deteriora
Rajasthar
susceptib
ones are
question
indicator
are needc
protect h
into artif
other eco
factors w
following
human s
useful to
landscape
natural f
developm
pollution
prevalent
intensity
choice as

4.2 IN

4.2.1 S

Determin
plants co
inflicted
or comn
morpholc

CHAPTER - 4

POLLUTION INDICATOR, ACCUMULATOR & PROMOTER PLANTS

4.1 WHY PLANTS AS INDICATORS

Pollutants of various kinds as reviewed in preceding chapters have been causing serious deterioration in the quality of life support systems of this region comprising Haryana, Rajasthan, Uttar Pradesh and NCT of Delhi. Plants are primary life forms and thus also susceptible to these deteriorations. Other life forms namely the animals - the secondary ones are open to hazards directly or through their respective food chain as well. The question may arise as to why animals and birds or human beings should not be used as indicators. We from human societies work for safety of human kinds. The indicators are needed to have fore warning so that appropriate steps could be taken well in time to protect human beings. Besides food habits and chains for human societies have evolved into artificial ones following the evolutions of land husbandry, industrialisation and other economic development. Thus impact on human beings of any pollution has many factors working in conjunction. While that on other animals, will be in a sequence following the individual consumption patterns which no more follow basics as of the human societies. The systems and causes identified through them thus may not be useful to human being interse. On the other hand plants, notwithstanding all changes in landscape and world of human beings, continue to maintain a direct relationship with natural forces effecting transfer of energy in different forms, for their growth, development and maintaining the continuity of their lines. The effect of a type of pollution or pollutant loads on the plants will be a measure of real processes as prevalent in nature. These will be much simpler to understand in terms of spread, intensity and consequence of a specific pollution type. Therefore, plants are natural choice as indicators of the effect of pollution hazards.

4.2 INDICATOR PLANTS

4.2.1 Symptoms & Damages

Determining the effect of the concentration of a pollutant, gaseous/liquid/solid, on plants could be a exciting study as well as a horrifying experience. Further the injuries inflicted or disorders caused could get mixed up with the symptoms of natural disorders or common health problems. Any unusual symptom or perceptible changes in morphology, mineral composition, physiological and biochemical functioning could be

considered as an effect of a kind of pollution which is not natural and clearly an induced one. In doing so, with and without the source of pollutant conditions should be considered. Some of the type of damages due to air pollutants are given in Box 4.2.1.

Box 4.2.1 Effects due to various air pollutants on plants

Sl. No.	Air pollutant	Type of damage
1.	Sulphur dioxide	Interveinal Chlorosis
2.	Nitrogen oxide	Defoliation, marginal and tip burning, irregular black spots
3.	Ozone	White or yellow or brown flakes on upper leaf surface associated with stomata
4.	Hydrogen fluoride	Tip burn or marginal neurosis
5.	Hydrogen sulphide	Whitish or tan markings on young growing leaves
6.	Carbon monoxide	Leaf curling, aging and reduction in leaf size.
7.	Particulate matter	Clog stomata, preventing gas and vapour exchange.

Source - "Pollution Ecology" - S.K. Agarwal (1991), Himanshu Publication.

4.2.2 Distribution of Plants

Pollutants are known to affect distribution and composition of species. These may cause extinction of one or more species or emergence of new ones in the habitats where the same are not found naturally. It is becoming possible to relate the presence or absence of species, their numbers, frequency, external or internal symptom of injury by various scientific means.

4.2.3 Plant species and tolerance to Pollutants

Leaves & barks are mostly provide early indication of injury or distortion. Whereas flowers are generally remain unaffected. Of course opening of buds etc. may not take place if pollution is severe. Plants respond differently to the same pollutants. There could be modification in seasonal rhythm of plants. Variable injuries on leaf tip and edges, under surfaces in the form of chlorosis and neurosis are common. There could be abortion of flower buds and reduction in flower size as well. A large number of plant species has been identified as indicators to different pollutants. An abstract of the same (quoted from Atri, 1996) is given in Box 4.2.3.

The list has
Varanasi, ii)
NBRI, Lucki
Unv. Waltair
studies, Labo
al, 1996).

Box No. 4.2.	
S.No.	Pollute
1.	SO_2
2.	Fluori
3.	Cement
4.	Flyash
5.	Petro
6.	Smoke
7.	Dust
8.	Hortic
9.	Combin
	Total

Source : Air Po

4.3 AIR I

There are pla
The accumul
particles settl
to settle early
from either
absorb and r

The list has been prepared from the results published by BHU, institute of Science, Varanasi, ii) BARC, Mumbai (iii) JNU, Delhi (iv) Vikram University, Ujjain, (v) NBRI, Lucknow, Unvs. of Calcutta, M.S. Unv. Udaipur, P.G. College Kota, Andhra Unv. Waltair and many others. Evaluation of indicator plants was done through field studies, Laboratory experimentation and observation of trans planted plants (Kumar, et al, 1996).

Box No. 4.2.3 Indicator Plant Species in Number for Different Pollutants

S.No.	Pollutant	Animals & Grass	Herbs	Shrubs	Trees	others	Total
1.	SO_2	17	8	1	7	5	38
2.	Fluoride	1 (Cynodon dactylon)					1
3.	Cement Dust	2	2	--	2	---	6
4.	Flyash	1 (Triticum aestivum)	--	--	--	---	1
5.	Petro Coke	1 (Phaseolus aureces)					1
6.	Smoke			---	1 (Azadirachta indica)	---	1
7.	Dust	1 (Triticum aestivum)	1 (Helianthus annus)	---	4	---	6
8.	Horticide	1 (Cicer arietium)	---	---	---	---	1
9.	Combinations	9	2	4	5	---	20
	Total	33	13	5	19	5	75

Source : Air Pollution and plants, MOEF, 140-147, Varshney (1985). Names are given in Annexure 4.1

4.3 AIR POLLUTANT ACCUMULATING OR REMOVING PLANTS

There are plants which permit and stand accumulation of air pollutant to a great extent. The accumulation of gaseous pollutants is mainly by absorption through stomata. Dust particles settles on the leaf surface. Heavier dust particles e.g. of coal dust were found to settle early and on shrubs i.e. at lower heights. While heavy metals get accumulated from either foliar deposits or by up take through roots. The ability of a species to absorb and remove pollutants is related to the characteristics of foliar surface. Barks

foliar surface ?

have also been found to promote surface deposition of Sulphur dioxide. The quantum of accumulation is also influenced by i) distance of the plant from the source and ii) prevailing wind direction.

Some of the important data on the accumulation or removal of air pollutants are given in Box 4.3. As these plants act as sink for the pollutants and thus continuously cleanse the atmosphere are also called as Pollutant Scavenging Plants. This ability of the plants is mostly due to ever green simple leaves having rough surface. However, barks of some plants also do remain pollutants in many case. *Nirium indicum* has shown this ability under Delhi condition and remained unaffected by pollution promoters.

Box 4.3 SOME IMPORTANT DATA ON PLANTS, PERFORMANCE ATTRIBUTES AND ABILITIES

Species	Type of pollutants accumulated/Removed	Data if any
Argyrria spieiosa (Samudrashok)	Dust and others	Climber
Nerium indicum Bougain villea spectabilis Duranta plumieri	Effective as hedge plants. These are perennial and continuously shoots new leaves and this is not one time scavengers Dust and pollutants generated by traffic.	Shrub 77.64 Kg/Km (Ring Road, Delhi) All three when planted along ring road reduced 40% of the particulates
Douglas fir	38 cm dia	Has potential to remove 20 Kg of SO_2
Alfalfa, Oat and barley	Water soluble pollutants by canopy	Ability in decending order Hydrogen fluoride, Sulphur Oxide, Chlorine, Nitrogen etc.
Solanum melongene Cymopsis tettra gonoloba		When moist, leaf surface can remove SO_2 upto 0.5 ppm concentrate
Ficus religiosa (Peepal)	A tree of 50 t wt	Absorbs 2252 Kg CO_2 Releases 1712 Kg O_2 per year
A tree (Standard)	Weighing 50 t	Release 1000 Kg (app) of O_2 per year or absorb 1315 Kg of CO_2
18 hole golf course	Grasses	Can provide enough O_2 for 6000 to 9000 person

Source : Compile

4.4 EXOT

4.4.1 Source

Out of many later identifie affected huma

Available info elements are

BOX 4.4.1 CON

S.No.	Name
1.	Partheniu
2.	Lantana c
3.	Argemone
4.	Xanthium
5.	Tribulus
6.	Agrostema
7.	Eupatoriu
8.	Clidemia
9.	Hyptis su
10.	Croton sp
11.	Euphorbia

Source : Parihar

An estimate in 5 m ha has b spread over al

Source : Compiled from various contributions listed in the references

4.4 EXOTIC PLANTS TURNED WEEDS

4.4.1 Sources and Toxic Elements

Out of many plants which came to India with visitors and trading goods, some were later identified as exotic weeds and found to foul land, water & air and thus adversely affected human health (Parihar, 1996)

Available information in respect of 11 such species such as source, principal toxic elements are given in Box 4.4.1.

BOX 4.4.1 COMMON EXOTIC WEEDS WHICH HAVE AFFECTED LAND HUSBANDRY IN INDIA

S.No.	Name	Native Region	Toxic Principal
1.	Parthenium hysterophorus	Central America	Parthenin & phenolic acids
2.	Lantana camera	Tropical America	Lantedene, Lancamarone
3.	Argemone mexicana	Mexico	Senguinarine etc.
4.	Xanthium strumarium	America	Sesquiterpene lectone
5.	Tribulus terrestris	Africa	Steroidae, Sapogenins, alkaloids, resins etc.
6.	Agrostema githago	Europe	Githagin
7.	Eupatorium riparium	Mexico	No forage value
8.	Clidemia hirta	Tropical America	Avoided by cattle
9.	Hyptis suaveolens	"	Avoided by livestock
10.	Croton sparsiflorus	"	Lactone
11.	Euphorbia geniculata	"	Alcohol enpatol

Source : Parihar, 1996

An estimate indicates that vast areas have been affected by some of these plants. About 5 m ha has been infested by *Parthenium* and 2 m ha by *Lantana*. These plants have spread over almost all types of land such as cultivated, rangeland and forest areas.

CHAPTER - 5

TOLERANT AND POLLUTION SPECIFIC PLANT SPECIES

5.1 TOLERANT SPECIES

Plants which are indicators may not be appropriate for remediation of an affected atmosphere, water or land as it could be very sensitive. Similarly a good accumulator or one with high capacity to remove pollutants need not necessarily be an effective one to abate pollution. To be suitable and effective a plant has to be a sustained accumulator or abater. Further, if the level of pollution steadily increases, then more and more plants with the ability to collect or abate will fail to perform on sustained basis. Thus these plants are to be screened by bringing in a reliable index.

5.2 AIR POLLUTION TOLERANCE INDEX (APTI)

The relative ability of the plant which can tolerate and remove pollutants from the atmosphere is measured by a composite index called Air Pollution Tolerance Index (APTI). It is computed from five attributes of a plant (Aggarwal, 1991; Singh and Rao, 1983)

i) Ascorbic acid content of leaf
ii) Total chlorophyll content of leaf
iii) Leaf extract pH
iv) Relative water content of leaf tissue
v) Foliar phenol content.

From various assessments about 63 plants have been identified as tolerant plants. This list includes 23 Trees - deciduous, 15 Trees - evergreen, 10 Shrubs and 15 Herbs & Grasses. The plants have been listed in order of rank in the Box No. 5.2. Further, these rankings are entirely on the basis of plant attributes. Whereas a plant cannot get water if it is not routed through soil and not provided by precipitation the ultimate supplier. These cannot get nutrients unless soil body has these and is in a position to release the same to solutes. These cannot uptake unless force matrix of climate, soil and their roots are favourably poised. Thus like any other life form, plants cannot perform to its potential if the abiotic support base is not helpful. APTI lacks consideration of all these.

BO

Deciduous
Ficus rel
Albizzia
Cassia fi
Phyllanth
Zizyphus
Azadirach
Phyllanth
Sapindus
Tamarindu
Psidium g
Morus alb
Moringa ol
Anthocepha
Bombax cei
Madhuca in
Aegle marm
Feronia el
Cordia myx
Delonix re
Bambusa ba
Butea fron
Tectona gr
Dalbergia

Sou

BOX 5.2 PLANTS ARRANGED IN DECREASING ORDER OF THEIR AIR POLLUTION TOLERANCE INDEX (APTI)

Deciduous Trees	Evergreen Trees	Shrubs, Herbs & Grasses
		SHRUBS
Ficus religiosa	Ficus glomerata	
Albizzia lebbek	Pithecelobium dulce	Bougainvillea spectabilis
Cassia fistula	Polyalthia longifolia	Calotropis gigantea
Phyllanthus distichus	Ficus infectoria	Poinsettia pulcherrima
Zizyphus jujuba	Leucaena leucocephala	Ricinus communis
Azadirachta indica	Mangifera indica	Rosa indica
Phyllanthus emblica	Anona squamosa	Calotropis procera
Sapindus mukorossi	Syzygium jambolana	Duranta plumceri
Tamarindus indica	Acacia arabica	Murraya exotica
Psidium guava	Artocarpus heterophyllus	Lantana indica
Morus alba	Alstonia scholaris	Lagerstroemia indica
		HERBS & GRASSES
Moringa oleifera	Grewia asiatica	Carissa carandas
Anthocephalus cadamba	Casuarina equisetifolia	Vinca rosea
Bombax ceiba	Nyctanthes arbortristis	Croton tiglium
Madhuca indica	Litchi chinensis	Argemone mexicana
Aegle marmelos		Ageratum conyzoides
Feronia elephantum		Phyllanthus niruri
Cordia myxa		Clerodendron infortunatum
Delonix regia		Ocimum basilicum
Bambusa bambos		Cynodon dactylon
Butea frondosa		Leucas aspera
Tectona grandis		Musa sapientum
Dalbergia sisso		Ipomoea cornea
		Euphorbia hitra
		Dichanthium annulatum
		Chrozophora sp.

Source: Singh, S.K. and Rao, D.N. (1983)

5.3 PLANTS FOR AIR POLLUTED AREAS

Investigators working in different parts have tried with a varieties of plants to scavenge the polluted atmosphere and check the rate of pollution in future. Some specific details are given in Box 5.3.

Box 5.3 Plants Suitable for Areas where Gaseous Pollutants are Dominant
(In order of Ranking)

1. *Acacia arabica*	15. *Leucaena macrophylla*
2. *Aegle marmelos*	16. *Madhuca indica*
3. *Ailanthus excelsa*	17. *Mimusops elengi*
4. *Albizzia lebbek*	18. *Murraya paniculata*
5. *Alstonia scholaris*	19. *Neriun indicum*
6. *Argyreia speciosa*	20. *Phoenix sylvestris*
7. *Azadirachta indica*	21. *Phyllanthus emblica*
8. *Bougainvillea spectabilis*	22. *Pithecolobium dulce*
9. *Dalbergia sissoo*	23. *Polyalthia longifolia*
10. *Ficus bengalensis*	24. *Quisqualis indica*
11. *Ficus infectoria*	25. *Tabernaemontana coronaria*
12. *Hibiscus rosa-sinensis*	26. *Tamarindus indica*
13. *Lagerstromia flos-reginae*	27. *Zizyphus mauritiana*
14. *Lantana camera*	

Source : Varshney, C. K., 1996

Considering variable performances and research results the list of plant species suitable for areas with heavy gaseous pollutants is given in Table - 5.3(a).

Table

Site/Place	A
I.P Power Plant Delhi & JNS	JNU
Delhi Ridge	Vat Del
Jodhpur	CAZ
Jodhpur	AFR
U.P.	FRI
Korba, M.P.	SFR Jab
Calcutta	Cal Uni
Delhi	JNU New

Source : Co

5.4 PI

Dust polli as well a research r chemical

o scavenge
ific details

es suitable

Table 5.3(a) Plants that Survived/Thrived in Different Polluted Areas

Site/Place	Agency	Major Pollutant	Plants
I.P Power Plant Delhi & Jhs	JNU, Delhi	SO_2	Species of Ficus, Melia, Bauhinia, Lagerstroemia, Eugenia, Morus Populus, Eucalyptus, Delonix, Azadirachta indica and Callistemon. Leaves & barks were found to help scavenge pollutants
Delhi Ridge	Vatavaran, Delhi	a) Infertile both in inorganic nutrient & organic matter	a) Acacia nilotica, Butea monosperma, Erythrina suberosa Anogeissus pendula
		b) Sodic Soils	b) P. juliflora, A. nilotica, Terminalia arjuna, Accumulate maximum amount of Na with uptake of Mg+Ca from soil, reduction in pH, EC, rise in Organic carbon, K + P achieved.
		c) Infertile	c) Continuation of A. nilotica, Syzyginumcumim, Dalbergia sissoo and Emblica officinalis, Reduction in pH, increase in organic carbon achieved. Improved soil 1230 cm depth to permit planting of another 8 spps.
Jodhpur	CAZRI	Textile effluents	Acacia (nilotica and tortilis), Az. indica, Hardwikia binata, Prosopis cineraria, P. juliflora, E. camaldulensis But only A. nilotica, P. juliflora and E. camaldulensis grew well
Jodhpur	AFRI	Textile	Seven spp. A. lebbek and P. juliflora responded well & application of gypsum helped.
U.P.	FRI, Kanpur	Flyash	Leucaena leucocephala, Acacia nilotica, Albizzia lebbek, Pithecolobium dulce
Korba, M.P.	SFRI, M.P. Jabalpur	Flyash	Ficus religiosa, Terminalia arjuna, Shorea robusta, Azadirachta indica, Ficus bengalensis, Butea monosperma
Calcutta	Calcutta University	Dust	Ficus religiosa, F. infectorea, Tectona grandis, Shorea robusta, Terminalia arjuna, Polyalthia longifolia, Mangifera indica, Lagerstromia flos-reginae
Delhi	JNU, New Delhi	Dust	Neriun indicum, Bougainvillea spectabilis, Duranata plumiceri

Source : Compiled from various references listed at the end.

5.4 PLANTS FOR DUST AND TEMPERATURE CONTROL

Dust pollution from industries, traffic and a most of social activities comprise physical as well as chemical pollutants. The experience of development departments and research results indicate that about 14 plant species are suitable to abate dust as well as chemical pollutants and temperature rises.

Box 5.4 Plants Suitable to abate Pollution of Dust, Temperature, Chemicals, Emissions	
i. *Azadirachta indica*	viii. *Mangifera indica*
ii. *Bambusa multiplex*	ix. *Pongamia pterocarpus*
iii. *Cassia fistula*	x. *Syzygium cumini*
iv. *Dalbergia sissoo*	xi. *Samanea saman*
v. *Ficus spp.*	xii. *Terminalia arjuna*
vi. *Kigelia pinnata*	xiii. *Tectona grandis*
vii. *Mimusops elengi*	xiv. *Tamarindus indica*

Source : Krishna Kumar et al, 1997

5.5 PLANTS FOR NOISE ABATEMENT

From various studies about a dozen and half plants could be identified as suitable for absorbing sound and keep the atmosphere tolerably free from noise pollution. This is given in Box 5.5

Box 5.5 Trees with good canopy for noise attenuation	
1. *Azadirachta indica*	10. *Ficus bengalensis*
2. *Bauhinia variegata*	11. *Ficus racemosa*
3. *Bauhinia acuminata*	12. *Ficus religiosa*
4. *Bombax ceiba*	13. *Jacaranda mimosaefolia*
5. *Cassia nodosa*	14. *Lagerstroemia flos-reginae*
6. *Cassia javanica*	15. *Madhuca latifolia*
7. *Cassia racemosa*	16. *Millingtonia hortensis*
8. *Cassia fistula*	17. *Pithecolobium dulce*
9. *Erythrina variegata*	18. *Saraca indica*

Source : Varshney, 1996.

5.6 GARBAGE AND SOLID WASTES

The emphasis on tackling pollution hazards arising from dumping of garbage and solid wastes has been on the forefront, namely :

i) Disposing substantial portion of the garbage and solid wastes, which are bio-degradable, either through pit composting or through bio-degradation. Vatavaran has successfully tried this through Vatavaran Cleaning Brigades to dispose about 30 to 40 percent of household wastes through bio-degradation. (Malik, 1996). The project is going on at more than a dozen Housing & Group Housing Societies and DDA colonies of Delhi on a sustainable basis. It has also used compressed air dried and compressed bio-gradable wastes as manure to greening projects. Shristhi (1996) explored this method combining with the vermi compost and felt that it calls for hardwork. Gupta (1996) advocated to adopting of vermi composting for disposing biogradable wastes.

In West Bengal however, afforestation of garbage dumps has been sucessfully carried out to bring back lost greenery and recreate pleasant environment in areas fouled by the garbage or sewage. The plant species used sucessfully are given in Box 5.6.

Box 5.6 Plants that Restored Garbage Dumps to Pleasant Green Landscape in Calcutta

Acacia auriculiformis	*Delonix regia*
Leucaena leucocephala	*Peltophorum petrocarpin*
Eucalyptus tereticornis	*Jacaranda mimosaefolia*
Terminalia arjuna	*Acacia mangium*
Anthocephalus chinensis (Cadamba)	*Albizzia lebbek*
	Lagerstroemia flosriginae
	Cassia fistula
	Erythrina variegatal indica
	Syzygium cumini
	Spathodea campanulata
	Ticoma stans

Source : Das and Kaul, 1992

CHAPTER - 6

VALUE OF PLANTS FOR POLLUTION ABATEMENT

6.1 HYPOTHESIS

The plants provide many other commodities which the societies have been using besides the known major and minor produces. These could be in solid, liquid, gaseous and even biological forms. Just because these are not conventionally traded, these are without a price. The hypothesis is, therefore, that plants have values other than conventional ones. Since these are mostly related to eco-regeneration or restoration of environment, these could be called eco-produce or eco-service values.

Accepting the above hypothesis, one automatically faces a question i.e. can these values be assessed and could there be an economic tag on each of these. The attempts made so far inspires us to believe that both assignation of a quantitative value and putting on it a price tag is possible. Like the material goods of plants the prices of eco-produce/service will have a price depending on the socio-economic conditions and cultural backdrop. Both these hypothesis were used for assessing the worth of sacred trees and groves, which were found in the sacred groves of Kurukshetra, in absorbing CO_2 and releasing O_2 (AFC, 1995).

6.2 AVAILABLE INFORMATION

6.2.1 Approaches

Prof. T.M. Das was the first to attempt in putting value on different ecological or environmental services. Prof. Das worked on the (i) production of O_2 (ii) conversion to animal protein (iii) controlling soil erosion and soil fertility (iv) recycling of water (v) sheltering birds etc. and (vi) controlling air pollution. He has used scientific data based on physical & chemical experimentation and repeated observations on others. (AFC, 1995, Beckham, 1992).

The USA Council of Tree and Landscape Appraisers has used the method of assigning a basic value according to the diameter of the tree trunk. This value is then used to estimate the value of a standing tree and then a standing plantation or forest. In this system even a dead tree is assigned a value as the dead tree help recycle microbial population and maintain balance among different types besides putting back chemical nutrients or recirculation route.

The Australian Institute of Horticulture Inc. has developed a system to assign value to trees considering rarity of the species, historical significance, location, form, vigour, live crown size and life expectation. In USA, homes with trees have 7 to 10 percent more market values.

It is now clear that approach has differed from country to country. Valuations made by the countries vary widely. Indian assessment is 10 times that of Australian and double of the American value. Population, per capita, availability of biomass and environmental services could be the cause of these differences. (Beckham, 1992).

6.2.2 Strategy

There is a need to develop a rationale towards the necessity of such valuations. Pollution abatement and remediation of polluted areas would need investment even when it becomes people's movement. Because, time of the people and their materials too have some cost/price as that of a Govt. Official and the materials provided by the same. The contribution of the people will be in the form of services and this will claim the opportunities that they could use to earn money. Therefore, nothing can be done without paying a price.

Now funds irrespective of the source from whom it comes, have to be on competitive basis. Valuation of environmental services rendered by a plant would provide us with rationales to obtain a relatively higher priority for allocation of fund by the Government and also time and material by the house holds to pollution abatement works. Similarly, activities, which cause pollution of various kinds, such as of industries, mining authorities, tourism promoting agencies, corporate bodies, religious institutions, private bodies, individuals should be assessed and price tag put on these.

Once this is done, there may not be much difficulty in obtaining methods and tools through sponsored reviews of related scientific details and also after focussed experimentations to draw a proper plan. An objective base of collaborations as well as cooperations including fund mobilisation, could then be built between the Govt. Dept. and the concerned community or the Industrial, mining and other corporate bodies. This could be done with pollution related industries, commercial bodies, private sector companies and Govt. bodies whose activities induces pollution. These agencies should sponsor fund and also cooperate in implementing the projects. Appropriate incentives such as tax rebate could be a reciprocatory contribution by the Government.

6.3 AVAILABLE DATA

In case of Uttar Pradesh, Rajasthan and Haryana some assessment of values of environmental services have been carried out. These data could be used for the time being.

6.3.1 Plants as Carbon Sink and Oxygen Producer

Reported scientific data states that an average plant when absorbs one gram of CO_2 from atmosphere it releases 2.66 gram of O_2. The information on leaves shed in a year and age of the tree is used to estimate the amount of CO_2 is likely to be absorbed by a tree in a year. Thus to understand the relative ability of plants the values of CO_2 absorption by different spps. are to be known. Some observed/estimated data in this respect are given in Table 6.3.1

Experiments revealed that a person absorbs on an average 16 kg of O_2 in a day and this quantum can be provided by seven trees. In that case for every person we need seven trees to keep him/her leaving in good health. This assessment says that an hectare of trees or equivalent vegetation can keep 43 person alive. Similar analysis revealed that 18 hole golf course can supply enough oxygen for 6000 to 8000 persons (Bekham, 1992).

Table 6.3.1 Assessed/Observed Capacities of plants to absorb CO_2 & release O_2

Sl. No.	Tree/ Plant	CO_2 Taken	O_2 Released	Source
1.	Ficus religiosa one tree of 162 m^2 canopy spread	2252 kg/hr	1712 Kg/hr	TVNF 1981 quoted from Mathur, 1981
2.	100 trees	307 tonnes/yr	205 tonnes/yr	Smith, W H quoted from OmKumar et al, 1996.
3.	One ha Forest	2.2 tonnes/yr	-	Kushwa 1984 from OmKumar et al, 1996
4.	One m^2 of leaf surface	1.5g/hr	-	Shiva quoted from OmKumar et al, 1996
5.	A 50 tonne tree	1 tonne/yr		Nancy Beckham, 1992

6.3.2 Plants abating Capacity of Pollutants

In addition to the above following results could be of interest to the professionals engaged in pollution abatement programmes or ecoregeneration activities

i.	Vegetation at 200 m distance was able to reduce air pollutant concentration by 120 gm/m^3	Chandra, 1982 quoted from OmKumar et al 1996
ii.	In London's Hyde Park air pollution was 27 percent less compared to other parts of the city	
iii.	23 trees offset polluting effect of one car driven 96 Km.	
iv.	A combination of tall trees and shrubs 9-13 m wide was effective in controlling highway noise	Nancy Beckham, 1992
v.	36 m wide and 16 m high green belt can reduce highway noise by 50 percent	
vi.	Just to offset pollution there should be three trees per person on earth	

6.3.3 Value of Sacred groves in Kurkshetra District of Haryana

The study in the districts of Kurukshetra revealed a total of 248 Sacred or Sanctified groves. Out of these 36 sampled groves were found to have 275 old trees with acceptable growth standard. There were 12 species in all. The predominant ones are *Ficus bengalensis, Ficus religiosa, Azadirachta indica, Aegle marmelos and Syzygium cumini*. The equivalent values of environmental services only as carbon sink were computed and reproduced in Table 6.3.3. as under.

Table 6.3.3Environmental Services Value of trees in 36 Sacred Groves in Kurukshetra for Absorption on CO_2 and Release of O_2

Sl. No.	Condition of Regeneration	Value in Rs. lakhs	
		Per Year	Per ha
1.	36 groves with a net area of 160.7 ha and 275 trees as at present	86.35	0.54
2.	36 groves with net area 160.7 ha @ 200 trees/ha total No. of trees- 32,144	10093.20	62.80
3.	36 groves with total area - 384.74 ha @ 200 trees/ha total No. of trees-76948	24161.70	62.80

The information indicate that possibility exists to enhance the values of the sampled sacred groves from Rs 86.35 lakh now to Rs 100.93 crores if these groves are replanted with the sacred trees @ 200/ha for 160.7 ha.

6.3.4 Total Ecological Benefits from Forests

Taking 74.8 m ha of forests and Rs 622 as the rate per ha., Indian forests offer ecological benefit worth Rs 46,52,560 per year against Rs 2,927 million of material benefit. Thus the former accounts for 99.94% against 0.06% by the latter, (Mathur, 1981)

6.3.5 Ecological value of a forest Tree

The monitory value of eco-services of 3 important trees have been assessed as under (Mathur, 1981)

Shorea robusta	Rs. 67.06
Tectona grandis	Rs. 28.03
Pinus roxburghii	Rs. 24.50

6.3.6 Ecological Value of One hectare Forest

Trees in nature such as forests or raised elsewhere such as in temple compounds, along roads, railways, settlement etc. will be in quite diverse combination. It is, therefore,

necessar
combina
pollution
preparati
6.3.6.

Sl. No.	Type o
1.	Value of for prod
2.	Value of for air p
3.	Average a on 8 coun

Source :

necessary to work out the eco-service values of one ha of forests under different combination, shape and site. The values for major benefit such as O_2 release and air pollution control should be worked out separately. These data will be needed for project preparation and for justification for seeking investment. Some of these are give in Table 6.3.6.

Table 6.3.6 Ecological Values of Different Forest Types

Sl. No.	Type of Benefit	Forest Type	Ecological Value (Rs in lakh)
1.	Value of one hectare of forest for producing O_2	a) Tropical assessed weight 450 t/ha	22.50
		b) Sub tropical deciduous assessed weight 410 t/ha	20.50
		c) Temperate assessed weight 300 t/ha	15.00
2.	Value of one ha forest for air pollution control	a) Tropical	45.00
		b) Sub Tropical deciduous	41.00
		c) Temperate	30.00
3.	Average annual eco-benefits on 8 counts of one forest tree	a) Tropical	2.82
		b) Sub-tropical	2.53
		c) Temperate	1.88

Source : Compiled from some of the publication listed at References

CHAPTER - 7

PROGRAMMES AND FUTURE PERSPECTIVES

7.1 ONGOING EFFORTS - RESEARCH

There are quite a few research activities in progress with the support of the environment division of Ministry of Environment & Forests, ICFRE, ICAR, CSRI and Universities. Notable amongst these are :

1. Institute of Science, BHU, Varanasi
2. Dept. of Botany, University of Calcutta, Calcutta
3. Dept. of Botany, Delhi University, Delhi
4. Dept. of Botany, Kota, Rajasthan
5. Baba Atomic Research Centre, Bombay
6. JNU, New Delhi
7. Vikram University, Ujjain
8. National Botanical Research Instt., Lucknow
9. M S University, Udaipur
10. Andhra University, Waltair
11. Central Arid Zone Research Instt. Jodhpur
12. Arid Zone Forestry Research Instt., Jodhpur
13. Central Soil Salinity Research Instt., Karnal
14. Central Soil & Water Conservation Research and Training Instt., Dehradun
15. CSS Haryana Agriculture University, Hissar
16. Forest Research Institutes, U.P., Kanpur
17. Forest Research Institutes, M.P., Jabalpur
18. Jadavpur University, Jadavpur, Calcutta
19. National Environmental Engineering Research Institute, Nagpur
20. School of Mines, Dhanbad

The areas covered are air pollution, noise pollution, pollution through sewage & waste water, solid wastes, Industrial effluents, mining rejects and effluents etc.

7.2 DEVEI

For control o
afforestation is
have become
plantations are

7.2.1 NCT of

NCT of Delhi,
means to abate
sewage and wa
large selection
material, flowe
shrubs being pl
Area include
ameliorator. Tl
Azadirachta ind

7.2.2 Uttar Pr

In Uttar Pradesh
pollution. How
pioneering worl
and distilleries a
regeneration of
follow up actior
the usual list of
(i) *Pithecolobiu*
etc. Using sew
Varanasi.

7.2.3 Rajasth

In Rajasthan too
be successfully
confirmation of
programme has

7.2 DEVELOPMENT PROGRAMMES OF THE DEPARTMENTS

For control of air and noise pollution no specific and focussed programme of afforestation is there. Planting trees, raising green belts and developing green verges have become part of some urban development projects. Similarly for restoration, plantations are being raised by authorities, for mines as well as for certain industries.

7.2.1 NCT of Delhi

NCT of Delhi, where problem of pollution is acute, greening has been taken up as a means to abate pollution and remediate polluted air. For mitigating the hazards from sewage and waste water some plantations are being raised using sewage water. By and large selection of species was based upon ornamental quality, easy availability of material, flowering nature and capability to provide shed. However, the trees and shrubs being planted both in residential area and non-residential areas such as Ridge Area include quite a few which have been found to be effective absorber and ameliorator. The notable ones are (i) Ficus spp. (ii) *Polyalthia longifolia* (iii) *Azadirachta indica*, (iv) *Pithecolobium dulce* (v) *Butea monosperma* etc.

7.2.2 Uttar Pradesh

In Uttar Pradesh too, there is no specific and exclusive programme of greening to abate pollution. However, Forest Research Institute of UP, Kanpur has done remarkable pioneering works to tackle flyash dumps, use industrial effluents from tannery, dairy and distilleries and established the credibility of the plants and technology for successful regeneration of areas affected by these wastes. There has however, been almost no follow up action to popularise the same. However, some top performing species are in the usual list of afforestation works which are being carried out in the State. These are : (i) *Pithecolobium dulce*, (ii) *Acacia nilotica*, (iii) *Albizzia lebbek* (iv) *Syzygium cumini* etc. Using sewage water for raising forests, has been undertaken in small scale at Varanasi.

7.2.3 Rajasthan

In Rajasthan too, the situation has been the same. Though use of textile effluents could be successfully demonstrated by CAZRI, Jodhpur and seems to have received initial confirmation of AFRI, official patronage to its extension or adoption by the Dept., for a programme has not yet come. Nevertheless, a few successful species are traditional

ones and are raised in most of the afforestation programmes. These are (i) *Prosopis juliflora* (ii) *Acacia nilotica* (iii) *Eucalyptus camaldulensis* (iv) *Azardirachta indica* (v) *Acacia tortilis* etc.,

7.2.4 Haryana

In Haryana too the case is not much better. The State however, seems to have interacted with CSSRI, Karnal for technology and its effectiveness. At Faridabad, Panipat, and few more places, district authorities as well as Dept. of forests have used the technology for using sewage and waste water in a limited extent.

7.2.5 Other Programmes

Even though there are a large number of projects for catchment treatment, eco-development, wasteland development, land reclamation, the aspect of pollution is not one of the objectives. Similarly mandatory plantations being carried out on mined areas and a few industries which do not specifically stipulate the pollution abatement as an objective as these are done for rehabilitation of areas degraded by different means.

7.3 EFFORTS OF NGOs AND INSTITUTIONS

7.3.1 Vatavaran :

This NGO has carried out greening of three patches on the Delhi ridge. The success of greening at three patches has been analysed as under (Malik, 1997)

1) Unattended Reserve Forest
   Survival was the least (45 percent)

2) Notified reserve forest with CRPF camp
   Survival rate was high till some jawans stayed in the camp.
   When change took place condition deteriorated (59 percent)

3) Nicholson's, Ridge under Army
   Survival was the highest (87 percent)

It was obser

Condition - 1

Condition - 2

Condition - 3

Condition - 4

To motivate p
survival is ov

7.3.2 Green

The Corporat
WWF. About

Some NGOs
Corporate Hou

7.4 GREE

7.4.1 Feasibi

A number of e
by JNU, Calc

It was observed that for successful greening four conditions should be fulfilled i.e.

Condition - 1 Site condition should be improved by using soil and water conservation measures.

Condition - 2 Species should be hardy to withstand harsh condition and should be able to improve micro level environment

Condition - 3 The involvement of the associates, whether CPRF jawans, Army jawans or students, should be for a sufficiently long duration, say two years. This would provide close care to the struggling seedlings.

Condition - 4 Monitoring and after care is a must for success. The responsibility should be given to a fixed set of people. Soil analysis and periodic checking of the changes with survival and growth rates are other needs. Because these help develop concern as well as confidence.

To motivate people and their continuing participation it was suggested that wherever survival is over 60 percent, concerned person should be rewarded.

7.3.2 Green Delhi Project :

The Corporate Houses have come forward to green Delhi with the assistance from WWF. About 40 Corporate houses have sponsored the project with the target of :

Roads	200 Km
Parks	43 No.
Round about	18 No.

Some NGOs have also been carrying out similar works under the sponsorship of Corporate Houses.

7.4 GREEN BELT

7.4.1 Feasibility

A number of experiments, which have been carried out in the country such as in Delhi by JNU, Calcutta, Lucknow and Bombay as well as some in other countries, have

established the efficacy of Green Belts as scavenger of pollutants. These belts need to be of appropriate combination of plants and the geometry of the stand, both vertical and horizontal as well as and of desired width. These are needed for :.

i) Soil erosion control
ii) Scavenging air pollutants
iii) Noise abatement
iv) Dust absorption and screening
v) Moderation of visual strain
vi) Enhancement of biodiversity

7.4.2 Criteria for Selection of Plant species

Suitability of plant for abating pollution is a variable attribute with type of pollution and pollutant as well. Once these are known, then species get shortlisted vis-a-vis each type of pollution. Again from amongst these, a combination of trees and shrubs should be chosen which collectively should have the following :

- Indigenous- abilities in full use
- Perennial cover is maintained even it be through a few members of the combination
- Ever greenness is also visible, may be through a few of the combination
- Large leaf area with rough surfaces to provide aggregated large operational base
- Rough bark for same purpose as of leaves
- Fast growing - to overtake the forces that may destroy these at seedling stage
- Low water requirement and moisture conservation ability.
- Need minimum care & protection
- Ecologically compatible

It is, therefore, necessary to have an idea of the canopy structure of different plant species. Some of the canopy types and the species, which have them, are listed in Box-7.4.2.

BOX 7.4.2

1. Round Typ
2. Flat topp
3. Cylindric
4. Chimney ty
5. Conical ty
6. Broken or
7. Drooping c

So

7.4.3 De

Wind is th
purpose of

i.

ii.

BOX 7.4.2 List of Plant Species having seven different Canopy Structures		
1. Round Type	:	Trees with more or less round crown and dense branches and leaves, e.g. *Ficus bengalensis*.
2. Flat topped canopy	:	The branches of the canopy uniformly give a flat topped crown and the spread of the crown is wide to cover a large area e.g. *Samanea saman*, and *Delonix regia*.
3. Cylindrical type canopy	:	The branches of leaves form a close network and give the longitudinal spread e.g. *Heterophragma roxburghii*, *Dalbergia sissoo*
4. Chimney type canopy	:	The branches give the appearance of long chimney e.g. *Eucalyptus sp.*
5. Conical type canopy	:	The growth of main stem and horizontal branches appear in the form of a cone. e.g. species of *Thuja* and *Cryptomeria* and other coniferous species.
6. Broken or interrupted crowns	:	The branching pattern & canopy formation is not uniform. e.g. *Bombax ceiba*
7. Drooping canopy	:	The branches and leaves droop downwards e.g. *Salix*

Source : Krishna Kumar et al, 1996

7.4.3 Design Criteria

Wind is the main medium. Thus the stand density and geometry will differ with the purpose of the green belt. Some possible ones are indicated hereunder :

i.	Filtering of Polluted air	:	i) Relatively these stand are multistorey rows on both side
		:	ii) To be raised at right angle to the main wind direction as far as possible
ii.	Filtering & Collecting dust	:	i) Medium density Plantation and multistorey rows with highest stand in the middle both on leeward and hindward direction

		:	ii) For assisting dust movement near ground level such as sand with saltation process an outer row of dense grass or herbs is needed.
iii.	Where polluted area accumulates in the centre	:	Concentric rows are needed of multistoried vegetation
iv.	Sound	:	i) Soft surface of leaves and branches with dense foliage can reduce as much as 7 decibels per 36 m of planting
		:	ii) Width varying from 9 to 13 m will be needed
		:	iii) Main side of plantation should face the area producing noise.
		:	iv) For high noise and when continuous, 36 m width and 16m high vegetation could cut noise by 50%

7.5 SEWAGE-GARBAGE INDUSTRIAL EFFLUENTS AND WASTES

7.5.1 Available Technology and Experience

All these rejects have two critical inputs that plants would need if we want to raise them in inhospitable sites. These are water and nutrients and the sites which will be available for greening will generally be severely deficient in both, while external source for these are quite expensive. On the other hand the sewage, garbage, industrial effluents & waste are rich in minerals as well as of organic matter.

The experiences of many research institutes and Universities, which have been compiled & published elsewhere (Das & Kaul, 1992), demonstrated that these wastes, liquid as well as solids, can be profitably used to raise luxuriant greenery. Further the

plants thus raised remove filth from soil and foul odour from air. Finally such application of these wastes would also create assets which will fetch considerable revenue to the owner of the land whether individual or civic body or corporate or Govt. Agency. These aspects were deliberated at a different forum and published in the form of report vide AFC (1996).

7.5.2 Garbage to promote greenery

Household garbage in towns and cities have become a serious threat. The dumping of garbage along the road side trees or in open space with some vegetation say park etc is a common site in cities like Delhi, Kanpur etc. The dumps are stifling the well grown up trees and may damage them in course of time. But these must be disposed of lest these become health hazards.

An Indian house-hold on an average produces about 0.75 Kg of garbage per person per day (Malik, 1996). Sixty percent of it is biodegradable and can be used to prepare rich organic manure. On the other hand many of the apartment houses in Delhi spend about Rs 1000 to Rs 2000/year for a small truck load of manure for whatever greenery the apartment complex can be proud of. Further these complexes each spend on an average Rs 12000 to Rs 20000 per year to collect and dump the garbage in MCD's garbage bins or nearby road side. The project of Vatavaran Cleaning Brigade could handle about 30 percent of biodegradable garbage to make manure within the campus. The volume to be dumped is thus reduced without any additional cost. On the contrary within four months the manure from a pit of 1.5 x 2 x 1.75 m is ready to provide good manure for the green park, flower beds and trees in the campus. No manure need be bought from out side. This is being practised at least in two dozen sites in Delhi. The cost of a kg of compost bought on an average is Rs. 2.00. A single pit can give compost almost half a ton or worth Rs 1000/-. But a major constraint is lack of space for composting and absence of any official support either technical or material wise.

The composting is being done by anaerobic method. If vermi compost is made through earthworm culture the quality of manure will be more than three times better. This will make the enterprise economically more viable.

The metropolis of Delhi produce 3368 metric tonnes of bio degradable garbage per day from sectors such as residential colonies, bazars, industrial areas and Railway Stations. If composting is resorted to, at least a 1000 mt compost or biofertiliser will become available (Gupta, 1996). This will be worth Rs. 2000 X Rs. 1000 = Rs. 20,00,000,

@ Rs. 2/kg sale price. And at the pit head if we put a rupee per kg it will be one million per day or a crore per 10 days and Rs 36 crore per year. Even if discounted by 50 percent it is perhaps not an small amount for MCD/NDMC. According to Malik (1996), MCD estimated that Rs 4 crore is needed to make Delhi garbage free. Is it a worth consideration proposal in the face of a proposition that could bring Rs 18 crore to the coffer per year while keeping Delhi clean?

Further our farm lands on rural India are starved of manure. Consequently the yield level is far lower than that prevailing in China where manure is applied almost 3 to 4 times the rate in India. At a much reduced rate this could be provided to the user Departments and agencies engaged in greening and eco-regeneration as well as to the adjoining rural households for their farms. The increased yield over two seasons should convince the farmer in sustainable economics of the proposition. The project has established that, it helps resettle rag pickers with a reasonable income to a path for a better living, because the activity is labour intensive (Malik, 1996).

Leaving aside the economics, greening project will yield faster results if bio-fertilisers are applied in good quantities. Thus in contrast of garbage dumping, which is a destroyer of existing greening, garbage composting is a promoter of greenery. The proposition should be analysed and feasibility examined by the Ministry of Environment and Forests for suitable action through civic bodies and should not be allowed to be ignored just because garbage handling is some one else problem.

7.5.3 Bioreactors for Disposal of Solid Wastes

This is being experimented at Dakshin Puri by TERI and Sristhi in association with WWF-India's Delhi Haryana Unit. (Agarwal and Chaturvedi, 1996)

The bio-reactor has been a modified design of the KVIC (Khadi and Village Industries Commission) which has been adopted to garbage.

The reactor is brought to a stable performance level using it as a Gobar(cowdung) gas plant. Two tonnes of gobar are fed in a 4 tonne tank - the biodigester. Through anaerobic process CO_2 is produced first and then comes methane gas and manure. After about 2 weeks it stabilises and then gradually organic waste is fed as per schedule given in Table 7.5.3.

Table 7.5.3 Schedule for bringing the Bioreactor to a stable level

Week	Qty of Waste (Kg)	Qty of Gobar (Kg)	Qty of Water
1.	15	55	Water is added in a 1:1 ratio in the bucket for both the gobar and the waste
2.	30	40	
3.	40	30	
4.	45	25	
5.	70	0	

Source : Agarwal and Chaturvedi, 1996

The switchover is complete after 5 weeks. The bio-reactor yields about 1.5 to 2 cylinder of LPG and 1/2 of fed material about 30-35 Kg/day or a tonne of manure in a month.

Another characteristic of the project is the community participation. The end use of both gas and manure need be defined to provide sustainability to the project both in the opinion of residents as well as for the workers involved. Manure thus produced could be used for greening the surroundings.

7.6 CONCLUSION

The central idea of the attempts is to turn wastes specially kitchen wastes into utility product while removing potential pollution hazards. In the process these projects could offer sustainable livelihood to those who eke out a miserable living through rag picking. Both these if properly formulated in a project and in the form of a network, the civic authorities would not only solve the environmental hazards but also find ways to earn reasonable revenue. But who is to sponsor the projects/programme and promote the activities?

CHAPTER - 8

ISSUES AND ACTION POINTS

8.1 REFLECTIONS :

During the deliberations the urgency for formulating appropriate strategy and approach as well as undertaking some on-going programmes with available knowledge have been time and again emphasised by all participants. The subsequent deliberations, therefore, were in search of a rationale for setting inter-sperse priorities amongst the problems, affected areas, methods to obtain available knowledge and the organisations for carrying out various activities. The panel, therefore, addressed to locate the relevant issues which need to be considered and then decide on action points for various agencies involved. The subject covers wide range of problems needing expertise of various disciplines and also involvement of many line departments, research institutes and other agencies. Similarly, programmes and projects, which could be formulated will demand investment and therefore, it was necessary to consider ways and means to raise necessary funds. Similarly, for impact assessment a continuous mechanis are to be formed for obtaining data on identified indicators for representative sites scattered over extensive areas. The discussions, therefore, identified a set of six issues for immediate consideration by Ministries and line departments and also identified about 20 action points for follow up.

8.2 ISSUES :

8.2.1 Pollution abatement in Forest Department's Activity List

Examination of current efforts in terms of programmes, expenditure, organisational facilities, policy support etc. revealed that pollution abatement has not yet been an activity of the State Department of Forest in this region. It was, therefore, necessary to take steps to include it in the department's list of activities and make it a priority one as well.

8.2.2 Building Conviction in plant's ability to abate pollution

Presentations and discussions have brought out that the officials, managers and policy makers have developed some understanding of the role of greenery in containing

pollution hazards and in restoring the damaged environment. However, the same does not appear to have become a strong conviction as it has not been sufficiently supported by the available information on the ability of greenery to specially restore health of air, water and land and to act as scavanger for pollutants. It would, therefore, be necessary to deal this issue and develop appropriate means to strengthen this conviction and translate it into action.

8.2.3 Putting plants for pollution abatement in agenda of Civic Bodies and infra structure development departments

The scientists and professionals dealing with plant sciences and forest have a back-up about the ability of the plans to abate pollution whereas the managers and professionals charged with conservancy of cities and towns including metropolis of Delhi as well as infrastructure do not have clear perception of a mechanism to put plants on the agenda of the respective Department/agency involved. It was, therefore, considered an important issue to develop clear mechanism to put plants on the agenda of these departments and agencies.

8.2.4 Coordinating Agency and Mechanism

One of the greatest problems to greenery vis-a-vis pollution abatement is the multiplicity of agencies involved in planning and implementation of the programmes. After greening/afforestation over extensive areas to build a deterrent in the form of clusters or net-works, there is necessity for periodic dialogue and coordination in planning, implementing as well as monitoring the impact through the activities of multiple agencies. As on today, such mechanism is lacking and therefore, to make pollution abatement by greening, a cost effective and technically useful activity, a coordination mechanism and periodic dialogue among all concerned department/agencies should be worked out.

8.2.5 Data Bank

Whether for developing programmes or preparing projects, information is a necessity. As on today these are scattered and scanty. Further, the information and the data would also be necessary on a standard uniform pattern. It is, therefore, considered an important issue to find strategy to gather information, document and disseminate the same amongst various sections of the officers and managers of different departments and agencies involved in order to help them act effectively towards abating pollution.

8.2.6 Mobilisation of Funds

Any efforts for organising activities to abate pollution through greening would cost large investment. Presently, in the planning system no separate provision seems to be available to support such activities through the implementing agencies such as Departments of Forest, Public works and Health, Horticulture etc. Further, the works will be on a small scale at large number of sites over extensive areas. Again the cause of pollution are settlements, activities of corporate bodies dealing with mining, industries, tourism etc. and individuals. The resources mobilisation. therefore. should not be only from the public sector or plan outlays but contributions from the corporate bodies, private sector and NGOs should form a significant portion of resources to fund pollution abatement activities.

8.3 ACTION POINTS

The important points which emerged from the Workshop deliberations are as under

1. Greening with a purpose should be a necessity to counter different types of pollution hazards in the region and an urgent one for NCT of Delhi.

2. Immediate need is to document existing information available both from traditional and modern sources to offer best possible set of species for application. Thus a state of art publication could be brought out as soon as possible.

3. In order to have better problem identification and clear determination gaps, quantitative assessment of different type of situations should be undertaken.

4. In identified situations more penetrating investigation should be undertaken and a few pilot projects should be carefully designed and started.

5. Planting trees and other plants, for raising green belts, verges or afforestation of road side, nala banks, open spaces vis-a-vis pollution abatement as an activity is a combination of forestry, horticulture, land scape planning etc. The problem and solution thus should be identified more comprehensively and holistically.

6. Evei
ther

7. Ther
and
Thes
depa

8. With
proje
or N
5 to

9. Partic
in gr
distri
NCT
vogu
differ

10. Fores
given
activit
guidel

11. Infras
profes
So tha
involv

12. NCTs
one st
Sanctu
green
city an

6. Every plant has a separate set of abilities to tackle pollution hazards and hence there should be site and problem specific selection of species.

7. There are many gaps and many questions are yet to be answered. Therefore, site and problem specific investigations and research programme should be taken up. These should be a joint one by research bodies and development departments/agencies concerned.

8. With the available research results and other established experience, some pilot projects could be started jointly by the Department of Forests with Communities or NGOs or Institutions with appropriate monitoring mechanism for a period of 5 to 10 years.

9. Participatory forest management will be a necessity, rather a rule than exception in greening as a deterrent to pollution. This is also due to complex demographic distribution, land utilisation pattern and pollution sources. PFM specially in NCT of Delhi however, will be quite distinct in many aspects from JFM in vogue in other States as services and goods expected from greening are different.

10. Forest Dept. should equip itself and function as a nodal agency. It should be given a greater role through an appropriate mechanism to coordinate all activities relating to greening and oversee the progress vis-a-vis a set of guidelines or agreed objectives.

11. Infrastructural development in the area of communication, mobility, updating professional skill are immediate needs for the Dept. of Forest, NCT of Delhi. So that the Dept. can act with speed and in collaboration with other agencies involved.

12. NCTs Dept. of Forest also needs to be strengthened into two streams namely (i) one stream to deal with reserved and protected forests as well as Asola Game Sanctuary, and (ii) the other with community, farm forestry, new sanctified green areas in rural areas and road side, round abouts, nala side plantations in city and settlement areas i.e. residential complexes etc.

13. Forest Dept. should also undertake field trials based on available research results & development experience and collaborate with JNU, CPCB and others for monitoring pollution at points relevant from greening point of view and for Asola Game Sanctuary in particular. This will help obtain time and space series which will be necessary for future analysis and interpretation.

14. Greening for pollution abatement is a very extensive activity and it needs action from grass root level to the policy and higher management decision making level. Thus publicity and awareness generation should be a specific activity and a continuous one.

15. NGOs could be effectively involved for awareness generation activity, facilitating community participation in investigation, organising operational or field trials, monitoring and even in fund raising from non-Governmental sectors.

16. Planting and after caring of trees and plants in settlements, rural or urban, will be needed at scattered and generally on small area basis. It would be desirable to build up a Green Guard Cadre.

17. There should be specially designed refreshing/reorientation courses on pollution abatement through greening for the officers of the Department of Forests, PWDs, Horticulture, MCD/NDMC, DDA and civic bodies in other towns and cities of the region.

18. Similarly field level functionaries should be trained in planting, caring and disseminating the culture of greening for health, water and environment security and also be provided with effective communication packages.

19. For these activities considerable funds will be needed and viability of investment could be tested if all environmental goods and services are also assessed. Action should be initiated to evolve and obtain a methodology to achieve the same.

20. Mobilisation of funds should be done from government and public sectors by making specific provision in the Plans. But substantial contribution should come from industries, corporate bodies, civic authorities as well as individuals.

ANNEXURE-1.1

LIST OF PARTICIPANTS

I **Shri Sahib Singh, Hon'ble Chief Minister of Delhi**

II **Ministry/Departments of GOI, New Delhi**

2. Shri D K Biswas, Chairman, Central Pollution Control Board
3. Shri Alok Jain, Joint Secretary, Min. of Env. & Forests
4. Dr B S Atri, Director (Research) MOEF
5. Dr Anil Mainra, Dy Secretary NAEB
6. Shri R K Sinha, AIGF, NAEB
7. Dr R K Suri, Addl Director, MOEF

III **Forest Department NCT New Delhi**

8. Shri R K Goel, CF
9. Shri D C Khanduri, DCF
10. Shri Yogesh Kumar, DCF
11. Shri Iswar Singh, DCF
12. Shri Satbir Singh, ACF
13. Shri Tilak Chand, RO
14. Shri Ashok Kumar, ARO

IV **Forest Department, Haryana**

15. Mr Jeethram, CF, Gurgaon
16. Shri S Dalal, DFO (Production), Gurgaon
17. Shri Rajbhir Singh, HFS, Aravalli Project, Gurgaon
18. Shri Mohan Lal, Dy Ranger, Narnaul
19. Shri Dayanand, Dy Ranger, Dadri
20. Shri Devandar Singh, Range Officer, Sona (Aravalli Project)

V **Forest Department, U.P.**

21. Shri Ramjee Srivastava Forest Influence Officer, FRI, Kanpur
22. Shri G S Kashi, Range Officer, Soil Conservation Division, Nainital
23. Shri L M Kaul, Range Officer, Khatina Haldwani, U.P.
24. Shri D C Pant, Range Officer, Dharahat, West Almora, UP Hills

VI NGOs

25. Shri Sunderlal, Khori
26. Shri Shikar Sarkar Garg, Khori
27. Shri R S Srivastava, Kanpur
28. Dr M L Dewan, Tree for Life, New Delhi
29. Dr (Mrs) Iqbal Malik, Vatavaran, New Delhi
30. Miss Meenu, Vatavaran, New Delhi
31. Miss Alka, Vatavaran, New Delhi
32. Shri H N Mathur, SOFEM, New Delhi
33. Dr Ravi Agarwal, Shristi, New Delhi
34. Ms. Bharati Chaturvedi, NGO Shristi, New Delhi
35. Dr K G Tejwani, Land Use Consultant International, New Delhi
36. Dr O S Tyagi, ISI New Delhi
37. Dr A Dey ISI New Delhi
38. Dr J M S Rawat, Society for Forest & Env. Management (SOFEM), New Delhi

VII **Institutions/Industries**

39. Dr D.K. Chakravarty, Jadavpur University, Calcutta
40. Dr Vinod Shanker, IGFRI of ICAR, Jhansi
41. Dr S S Parihar, IGFRI of ICAR, Jhansi
42. Dr Murugesan, AFRI of ICFRE, Jodhpur
43. Shri P K Kaku, ACC, Lakheri, Rajasthan
44. Dr Subrata Maity, B C Agrl. University, (BCKV) Kalyani, W.B.
45. Prof. C K Varshney, JNU, New Delhi
46. Dr H B Basisth, ICFRE, Dehradun
47. Dr A R K Sastri, WWF, New Delhi
48. Ms Archna Chatterjee, WWF, New Delhi
49. Shri Sudipta Chatterjee, WWF, New Delhi
50. Dr Krishna Mohan, Fellow, TERI, New Delhi
51. Md. Asif, Programmer for Tribal Studies, TERI, New Delhi
52. Dr S P Banerjee, TERI, New Delhi

VIII **RC-N**

53. Shri V
54. Shri R
55. Shri D
56. Dr S I
57. Dr De
58. Shri K
59. Shri R
60. Shri S
61. Shri D
62. Shri S
63. Shri V
64. Shri A
65. Mrs D

VIII **RC-NAEB, AFC, New Delhi**

53. Shri Vijay Kumar, DGM & Co-ordinator
54. Shri R D Gupta, Team Leader cum Sr Consultant
55. Shri D C Das, Sr Consultant
56. Dr S P Gawande, Sr Consultant
57. Dr Deb Roy, Sr Consultant
58. Shri Khem Chand, AGM
59. Shri R C Vaish, Consultant
60. Shri S P Malhotra, Consultant
61. Shri D V Nithyanand, APO
62. Shri S N Misra, System Analyst
63. Shri V Somasundaran, Admn.cum. Accounts Officer
64. Shri A K Kalia, P.S.
65. Mrs Devi Sundar, P.S.

ew Delhi

ANNEXURE - 1.2

WORKSHOP ON

SELECTION OF PLANTS FOR POLLUTION ABATEMENT
(28-30 Oct. 1996 - ISI AUDITORIUM, Third Floor, New Delhi)

Organised by Delhi Forest Department & Regional Centre, NAEB
AGRICULTURAL FINANCE CORPORATION LTD., NRO, NEW DELHI

INAUGURAL SESSION
(28.10.96 : 10.30 TO 11.30 A.M.)

Presenting Boquette to the Chief Minister- Invocation/Lighting of the Lamp.		
Welcome Address	Vijay Kumar DGM & Coordinator, RC-NAEB	
Inaugural Address	Chief Guest, Shri Sahib Singh Hon. Chief Minister of Delhi	
Release of RC-NAEB, AFC Publications	-do-	
Key Note Address	D K Biswas Chairman, CPCB, New Delhi	
Chairman's Address	Alok Jain JS, MOEF, New Delhi	
Vote of Thanks	R K Goel, CF NCT, Delhi	
Tea		16.15-16.30

****

TECHNICAL SESSIONS

(From 28th Oct. Noon to 29th Oct. Noon)

28.10.96

12.00-13.30 **SESSION - I POLLUTION PROBLEMS VIS-A-VIS ECO-DEVELOPMENT PROGRAMMES AND POLICIES**

Chairman : Dr. K G Tejwani

Status of Pollution Hazards and its Neutralisation by Plants in NCT of Delhi	R K Goel C F, NCT of Delhi
The Biggest Arsenic Calamity through Polluted Ground Water	D K Chakravarty Jadavpur Uni. Calcutta
Plants in Abating Pollution Hazards through Fly Ash, Industrial Effluents etc.	Dr. Ramjee Srivastava FRI, UP, Kanpur

13.30-14.30 Lunch

14.30-16.15 **SESSION - IIRESEARCH INPUTS AVAILABLE AND GAPS**

Chairman : Shri P K Kaku

Plants for pollution abatement with special reference to air and dust pollution	Dr B S Atri Dir (Res) MOEF, N. Delhi
Using Industrial Effluents for raising plants and reducing pollution risks.	Dr. Murugesan AFRI of ICFRE Jodhpur
Restoration of Mine Eco system	Dr. H B Bashist ICFRE, Dehradun

16.15-16.30 Tea

16.30-18.15 **SESSION - IIB RESEARCH INPUTS AVAILABLE AND GAPS**

Chairman : Dr. M. L. Dewan

Green belt for Environmental Improvement	Dr C K Varshney, JNU, New Delhi
Land pollution caused by exotic weeds and its abatement by silvipastoral management	Dr S S Parihar IGFRI, Jhansi
Vermiculture for economic utilisation of Garbage	R D Gupta, Sr. Consultant & Team Leader RC : NAEB, AFC, New Delhi

29.10.1996

9.30-11.15 **SESSION - III NATIONAL AND REGIONAL PERCEPTION AND EMPHASIS**

Chairman : Shri R S Srivastava

Air Pollution : Plants as means of Control	Dr A R K Sastry WWF, New Delhi
Industry in raising trees and other plants for neutralising pollution hazards	P K Kaku ACC Ltd, Lakheri,(Raj.)
Problems and Options for some initiatives for Pollution abatement in Harayana, Rajasthan, UP & Delhi	Shri D C Das Sr. Consultant RC:NAEB, AFC, New Delhi

11.15-11.30 Tea

11.30-13.(

Ch

Co

Us

Wa

En

pol

13.00-14.(

14.00-18.(

Cha

Members :

1.
2.
3.
4.
5.

11.30-13.00 **SESSION - IV** **PERCEPTION AND EXPERIENCES OF NGOs**

Chairman : Vijay Kumar

Community participation for successful greening of areas	Dr (Mrs) Iqbal Malik, Director, Vatavaran, New Delhi
Use of bio-reactor to manage Solid Wastes in low income Community	Dr. Ravi Agarwal & Ms. Bharti Chaturvedi, Srishti, New Delhi
Environmental forestry for pollution Abatement	Dr.J.M.S. Rawat SOFEM & Dr.R.K.Suri,(MOEF), Delhi

13.00-14.00 Lunch

14.00-18.00 **Field Visit to Asola Sanctuary Regeneration Works** — Shri Yogesh, DFO, NCT, Delhi

PANEL DISCUSSION

(30.10.96 : 9.30 - 11.30 A. M.)

Chairman and Moderator : Shri H. N. Mathur

Members :

1. Dr. A.R.K. Shastri - WWF - India
2. Shri Vijay Kumar - Coordinator RC:NAEB, AFC, New Delhi
3. Shri R K Goel - CF, NCT of Delhi
4. Dr. Iqbal Malik - Vatavaran, New Delhi
5. Dr. C K Varshney - JNU, New Delhi

Topics :

1. Important issues needing immediate attention.
2. Plant Species for abating Pollution - Air & dust, water, land and noise.
3. Support of other technological inputs
4. Action points for -

    (a) Immediate application in field
    (b) Field trial and operational investigation
    (c) Research areas
    (d) Updating professional back-up

WRAP-UP AND VALEDICTORY SESSION

(30.10.96 : 12.00 TO 13.30)

Chairman : Dr K G Tejwani
Co-Chairman : Shri R D Gupta

12.00 Summarisation of the Workshop Deliberations — D C Das, Sr Consultant RC-NAEB, AFC, New Delhi

12.15 Presentation of Action Points : H N Mathur SOFEM, New Delhi

12.30 Discussions : Delegates

13.00 Chairman's Address : Dr. K G Tejwani

13.20 Vote of Thanks : Delegates R S Srivastava, Dr S S Parihar, RC-NAEB : Vijay Kumar

13.30-14.20 Lunch & Dispersal

******

ANNEXURE - 4.1

LIST OF PLANT INDICATORS OF AIR POLLUTION

1. SO_2 INDICATOR

(i) Non-flowering Plants

Alternaria tenuis
Aspergillus niger
Fusarium moniliforme
Penicillum nigricans
Rhizopus nigricans

(ii) Flowering Plants

Annuals	Herbs	Shrubs	Trees
Amaranthus viridis	Carthamus tinctorius	Nerium indicum	Adenia cordifolia
Abelmoschus esculantus	Gossypium s		Buchanania lanzan
Arachis hypogia	Helianthus annus		Butea monosperma
Brassica nigra	Hibiscus esculentus		Diospyros melanoxylon
Cyamopsis tetragonoloba	Hordeum sp.		Mangifera indica
Glycine max	Lactuca sativa		Pyrus malus
Hordeum vulgare	Medicago sativa		Pinus sp.
Ipomoea crassicauli	Spinacea oleracea		
Medicago sativa			
Phaseolus aureus			
Phoenix sylvestris			
Phaseolus radiatus			
Pisum sativum			
Raphanus sativus			
Solanum meglongena			
Spinacea oleracea			
Triticum aestivum			

Annuals	Herbs	Shrubs	Trees
2. **FLUORIDE INDICATOR**			
Cyanodon dactylon			
3. **CEMENT DUST INDICATOR**			
Glycine max	Calotropis procera		Cassia fistula
Triticum aestivum	Withania somiinifera		Dalbergia sissoo
4. **FLY ASH INDICATOR**			
Triticum aestivum			
5. **PETRO-COKE INDICATOR**			
Phaseolus aureus			
6. **SMOKE INDICATOR**			
			Azadirachta indica
7. **DUST INDICATOR**			
Triticum aestivum	Helianthus annus		Erythrina indica Mangifera indica
			Polyalthia longofolia
			Thespesia populnea
8. **HERBICIDE INDICATOR**			
Cicer arietimum			
9. **COMBINATION OF POLLUTANTS**			
Brassica oleracca	Croton sparsiflorum	Lantana camara	Aegle marmelos
Chenopodium album	Withania sominifera	Nerium odoratum	Diosyros melanoxyla
Cicer arietinum		Tabernae montana	Mangifera indica
Commelina bengalensis		Coronaria sp.	Melia indica
Dolichos lablab			Tectona grandis
Glycine max			
Helianthus annus			
Medicago sativa			
Sonchus asper			

Source : C.K. Varshney, 1985 : Air Pollution and Plants, Ministry of Environment and Forests, Government of India : 140-170.

REFERENCES

1. AFC (1991) : Role of Non-Government Organisations in Social Forestry. A Core Group Report, RC:NAEB Agricultural Finance Corporation Ltd. NRO, New Delhi, RC : 9 pp. 93.

2. AFC (1994) : Eco-fragile Aravallis of Rajasthan, Haryana and Delhi Problems and Perspectives. RC:NAEB AFC, NRO, New Delhi. RC : 29 pp 249.

3. AFC (1995) : Study on Sacred Groves of Kurukshetra, Haryana, RC:NAEB AFC, NRO, New Delhi, RC : 36 pp 100.

4. AFC (1996) : Afforestation of areas affected by Canal Water logging Salts and Wastes RC:NAEB AFC, NRO, RC : 40 pp. 73.

5. Agarwal, S.K. (1991) Pollution Ecology, Himanshu Publication, Udaipur.

6. Agarwal, Ravi and Chaturvedi, Bhavati (1996) Using bio-reactor technology for Management of Solid Waste in a low income Community at Dakshinpuri, New Delhi. First Report Shristhi, New Delhi pp 7.

7. Arrawatia M.L. (1996) Using industrial effluents for raising of plants and reducing pollution risks. Presented at the Workshop on Selection of Plant Species for Pollution Abatement, New Delhi Oct., 1996.

8. Atri, B.S. (1996) Air pollution and its abatement with the special reference to role of plants. Presented at the Workshop on Selection of Plant Species for Pollution Abatement by AFC Oct. 1996, New Delhi.

9. Beckham, Nancy (1992) The value of an Urban tree, Indian Biologist XXIV (1), I-II.

9A. CES (1996) Slow murder : The deadly story of vehicular pollution in India. Study & Editor Team : Anil Agarwal, Arjun Sharma and Anamika Roychowdhary Centre for Science & Environ. CSE Series No. 3, New Delhi

9B. CES (1997) Homicide Pesticides. What pollution does to our bodies. Ed. by Anil Agarwal, Centre for Science and Environment. CSE. Series No. 4, New Delhi.

10. Chakravarty, D.K. (1996) The Biggest Arsenic Calamity - Through polluted ground water. Presentation at the Workshop on Selection of Plant Species for Pollution Abatement, by AFC Oct. 1996, New Delhi.

11. Das, D.C. and Kaul R.N. (1992) Greening Wastelands through Waste water National Wastelands Development Board (NWDB), New Delhi.

12. Das, D.C. (1994) A Critical appraisal of Soil and Water Conservation measures undertaken to combat land degradation. Soil management in relation to land degradation and environment. Ind. Soc. Soil Science, New Delhi : 27-40.

13. Das, D.C. and Nithyanand, D.V. (1996) Problems and Options for some initiatives for pollution abatement in Haryana, Rajasthan, Uttar Pradesh and Delhi by AFC Oct. 1996, New Delhi.

14. Gupta, R.D. (1996) Vermiculture for economic utilisation of Garbage. Presented at Workshop on selection of plant Species for Pollution Abatement by AFC Oct. 1996, New Delhi.

15. Goel, R.K. (1996) Status of Pollution hazards and its neutralisation by plants. Presented at the Workshop on Selection of plant species for Pollution Abatement by AFC, Oct. 1996, New Delhi.

16. Kishna Kumar, Sastry, A.R.K., Chatterjee Sudipta and Usha, M.(1996) Air Pollution : Plants as means of Control, Presented at Workshop on Selection of Plant Species for Pollution Abatement by AFC, Oct. 1996, New Delhi.

17. Mathur, H.N.(1991) Forest and Environment - An Economic Appraisal of Economic Benefits. Presented at National Seminar on Forest and Environment held in Dec. 1991, Bangalore.

18. Malik, Iqbal (1996) Garbage Management : my experience A Vatavaran Report, Vatavaran, New Delhi pp 126 plus 2.

19. Malik, Iqbal (1996a) Mass participation and Constant monitoring - Two basic factors for successful greening. Presented at the Workshop on selection of Plant Species for Pollution Abatement by AFC, Oct. 1996, New Delhi.

20 MOEF (1996) Annual Report for 1995-96. Min. of Environment and Forests GOI, New Delhi.

20a MOWR (1991) Special Issue on Ground water statistics. Min. of Water Resource (MOWR) Bhujal News, Vol 6(i): 58-93.

21 NEERI (1993) Annual Report for the Year 1993. National Environmental Engineering Research Inst. (NEERI) C.S.R.I., Nagpur pp. 1988.

22. NIH (1992) Control Water Pollution Conserve Water Quality for Clean & Healthy Environment, National Institute of Hydrology, Roorkee.

23. Om Kumar, Vashisht and Mathur, H.N. (1996) Greenbelt and air pollution management. Div. of Ecology & Envn. FRI, Dehradun, Paper sent for the Workshop on Selection of Plant Species for Pollution Abatement by AFC, Oct. 1996, New Delhi.

24. Parihar, S.S. (1996) Land pollution by exotic weeds and its abatement by silvi pastoral management. Presentation at the Workshop on Selection of Plant Species for Pollution Abatement by AFC, Oct. 1996 in New Delhi.

25. Singh, S.K. and Rao D.N. (1983) Evaluation of plants for their tolerance to air pollution. Procs. Symp. on Air Pollution Control Vol I Ind. Assoc for Air Pollution Control, New Delhi : 218-224.

26. Srivastava, Ramjee; Dubey, P and Rai. A. M. (1996) Plants to abate pollution hazards of air and land through fly ash, industrial effluents etc. Research experience of Forest Res. Inst. Kanpur UP. Presented at the Workshop on Selection of Plant Species for Pollution Abatement by AFC, Oct. 1996, New Delhi.

27. Varshney, C.K. (1985) Air Pollution and Plants. Min. of Envn. and Forests, GOI, New Delhi.

28. Varshney, C.K. (1996) Greenbelt for Environmental Improvement. Presented from JNU at the Workshop on Selection of Plant Species for Pollution Abatement by AFC, Oct. 1996, New Delhi.

UPTO DATE LIST OF PUBLICATIONS OF RC-NAEB,AFC Ltd., NEW DELHI

1. Report on the functioning of Village Forest Committees,Joint Management Plans and contact Persons in SIDA aided Bihar Social Forestry Project, RC-01, 1992
2. Orientation Workshop on "Greening of Haryana at Hissar"-Proceedings, RC-02,1992
3. Proceedings of the Seminar-cum-Workshop on Afforestation,Environment and Development Ghaziabad, U.P, RC-03,1990.
4. Status of Social Forestry in Haryana, RC-04,1991
5. Greening of Haryana: The first year- An appraisal report on nature and extent of participation, RC-05, 1992
6. Proceedings of "Green Rajasthan". National Workshop on the Role of NGOs in Social Forestry, Udaipur, (English Version), RC-06,1993.
7. -do- (Publication in Hindi), RC-07.1993
8. Status of Social Forestry in Rajasthan, RC-08,1993
9. Report on "Role of Non-Government Organisations in Social Forestry",RC-09, 1993
10. Status of Social Forestry in Uttar Pradesh, RC-10, 1993
11. Proceedings of Orientation Training Workshop in Forestry Extension for Junior Level Officers and Voluntary Workers-Pinjore (Haryana), RC-11, 1993
12. Study on Farm Forestry in Uttar Pradesh, RC-12, 1993
13. Proceedings of National Workshop on Development,Management & Transfer of Afforestation Technology for Arid and Semi-Arid Regions, Jaipur(Rajasthan), RC-14,1993
14. Proceedings of Training Workshop on Afforestation Technology for Hill Areas, Haldwani, U.P., RC-15, 1993
15. Training Workshop on Farm Forestry Practices-Present Status and Future Prospects (Haryana) Proceedings & Recommendations.,RC-16, 1993
16. Role of Women in Social Forestry, RC-17, 1993
17. WIMCO- Success Story, RC-18, 1993
18. Training Needs for Grass-Root Level Workers of Forest Department & NGOs., RC-19, 1993
19. Tarun Bharat Sangh -Success Story, RC-20, 1993
20. Khori-Success Story, RC-21, 1994
21. Experience of NGOs in promoting Social Forestry-Workshop proceedings-Sarnath(U.P.), RC-22, 1994
22. Survival Rate of Trees in Rajasthan, RC-23, 1993
23. Study on Farm Forestry in Rajasthan, RC-24, 1994
24. Women & Social Forestry -Workshop Proceedings, RC-25, 1994
25. PEDO -Success Story - An Integrated Development Model Based on People's Education & Eco-regeneration, RC-26, 1994

Joint Forest Management , RC-27, 1994

27. Forestry Extension : Problems & Prospects- Workshop Proceedings, Gurgaon (Haryana), RC-28, 1995
28. Eco-fragile Aravallis of Rajasthan, Haryana and Delhi- Problems and Perspectives, RC-29, 1995
29. Afforestation of abandoned and closed Mines in Doon Valley, RC-30, 1995
30. Multipurpose tree species for Agro-forestry in Uttar Pradesh, Rajasthan & Haryana, RC-31, 1996
31. Social forestry in National Capital Territory of Delhi, RC-32, 1996
32. Report on the working of Tree Growers Co-operative Societies, RC-33, 1996
33. Study on Seedling Pricing and Demand oriented Supply, RC-34, 1996
34. Institutional Arrangements for Social and Agro/Farm Forestry, RC-35, 1996
35. Survival Rate of Trees in Uttar Pradesh, RC-36, 1996
36. Study on Sacred Groves in Kurukshetra, RC-37, 1996
37. Manual for Assessment of Survival Rate of Trees, RC-38, 1996
38. Survival Rate of Trees in Haryana., RC-39, 1996
39. Afforestation of areas affected by canal water logging, salts and wastes-Workshop Proceedings. Hissar, (Haryana), RC-40, 1996
40. Afforestation and Eco-Development of IGNP Command Area- Travelling Workshop Proceedings, Bikaner-Jaisalmer-Jodhpur(Rajasthan)., RC-41, 1996
41. Management and Development of Plantations in Delhi- Problems and Options., RC-42, 1996
42. Natural Resources Accounting for Non-Marketed forest Produce for eight Hill Districts of Uttar Pradesh., RC-43, 1997.
43. Pamphlets on MPTS.-for wide circulation, RC-44, 1997.
44. Report on Study of Eco-Development in Vindhyan Region, RC-45, 1997.
45. Micro-planning and Joint Forest Management for Forestry Development - *Workshop proceedings and recommendations*, RC-46, 1997.
46. Eco-development Through Irrigated desert Plantations in IGNP areas, RC-47, 1997.
47. Species Selection for pollution Abatement-Workshop Proceedings- Delhi, RC-48, 1997.

II. FORTHCOMING PUBLICATIONS

48. Sacred groves of Rajasthan.
49. Study on Adoption of JFM Models in U.P. Haryana, Rajasthan & NCT of Delhi.
50. Selected Workshop Papers-Reference Compendium.
51. Rehabilitating degraded forests: Gains and Gaps in Hilly areas-Workshop proceedings -Dehradur (U.P.)