25th - 26th September 2008

5th NATIONAL IAUA SYMPOSIUM

on

Environment Pollution and its effect on Agricultural Production and Human Health

PROCEEDINGS

Sponsored By:

Indian Agricultural Universities Association

Organized By:

Allahabad Agricultural Institute

Deemed University

शरद पवार
SHARAD PAWAR

कृषि, उपभोक्ता मामले, खाद्य और
सार्वजनिक वितरण मंत्री
भारत सरकार
MINISTER OF AGRICULTURE
& CONSUMER AFFAIRS
FOOD & PUBLIC DISTRIBUTION
GOVERNMENT OF INDIA

- 4 SEP 2008

Message

I highly appreciate the efforts of **Allahabad Agricultural Institute-Deemed University** for providing an opportunity to discuss about environmental problem by hosting 5^{th} National Symposium of Indian Agricultural University Association with the theme **"Environment pollution and Its Effect on Agricultural Production and Human health"** on 25-26 September 2008

It is heartening to note that our agricultural universities are also deeply concerned about the degradation of environment. It is well established that chemical input to fields if increases the yield, is also found to be responsible for inducing sterility to soil, large irrigation projects provides water, but also give soil salinity and water logging condition. Such present profile needs the attention of agricultural bodies towards these environmental problems to be tackle in sustainable direction which will provide fruitful results along with improving environmental condition. Incorporation of technologies to agriculture along with proper resource management will provide the way to restore the balance of ecosystem equilibrium which is necessary for our own survival.

I hope the discussion at this Symposium will come up with future strategies and provide the direction of sustainable development.

I wish this symposium all success.

(SHARAD PAWAR)

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राजपाल त्यागी
मंत्री
कृषि शिक्षा एवं कृषि अनुसंधान
उत्तर प्रदेश

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सी.एच. : 3264
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57, विधान भवन,
लखनऊ

दिनांक 10-09-08

सन्देश

मुझे यह जानकर अति प्रसन्नता हो रही है कि ऐतिहासिक इलाहाबाद एग्रीकल्चरल इन्स्टीट्यूट जो अब डीम्ड विश्वविद्यालय है, के तत्वाधान में भारतीय कृषि विश्वविद्यालय संघ का दो दिवसीय अधिवेशन दिनांक 25–26 सितम्बर, 2008 को इलाहाबाद में आयोजित हो रहा है।

मैं विद्वतजनों के समागम पर अपनी शुभकामनायें देता हूँ और परम पिता परमेश्वर से याचना करता हूँ कि इस वैचारिक संगम को सफल बनायें।

शुभकामनाओं सहित,

(राजपाल त्यागी)

डा0 राकेशधर त्रिपाठी
मंत्री
उच्च शिक्षा, उ०प्र०

दूरभाष : का० 2239251
सी०एच०नं० : 3279
विधान भवन : लखनऊ

सन्देश

सह प्रसन्नता का विषय है कि विभिन्न कृषि विश्वविद्यालयों के कुलपतियों की संगोष्ठी दिनांक 25 एवं 26 सितम्बर, 2008 को इलाहाबाद एग्रीकल्चरल इंस्टीट्यूट– डीम्ड विश्वविद्यालय में आयोजित होने जा रही है।

यह एक महत्वपूर्ण अवसर है जब कृषि वैज्ञानिकों द्वारा कृषि शिक्षा, प्रसार एवं शोध तथा कृषि अर्थव्यवस्था के उन्नयन हेतु सम्यक् रूप से विचार– विमर्श किया जायेगा।

इलाहाबाद एग्रीकल्चरल इंस्टीट्यूट–डीम्ड विश्वविद्यालय एशिया का प्राचीनतम कृषि संस्थान है, जहॉ से कृषि की उच्च शिक्षा प्राप्त कर कृषि वैज्ञानिक देश में ही नहीं वरन् विदेशों में जनता की सेवा कर रहे हैं।

मुझे विश्वास है कि इस द्वि–दिवसीय कृषि विद्वानों के वैचारिक समागम से देश एवं प्रदेश के छात्र–छात्राओं एवं किसानों के लिए उच्च तकनीकी युक्त वैचारिक विधा निरूपित हो सकेगी।

संगोष्ठी की सफलता हेतु मेरी हार्दिक शुभ–कामनाएं ।

(राकेशधर त्रिपाठी)

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पत्रांक : दिनांक

It is indeed a matter of great pleasure to know that Allahabad Agricultural Institute-Deemed University and Indian Agricultural Universities Association, New Delhi are organizing the 5th National Symposium on "Environment Pollution and its effect on Agricultural Production and Human Health" on 25th and 26th September, 2008 at AAI-DU, Allahabad. I am confident that this forum of Hon'ble Vice- Chancellors of Agricultural Universities will design policies to enhance overall projection of higher education and research in this field. I hope that these policies may prove to be the guidelines for the nation to combat pollution affecting environment and human health. I appreciate the hard work and leadership of Rev.Prof.(Dr.)Rajendra B.Lal, Vice-Chancellor AAIDU to combat pollution and also in imparting quality education, research and extension. His untiring efforts have made AAIDU an international institution.

I wish the national seminar a grand success.

[Ashok Kumar Bajpai]
Chairman
Gramin Awas Vikas Parishad (State Minister)
Government of Uttar Pradesh

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Message

I am very happy that a National Symposium on "Environment pollution and its effect on agricultural production and human health" is being held at Allahabad Agricultural Institute on 25- 26 September. This is a timely symposium since many serious health disorders arise from environmental decay. Clean air and clean water are becoming rare. Ground water is getting contaminated and the warning issued by Rachael Carson in her book "Silent Spring" nearly fifty years ago is not being heeded. I hope the National Symposium will prepare a roadmap for sustainable food security and health for all and forever.

M. S. Swaminathan

सुखदेव थोरात
अध्यक्ष
Sukhadeo Thorat
Chairman

ज्ञान-विज्ञानं विमुक्तये

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September 4, 2008

MESSAGE

11 SEP 2008

I am very happy to know that Allahabad Agricultural Institute – Deemed University, Allahabad is organizing the 5th Indian Agricultural Universities Association's (IAUA) National Symposium on "*Environment Pollution and its effect on Agricultural Production and Human Health*" for the Vice Chancellors of all Agricultural Universities on September 25-26, 2008. To commemorate this occasion the University is bringing out a Souvenir. I send my best wishes and greetings to all the participants and the Organising Committee and wish the event / publication good luck and grand success.

(Sukhadeo Thorat)

Rev. Prof. Rajendra B. Lal
Vice Chancellor
Allahabad Agricultural Institute
(Deemed University)
Allahabad – 211 007.

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Message

The Indian Agricultural Universities Association and Allahabad Agricultural Institute Deemed University deserve the gratitude of the people of India for organizing the National Symposium on " Environmental Pollution and its Effect on Agricultural Production and Human Health" on 25th and 26th September 2008. This is because the theme is so closely related to the life and survival of the bludgeoning population of the country and its quality of life. The comprehensive range of sub-themes covers the entire gamut of vital concerns about the environment and the human life. The Symposium is taking place at a time when the neighboring state of Bihar has been ravaged by floods leading to untold human misery, when killer hurricanes have been lambasting the Caribbean and American coastal areas resulting in massive mandatory evacuation and when earthquakes and tsunamis are predicted by the prophets of gloom and doom, in the wake of the scientific experiment currently progressing in the Swiss-French border. We also need to consider whether God's Creation has been corrupted and mishandled by the human beings who were originally expected to be the Stewards and Sustainers of the Planet Earth and its manifold inhabitants, flora and fauna, aquatic and microbial life and amazing biodiversity.

The galaxy of Vice- Chancellors, scientists, researchers and other academicians attending this Symposium can make a creative and collective impact on the plans and projects of India for maximizing the agricultural output and feeding the hungry without corroding the environmental integrity and human health in coming decades. Disciplining the climate change or regulating the global warming or protecting the Ozone layer may be massive tasks at the macro level but how numerous are the minor manageable tasks which individuals and universities can undertake with time bound objectives and result-oriented activities! We hope that such a practicable action agenda will be crafted during the Symposium

In our search for safeguarding "human health" are we forgetting our brothers and sisters who move on four legs or crawl on the ground or climb on the trees or swim in the backwaters or oceans? The vast chain of non-human life forms and the vegetation is so inseparable from human life and health. Our ancient Indian tradition had discovered and treasured this vital cycle of life which has unfortunately being shattered almost irretrievably during the last three of four centuries and unlearning the destructive lessons of the industrial civilization created by the Science and Technology needs to find some space in the deliberations. A golden age in which the diversity of life and Integrity of Creation are treasured should be a dream which we should endeavor to weave failing which the Planet can only be sunk into Black Holes of varying monstrosities.

I heartily congratulate the Executive Committee of IAUA, especially the President Dr. S.A. Patil, Vice President Rev. Prof. Dr. R.B. Lal and Dr. S. B. Lal, Convener and Members of the Organizing Committee for their meticulous preparation of the Symposium. May God Almighty bless this unique event happening on the sacred banks of the Sangam, not far away from Anand Bhavan, abode of one of the architects of modern India. The visionary scientist and spiritualist founder of the AAIDU Dr. Sam Higginbotham would have been delighted if he were alive today to see the outcomes of this Symposium as he was totally committed to environmental sustainability, agricultural production and human health. Was it not the reason why he sculpted an Institute of Rural Life which has been seeking to maximize the harvest to feed the hungry and serve the Land!

Dr. Mani Jacob
Chancellor
AAIDU

FOREWORD

Rev. Prof. (Dr.) R. B. Lal
Vice Chancellor
Allahabad Agricultural Institute
Deemed University

FOREWORD

It gives me immense pleasure to organise the 5th National Symposium on "Environment Pollution and its Effect on Agricultural Production and Human Health" in our University sponsored by the Indian Agricultural University Association (IAUA) on 25th and 26th September 2008. I thank the almighty God, our Father, the Creator and Sustainer of everything, who has motivated us to host this high powered meeting participated by Hon'ble Vice-Chancellors and representatives of 46 Agricultural Universities, eminent scientists, researchers and academicians of our country. The theme is indeed relevant to the current and national and global as "Environmental Pollution" has now become the distinct threat to the very existence of mankind on planet earth. Environment management comes as a wake-up call at the time when the global population is increasing and the practices of our modern civilisation have transformed nature into exploitable resources that is drastically altering the ecological balances that is ordained and sustained by the Creator, the Almighty God. As a consequence more than 1500 million tonnes of carbon is being emitted to the atmosphere every year. It has been continuously reducing the life supporting system of the earth and has been adversely affecting the environment. It is not only the food security, which needs to be assured; but the environmental balance and security is also equally significant.

The IAUA is established with main objectives of promoting agricultural research, education and extension in the universities and states and thereby rural development in the country.

The Allahabad Agricultural Institute Deemed University (AAI-DU) is a minority institution, is a united endeavour of the Christian community in India, for promoting life and sustainable development in conformity with a Christian vision. Established by Dr. Sam Higginbottom in 1910 as an Institute, began its academic functioning with informal classes and research during the fall of 1912, became the first institution of the country to impart scientific agricultural education and the first institution in South East Asia in the field of agricultural engineering. The Institution is about to complete 100 years of sincere service with a vision of 'Feed the Hungry' and with a mission of 'Gospel and Plough'. We believe in the development of total personality of the students, motivating them to be responsible stewards of the environment and its resources by sustainable development. We deepen their commitment to a life of service as exemplified in JESUS CHRIST in accordance with the christian belief. AAI-DU is striving to acquire a place in the arena of International Science and Technology while holding a pioneering status in India.

With extreme gratitude and obligation I am looking forward to see the support and active participation and involvement of all the Agricultural Universities, right from the planning stage of the Symposium. I am sure the deliberations of the symposium will be highly useful in pursuing the cause to make the world a better place to live in and pray our Almighty Lord to bless every distinguish delegate and the proceedings.

Rev. Prof. (Dr.) R. B. Lal
Vice Chancellor

PRESIDENT, IAUA's MESSAGE

भारतीय कृषि अनुसंधान संस्थान, नई दिल्ली-110012

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Preface

It is a matter of immense pleasure to know that the 5th National Symposium of Indian Agricultural University Association with the theme "Environment Pollution and Its Effect on Agricultural Production and Human health" is being hosted by Allahabad Agricultural Institute-Deemed University, Allahabad on 25th & 26th September 2008.

It is indeed an encouraging truth that our agricultural universities are having deep eyes on application of technological advancement in agriculture thereby increasing production for the living needs of the human and animals. It also simultaneously is very well aware of continuous degradation in environmental settings. Our economy is greatly based on our agricultural output. No doubts environmental pollution is the result of excessive use of chemical fertilizers. Degrading the fertility of soil and creating a negative impact on productivity, soil erosion, deforestation and improper agricultural practices are also matter of great concern.

Understanding pollution and its impact is bidirectional phenomenon as if pollution of different environmental parameters has undesirable effect on agriculture; inadequate agricultural practices have its share in increasing pollution level. Agricultural fields and their product based industries are well known as a source of both Point and Non point pollution

I strongly believe, this symposium will provide a common stage to visiting Vice-Chancellors and senior officers of agricultural universities and organizations to share their views regarding pollution and its impact on agriculture and human health.

This will also help in formulating a sustainable approach in environmentally safe way to abate these pollution related problems.

I wish this endeavour a grand success.

(S.A. PATIL)
President, IAUA
New Delhi

FROM THE CONVENOR'S DESK

PREFACE

Prof. (Dr.) S. B. Lal
Convenor
Director Research & Dean PG Studies
Allahabad Agricultural Institute
Deemed University

It is a matter of great privilege and honour for the Allahabad Agricultural Institute Deemed University (AAI-DU) to host the 5th National Symposium on "Environmental Pollutions and its effect on Agricultural Pollution and Human Health" with the generous support of the Indian Agricultural University Association (IAUA) on 25th and 26th of September 2008. The whole hearted support from the IAUA and the overwhelming response of the distinguished dignitaries, the Hon'ble Vice Chancellors of the reputed Agricultural Universities, Directors, Scientists and Officers from all over the country to our call for participation in the National Symposium indicates their confidence in us and growing concern in environmental pollutions and its effect on agricultural production and human health. The participants have expressed their interests on various factors, aspects and causes of environmental pollutions occurring in the air, water and soil and also pollution due to biodiversity, noise, floods, droughts, acid rains etc and its effects on the society, crops/live stock/fisheries production, food and nutrition security; and the present policies and legal issues, business and the social and political responsibilities to combat the effects of pollution.

We are thankful to IAUA for giving an opportunity to organize 5th National Symposium at AAI-DU, which came to existence in the form of an Agricultural Institute established by Dr Sam Higginbottom in the year 1910, known as the Allahabad Agricultural Institute (AAI). AAI was the pioneering Institute to promote training, education and research in all fields of agriculture in our country and produced eminent officers, scientists and policy makers who have contributed at various capacities to developments in agriculture and allied sciences of our nation and internationally. The Central Government declared the Allahabad Agricultural Institute as Deemed University on 15 March 2000

We are highly obliged and grateful to Dr S A Patil, Director IARI and President of IAUA, and all Executive Members of IAUA for giving us the opportunity to host the Symposium in AAI-DU.

With most gratitude and respect we remember Dr R P Singh, Executive Secretary IAUA for his kind and generous support, constant advices and motivation for the smooth arrangements and conduct of the Symposium. We would like to acknowledge the gracious support and sponsorship of everyone directly or indirectly contributed towards the success of this endeavour, particularly all the Hon'ble Vice Chancellors of the Agricultural Universities, contributors of articles/papers; and other distinguished participants for not only for their financial and scientific support but also for their enthusiasm, motivation and best wishes.

We are grateful to Dr Mani Jacob, the Hon'ble Chancellor and Prof (Dr) Rajendra B. Lal, the Hon'ble Vice Chancellor of AAI-DU for their constant motivation, advices and support to us and prayers at every stage of the arrangements for the Symposium. We also thank all the press and media for giving vide publicity to the Symposium.

It is with great pleasure we present this souvenir to the distinguished participants and hope all of you will find this Symposium informative, enjoyable and memorable. I am sure your contributions and suggestions will help the researchers and policy makers to formulate their programs and policies for better management of environmental pollution, thereby sustain the agricultural production and human health globally.

Prof (Dr.) S. B. Lal
Symposium Convenor

Indian Agricultural Universities Association

The Indian Agricultural Universities Association is a registered society. All the forty-five Agricultural Universities in the country, including 5 deemed to be Universities of the ICAR (IARI, New Delhi, IVRI, Izatnagar, NDRI, Karnal and CIFE, Mumbai) and 2 Central University are its members.

The main objective of the Association is to promote agricultural research, education and extension in universities and states, and thereby rural development in the country.

Vice-Chancellors of all the Agricultural Universities constitute its "General Body". The General Body meets once a year for deciding agenda for the next convention, and also for approval of its audited accounts, budget estimates for the next financial year and election of office bearers. The "Executive Committee" of the Association consists of President, Vice-President, Secretary-Treasurer and 3 members. They meet in every quarter.

The office of the Association is manned by an Executive Secretary.

The Association organizes annual Convention. This is hosted by one of its member Universities on the theme selected by the General Body.

The Association has been bringing out a journal of the IAUA annually since 1987, to exchange and promote ideas, as this may help improve norms and standards in education, research and extension in Agricultural Universities and also act as a bureau of information to facilitate communication.

The main source of income of the Association is through the subscription from Agricultural Universities. IAUA jolds the objectives as follows:To serve as inter-agricultural university organization. To promote, support and to undertake such programmes as may help to improve norms and standards in education, research, training and extension in agricultural universities. To act as a bureau of information and to facilitate communication, coordination and mutual consultation amongst agricultural universities. To act as a liaison between the agricultural universities and the Government (Central as well as the State Government). To co-ordinate and cooperate with Indian Council of Agricultural Research, Council of Scientific and Industrial Research, Department of Science and Technology, University Grants Commission and other universities or bodies (national or international) in matters of common interest. To act as representative of agricultural universities of India. To help to maintain the autonomous character of agricultural universities. To facilitate exchange of members of the teaching, research and extension staff. To appoint or recommend, where necessary, a common representative of the Association at any conference national or international on agricultural education, research, extension or allied programmes. To assist agricultural universities in obtaining recognition for their degrees, diplomas and examinations from other universities – Indian as well as foreign. To undertake, organize and facilitate conferences, seminars, workshops, lectures and research projects in agricultural and allied programmes. To establish and maintain a sports organization for promoting sports among member universities. To establish and maintain organization dealing with youth welfare, student services, cultural programmes, farmers education and such other activities as are conducive to the betterment and welfare of students or teachers and others. To act as a service agency to agricultural universities in whatever manner it may be required or prescribed. To undertake, facilitate and provide for publication of newsletters, research papers, books and journals. To invest and deal with funds and monies of the Association and to vary, alter or transpose such investments from time to time. To sell, mortgage, lease, exchange and otherwise transfer or dispose of or deal with all or any property, movable or immovable of the Association for the furtherance of the objects of the Association. To construct, maintain, alter, improve or develop any building or works necessary or convenient for the purposes of the Association. To receive donations and to demand and receive payment of such fees and other charges as may be authorized by the bye-laws. To create administrative, ministerial and other necessary posts and to make appointments thereto. To establish a Provident Fund for the benefit of the employees of the Association. To do or get done all such other acts and things as are conducive or incidental to the attainment of the objects of the Association.

Allahabad Agricultural Institute - Deemed University

The Allahabad Agricultural Institute-Deemed University is a united endeavour of the Christian community in India, for promoting rural life and development in conformity with the Christian vision in relation with the human kind and the creation. The University is held in Trust as a common ecumenical heritage by the Christian Churches and Christian Organizations of the country. It seeks to be a national center of professional excellence in education and service to the people with the participation of its students and faculty members from all over India.

The University upholds and strives to achieve the following:

a) Responsible stewardship of the environment and its resources.
b) Sustainable development.
c) Linkage of Learning and Research to the needs and life of the people.
d) Justice to the minorities, and other weaker sections of the society, especially to women and the rural poor.
e) Holistic formation of the human person in, with and through the community for leadership instilled by Christian values.
f) National Unity and communal harmony.
g) International fellowship and co-operation in the educational and development ministry in the service of the LORD JESUS CHRIST.

In all of the above, the University helps the young and old without coercion or compulsion to deepen their commitment to a life of service as exemplified in JESUS CHRIST; by means of presentation of the Gospel through teaching, worship and witness in accordance with the Christian belief.

Students enrolled in the academic programmes are exposed to various technical training, which enables them to develop skills in their respective field. The University keeps the students informed about potential job opportunities and helps them in making prudent decisions for their future careers. It maintains and promotes close linkages and active contact with potential employers both National and Multinational. While involving their executives and facilitates their interaction with the students through lectures, discussions and classroom participation. The University also strives to prepare it's students to take their places as farmers on their own land,

Executive Committee

Dr. S.A Patil
President & Director, IARI, New Delhi

Rev. Prof. (Dr.) Rajendra B. Lal
Vice President & Secretary-Treasurer & Vice Chancellor, AAI-DU, Allahabad

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RECOMMENDATIONS

-:- Industrial effluents under strong Act should be analyzed critically for heavy metals, oxicity before they are recommended as source of irrigation/organic matter/ as nutrient supplement.

-:- Use of urban and agricultural waste through state act be promoted in crop cultivation as far as possible to save on or augment chemical fertilizers for high productivity and soil health.

-:- Union/state government/AUs through act must offer some incentives to the organizations/NGOs and farmers who are making used of Industrial effluents/urban and agricultural waste for higher crop production.

-:- Peri-urban waste water also be critically analyzed and be categorized for use with preference to floriculture rather than to grain corps/vegetables/horticultural crops

-:- Fertilizer and pesticide use in high productivity area be advised cautiously with the analysis of toxins in AUs, of the under ground water and soil through state act to protect human, animals and crops health under high productivity areas.

-:- Use of industrial affluents, urban and agricultural waste and peri-urban waste be looked into as coordinated projects for solutions to generate employment opportunities, and income to economized fertilize use in agriculture.

-:- Conservation of Bio-diversity in plants, animals, fish and microbs be fully recognized through act as means of pollution mitigation efforts.

-:- Invasive bio-diversity and texa introduction be established with systematic risk analysis before accession for this effective legal regulation may be put in place.

-:- Central role of live-stock and horticultural be recognized for sustainability in agriculture in reference to climate change poverty alleviation, availability of nutritive food to generate pollution free environment and revamp of fatigued crop production system.

-:- There is a strict need to enforce noise pollution act 2000, with public awareness and change in the attitude of the stake holders i.e. industries, traffic, agricultural machineries to check adverse effect on health of crops, live-stocks (eggs, meat, milk production) fishes, microbs.

-:- Use of Bio-fertilizer, bio-pesticides, afforestiation, zero-tiltage, conservation tiltage, use of sprinkler/drip irrigation be encouraged through rewards and training to scientists, students and to the farmers to check pollution. Burning of any agricultural and industrial by products be banned thorough legislation until and unless it is required to check pollution.

-:- Agricultural scientists who undertake research on and off the campus, involved in teaching, research guidance and also who undertake agricultural extension activities be encouraged by giving extra allowance (like medial doctors get no-practicing allowance)

-:- AUs, and ICAR scientists/teachers be paid atleast 25% more salary as compared to scientists/teachers in traditional universities looking into their load of work.

-:- Each AU should undertake detailed study on solid waste management in the cities around for its effective utilization and pollution control with funds from state government. ICAR/State Governments should award the universities which adopt the model in most efficient manner.

-:- To effectively mitigate and minimize dangerous effects of "acid rains pollution" systematic long term measures and policies be undertaken to analyze the rain water and its effect on soil profiles and its biota, crop in fields on animals and human health too

-:- A pollution mitigation cell be created in each AU for fore warning in its vicinity/jurisdiction with the help of community radio for which state Govt./ ICAR should finance

CONTEMPORARY PERSPECTIVES ON INFECTIOUS DISEASE AGENTS IN SEWAGE SLUDGE AND MANURE

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Sewage or municipal wastewater is the liquid waste containing some solids produced by humans which typically consists of washing water, feces, urine, laundry waste and other material which goes down drains and toilets from households and industry.

It is mainly comprised of water (99.9%) together with relatively small concentrations of suspended and dissolved organic and inorganic solids. Among the organic substances present in sewage are carbohydrates, lignin, fats, soaps, synthetic detergents, proteins and their decomposition products, as well as various natural and synthetic organic chemicals from the process industries. Municipal wastewater also contains a variety of inorganic substances from domestic and industrial sources including a number of potentially toxic elements such as arsenic, cadmium, chromium, copper, lead, mercury, zinc, etc. Even if toxic materials are not present in concentrations likely to affect humans, they might well be at phytotoxic levels, which would limit their agricultural use. However, from the point of view of health, a very important consideration in agricultural use of wastewater, the contaminants of greatest concern are the pathogenic micro- and macro-organisms. Various pathogenic viruses, bacteria, protozoa and helminths are present in raw municipal wastewater at very high levels and will survive in the environment for long periods.

Sludge treatment

Except when it is injected or otherwise worked into the soil, sewage should be subjected to biological, chemical or thermal treatment, long-term storage or other appropriate processes designed to reduce its fermentability and health hazards resulting from its use before being applied in agriculture. Table 1 lists sludge treatment and handling processes which have been used to achieve these objectives.

Characteristics of sewage sludge

Most wastewater treatment processes produce a sludge which has to be disposed of. Conventional secondary sewage treatment plants typically generate a primary sludge in the primary sedimentation stage of treatment and a secondary, biological, sludge in final sedimentation after the biological process. The characteristics of the secondary sludge vary with the type of biological process and, often, it is mixed with primary sludge before treatment and disposal. Land application of raw or treated sewage sludge can reduce significantly the sludge disposal cost component of sewage treatment as well as providing a large part of the nitrogen and phosphorus requirements of many crops. Sewage sludge contains pathogenic bacteria, viruses and protozoa along with other parasitic helminths which can give rise to potential hazards to the health of humans, animals and plants. A WHO (1981) report on the risk to health of microbes in sewage sludge applied to land identified salmonellae and Taenia as giving rise to greatest concern. The numbers of pathogenic and parasitic organisms in sludge can be significantly reduced before application to the land by appropriate sludge treatment, and the potential health risk is further reduced by the effects of climate and soil-microorganisms.

Using Sewage Sludge as Fertilizer

Sewage sludge is an end product of the wastewater treatment process. This material can be a wonderful source of nutrients for the soil. Using this material as a fertilizer can benefit the environment by turning wastes into valuable resources. These sludges would otherwise have to be disposed of by landfilling, lagooning, incineration, or ocean dumping. On the other

Table 1: EXAMPLES OF EFFECTIVE SLUDGE TREATMENT PROCESSES

Process	Descriptions
Sludge Pasteurization	Minimum of 30 minutes at 70°C or minimum of 4 hours at 55° C (or appropriate intermediate conditions), followed in all cases by primary mesophilic anaerobic digestion
Mesophilic Anaerobic Digestion	Mean retention period of at least 12 days primary digestion in temperature range 35°C +/- 3°C or of at least 20 days primary digestion in temperature range 25°C + /- 3°C followed in each case by a secondary stage which provides a mean retention period of at least 14 days
Thermophilic Aerobic Digestion	Mean retention period of at least 7 days digestion. All sludge to be subject to a minimum of 55°C for a period of at least 4 hours
Composting (Windrows or Aerated Piles)	The compost must be maintained at 40°C for at least 5 days and for 4 hours during this period at a minimum of 55°C within the body of the pile followed by a period of maturation adequate to ensure that the compost reaction is substantially complete
Lime Stabilization of Liquid Sludge	Addition of lime to raise pH to greater than 12.0 and sufficient to ensure that the pH is not less than 12 for a minimum period of 2 hours. The sludge can then be used directly
Liquid Storage	Storage of untreated liquid sludge for a minimum period of 3 months
Dewatering and Storage	Conditioning of untreated sludge with lime or other coagulants followed by dewatering and storage of the cake for a minimum period of 3 months if sludge has been subject to primary mesophilic anaerobic digestion, storage to be for a minimum period of 14 days

Source: Department of the Environment (1989)

hand, heavy metals sometimes found in sewage sludge may present environmental problems. Several practices, similar to those used with other organic fertilizers, will maximize the benefits of using sewage sludge while minimizing the risks. The public can be exposed to sewage sludge in several ways: direct ingestion, indirect ingestion (eating contaminated food like vegetables, meat, fish, etc.), dermal contact, inhalation, drinking contaminated water and/or recreating in contaminated water.

RISKS FROM SEWAGE SLUDGE

Venues for pathogen transfer:

Land application of sewage sludge can lead to the transport of pathogens through bioaerosols downwind of sludge storage or spreading sites, through contamination of ground water, drinking water wells, stockponds and surface waters, or through food contamination from eating food grown in sludge spread land. Pathogens can be transported to humans who walk through sludge spread fields. Wild animals, farm animals, birds, rodents and pets may become infected by or transmit sludge pathogens.

Bioaerosol risk:

A recent study from the University of Arizona shows that the risk of windborne pathogens is significant within a 10 km radius of a sludge spread field. In Canada, the relatively cooler and wetter climate may make this risk even higher.

Risk to water:

Significant amounts of pathogenic microorganisms are released with the land-applied or deposited animal waste and are subsequently transported with runoff water. To prevent the risk of movement and spread of human pathogens to water sources, the separation distances between sludge spreading sites and drinking wells, lakes, rivers and surface waters have to be maintained. In Canada, it is as high as 15 m to surface water.

Risk from food:
It is recommend that farmers observe a waiting period between sludge spreading and the harvesting of some crops, and also recommend that farmers restrict farm animals from fields recently spread with sludge.

Indian studies, reported by Shuval et al. (1986), have shown that sewage farm workers exposed to raw wastewater in areas where Ancylostoma (hookworm) and Ascaris (nematode) infections are endemic have significantly excess levels of infection with these two parasites compared with other agricultural workers in similar occupations. Furthermore, the studies indicated that the intensity of the Ascaris infections (the number of worms infesting the intestinal tract of an individual) in the sample of sewage farm workers was very much greater than in the control sample. In the case of the hookworm infections, the severity of the health effects was a function of the worm load of individuals, which was found to be related to the degree of exposure and the length of time of exposure to the hookworm larvae. Sewage farm workers are also liable to become infected with cholera if practising irrigation with raw wastewater derived from an urban area in which a cholera epidemic is in progress (Shuval et al. 1985). Morbidity and serological studies on wastewater irrigation workers or wastewater treatment plant workers occupationally exposed to wastewater directly and to wastewater aerosols have not been able to demonstrate excess prevalence of viral diseases.

Animal wastes can contain zoonotic organisms and enter the wastewater from farms, meat packing and processing facilities and from rats and other animals and/or vectors found in or around sewage or sewers. Humans come in contact with the pathogens and thus potentially disease by direct contact with sewage, by eating food or drinking water contaminated with sewage, or through contact with human, animal, or insect carriers. During the course of typical wastewater treatment, the microorganisms in sewage are reduced in number, becoming concentrated in the sewage sludge. Some organisms of concern are listed below. These pathogens excreted in animal feces have been known to initiate waterborne infections as well.

BACTERIA- Salmonella, Campylobacter, Shigella, pathogenic strain of E. coli O157:H7, Yersinia entercolitica, Helicobacter pylori, Mycobacteria, Listeria monocytogenes, Clostridium perfringens etc.

VIRUSES Adeno, Entero, Coxsackie, HAV, HEV, Coronaviruses.

PROTOZOA-Giardia lamblia, Cryptosporidium, Entamoeba histolytica, Microsporidium, Cyclospora, Toxoplasma, Gondii, Sarcosystis hominis.

The causative agents of many infectious diseases are excreted by the faecal route and also with other excretions or secretions of the body. Although the pathogens do not survive very long in stored farmyard manure because of the temperatures and biological and biochemical activities prevailing in the middens, they survive for rather long periods in slurry as the conditions in slurry are different because the temperature does not rise and biochemical activity is low. To avoid disease transfer by utilization of manure and slurry as fertilizers, certain precautions are necessary. In the sewage purification processes most of the pathogens are reduced in number but not completely eliminated. They are enriched in the sewage sludge by sedimentation processes. To protect the livestock of farms utilizing sewage sludge as fertilizer or for amending soils, it is necessary to sanitize hygienically sludges prior to their use.

Sewage Sludge Stabilization andnd Disposal Options
There are three main disposal alternatives for sewage sludge: (1) landfilling; (2) incineration; and (3) land application. Before being applied to land, sewage sludge must be stabilized and disinfected to reduce pathogens, the attraction of vectors (disease transmitting organisms like flies and rodents), and the potential to emit odors. During stabilization and disinfection, pathogens are either significantly reduced or reduced below detectable levels.

Table 2. Biological sludge Stabilization Methods

PFRP/PSRP	Method	Time/Temperature	Additional requirements
PSRP	Mesophilic Aerobic Digestion	40 days @ 20°C up to 60 days @ 15°C	Agitated with air or pure oxygen to maintain aerobic conditions
	Mesophilic Anaerobic Digestion	15 days @ 35-55°C up to 60 days @ 20°C	Closed to the atmosphere to maintain anaerobic conditions
	Composting (Windrow, Static Aerated Pile, or Within-Vessel)	40°C for 5 consecutive days	None
PFRP	Thermophilic Aerobic Digestion	55-60°C for 10 consecutive days	Agitated with air or pure oxygen to maintain aerobic conditions
	Autothermal Thermophilic Aerobic Digestion*	56-57°C for at least 16 hours during a total treatment time of 6 days	Two reactors in series; Agitated with air to maintain aerobic conditions
	Two-Phase Thermo-Meso Feed Sequencing Anaerobic Digestion (2PAD)*	Phase 1: 49-55°C for 2.1 days Phase 2: 37°C for 10.5 days	Phase 1: 55°C must be maintained for at least 3 hours during the 2.1 days
	Composting (Within-Vessel or Static Aerated Pile)	55°C for 3 consecutive days	None
	Composting (Windrow)	55°C for 15 consecutive	None

Stabilization methods include: Anaerobic Digestion and Composting

Both aerobic and anaerobic digestions reduce the volume of sewage sludge solids that require disposal. Both practices are known to kill human pathogens. Another benefit of anaerobic digestion is the generation of methane, which can be used as an energy source. Anaerobic digestion is only economical for larger communities due to the high capital costs involved. Composting or aerobic digestion, an energy-intensive process, can be practiced at small scale individual levels.

CONCLUSIONS

Concerns about the potential health risks from pathogens associated with the land application of sewage sludge and animal wastes will continue into the foreseeable future. Open field storage of sludge and sludge spreading near wells and surface water, increase the risk that sewage sludge pathogens will be transported to workers, farmers and neighbors, and increases the environmental risks of this waste disposal practice. The existing treatment technologies may not be adequate to disinfect sewage sludge and/or animal manure from all known pathogens. Innovative sewage sludge and animal manure treatment technologies for enhanced environmental quality need to be developed. This information will help wastewater industry and public health professionals, as well as the public, scientists, and environmentalists in gaining a contemporary perspective on the state-of-the-knowledge of the disinfection efficacy of various treatment technologies.

Water Pollution due to Industrial and City Effluents and their Effects on Crop Production

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Introduction

Fresh water is the important natural resource on the earth next to air. All over the world, water is becoming increasing by scarce and polluted. The ultimate irrigation potential of the country is 139.89 Mha, out of which 64.05 Mha i.e. 46 % is from groundwater. Farmers have control over the use of groundwater unlike surface water which are mostly released according to certain pre-specified policies. Therefore groundwater presents a promising alternative for solving the problems of water scarcity. Groundwater is generally less susceptible to contamination and pollution when compared to surface water bodies. Also, the natural impurities in rainwater, which replenishes groundwater systems, get removed while infiltrating through soil strata. However, groundwater if not used and recharged properly, easily get contaminated by seepage of water from polluted rivers in to wells during high tide conditions; indiscriminate use of fertilizers, insecticides and pesticides; letting of industrial effluent into open pits near wells without treatments, mining of groundwater, sea water intrusion, domestic wastes, etc. In India, where groundwater is used intensively for irrigation and industrial purposes, a variety of land and water-based human activities are causing pollution of this precious resource. Its over-exploitation is causing aquifer contamination in instances; while in certain others its unscientific development with insufficient knowledge of groundwater flow dynamic and geo-hydro chemical processes has led to its mineralization.

Major sources of pollution

Industrial effluents

According to the survey by Central Pollution Control Board, Government of India, groundwater pollution due to industrial effluent is critical in 16 states. There are about 57,000 groundwater polluting industries that generate about 13468 mld of waste water, out of which only 60% is treated and disposed. The major industries and their waste water disposal rates are presented in Table 1.

The state of Maharashtra is ranked first in terms of industrial investment in the country. Major industrial sectors are in power, fertilizer and sugar and cement industries. In Satara and Sangli districts of Maharashtra, 15 medium to large size sugar factories are located. The quantity of water consumed for domestic, industrial and irrigation uses are respectively 66, 14 and 3366 MCM. Correspondingly the amount of effluent that is being discharged from urban, industrial and irrigation are 29, 14 and 673 MCM. From the sugar factories and its surrounding domestic locations about 13400 and 1525 cu.m of effluent are being discharged every day.

Industrialization is gaining importance in recent years due to the changing policy of the Government. The sugar factory is one of the important industries, which are increasing in the rural areas of the State. The paper mill and distillery for efficient use of its byproducts supplement this industry. These industries are discharging various materials with high Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) and with a tremendous potential for carrying air, soil and groundwater pollution besides being obnoxious, colored and foul smelling. These effluents seriously affect the groundwater quality of open well in the adjoining areas and the farmers are forced either to abandon agriculture or restrict the choice of crops/cropping industry.

The similar situation that contributes to groundwater pollution exists in and around the industrial belts of the state.

All concerned, including industry environmentalists, Government and its agencies, neighboring farmers etc. are highly concerned to know the extent of deterioration and are looking forward to an early solution to this vexed problem. It is imperative to characterize the hydrological, chemical and biological hazards in the affected area and suggest suitable measures for the sustainability of irrigated agriculture in the region.

Domestic waste

About 423 class-I cities and Class-II towns having population of around 200 millions generate about 26254 mld wastewater of which only 6955 mld i.e about 255 is treated and disposed. In general the use of polluted water with heavy use of sewage water in agriculture is a global practice.

Table 1. Wastewater disposal rate from different industries

Industry	Quantum
Integrated iron and steel	16 m^3/tonne of finished steel
Sugar	0.4m^3/tonne of cane crushed
Pulp and paper industries	
Pulp and paper	175 m^3/tonne of paper produced
Rayon grade pulp	150 m^3/tonne of paper
Fermentation industries	
Maltry	3.5m^3/tonne of grain processed
Brewery	0.25 m^3/KL of beer produced
Distillery	12m^3/KL of alcohol produced
Membrane cell process	1m^3/ tonne of caustic soda produced
Mercury cell process	4m^3/tonne of caustic soda produced (mercury bearing)
Textile industries: Man-made fiber	
Nylon and polyester	120 m^3/tonne of fiber produced
Viscose staple fiber	150 m^3/ tonne of product
Viscose filament yarn	500 m^3/ tonne of product
Tanneries	25 m^3/tonne or raw hide
Starch glucose and related products	8 m^3/ tonne of maize crushed
Dairy	3 m^3/tonne of Milk
Natural rubber processing	4 m^3/tonne of rubber
Fertilizer	
Straight nitrogenous fertilizer	5 m^3/tonne of urea or equivalent produced
Straight phosphatic fertilizer (SSP & TSP)	0.5 m^3/tonne of SSP/TSP
Complex fertilizer	Standards of nitrogenous and phosphatic fertilizers are applicable depending on the primary product

The use of sewage water in agriculture indicated that it increases yield of crops and improves the soil properties. It also saves fertilizers (Patel and Parthesarsthy, 2001).

Sea water intrusion: Excessive utilization of groundwater from coastal aquifer covered the sea water intrusion in Gujrat, Maharashtra, Kerala, Tamilnaidu and West-Bengal.

Agricultural pollution: Non-point pollution caused by fertilizers and pesticides used in agriculture, often dispersed over large area, is a great threat to fresh groundwater ecosystem. Intensive use of chemical fertilizers in the farm results in leaching of the residual nitrate causing high nitrate concentration in groundwater. But the vulnerability of groundwater to pesticides and fertilizers pollution is governed by soil texture, pattern of fertilizer use and pesticide use, their degradation products and total organic matter in the soil.

The quality of groundwater is almost as important as its quantity. The physical, chemical and microbiological characterization of groundwater is important in determining its suitability for agricultural, domestic, industrial and other uses. The concentration and composition of dissolved constituents in water are cations (such as Ca++, Mg++, Na+ and K+) and anions (such as Cl, S04, CO3 and HCO3). The degree of adverse effect on soil properties and crop productivity are mainly related to chemical composition of irrigation water.

Issues in tackling groundwater contamination and pollution

Groundwater pollution and adoption of preventive and remedial measures to minimize the impact of pollution are the complex issues. Some of the important issues are highlighted in his section.

Accurate Information

The first step towards evolving measures to prevent and cure groundwater quality deterioration is generating reliable and accurate information through water quality monitoring (WQM) to understand the actual source/cause, type and level of contamination. However, there are limited observation stations in the country that cover all the essential parameters for water quality and hence the data obtained are not decisive on the water quality status.

Water Quality Monitoring involves expensive and sophisticated equipments that are difficult to operate and maintain and require substantial expertise in collecting, analyzing and managing data. Since water technology is still not advanced in India, it is very likely that the available data are less reliable.

Inadequate Methodology

The existing methodology for WQM is inadequate to identify the various sources of pollution. Integration of data on water with water supplies is very important from the point of view of assessing water availability for meeting various social, economic and environmental objectives. But this is largely ignored.

Absence of stringent norms on water quality testing

The results and interpretation of the data can change across agencies depending on sampling procedure, time of testing, and testing instruments and procedure. There is a need to have common platform and norms, mostly synonymous with WHO and UNICEF.

Technical issues in mitigating contamination

For seawater intrusion, artificial recharge techniques are available in India for different geo-hydrological settings. Artificial recharge could push seawater-freshwater interface seawards. These techniques can also be used to reduce the levels of fluoride, arsenic or salinity in aquifer waters on the principle of dilution. But, the issue is of availability of good water for recharging in arid and semi arid regions given the large aerial extent of contaminated aquifers. This is just one example but the constraints in adopting technical options need to be investigated.

Industrial pollution

The issues are, pumping out polluted water from the aquifer; treating this water to safe limits; and replenishing the depleted aquifer with freshwater. The entire chain need to be established.

Technically feasible methods
Technically feasible methods to clean polluted water often does not exist due to highly toxic substances in trade effluents as seen in a case in Rajasthan where a sulfuric acid manufacturing unit rendered drinking water source in 22 villages useless. Finding enough freshwater for replenishment was also a problem there. The cost of cleaning the aquifer in the Rajasthan case was estimated to be Rs. 40 crores.

Inadequate data
There are issues concerning adequacy of scientific data available from these agencies. They are the network of monitoring stations however those are not dense enough. Often water quality analysis excludes critical parameters that help detect pollution by fertilizer and pesticide, heavy metals and other toxic effluents. The available scientific data, particularly that on pollution is of civil society institutions, and there is a paucity of such institutions that are capable of carrying out such professionally challenging, technologically sophisticated, and often politically sensitive tasks.

Monitoring agencies
The Central Pollution Control Board (CPCB) and the State Pollution Control Boards (SPCBs) are the pollution watchdogs in India. Monitoring of groundwater quality has come under their purview only recently and water quality of rivers is being monitored. But monitoring does not cover "non-point" pollution from agriculture. An analysis of the performance of the Gujarat State Pollution Control Board (GPCB) in Sabarmati river basin showed that of the four priority areas identified by the Board for operations, its performance has been satisfactory in only identification of areas facing severe pollution. The monitoring ability itself was doubtful as the agency maintains only two observation wells for groundwater quality monitoring in the entire basin. The GPCB also lacks adequate staff to carry out its functions.

The SPCBs perform the dual functions of monitoring pollution and enforcing pollution control norms. But, the agency lacks legal teeth and administrative apparatus to penalize polluters. This reduces the effectiveness of the agency in enforcing pollution control norms.

Groundwater contaminants
Groundwater contamination mostly occurs due to geo-hydro chemical processes activated by pumping. Once contamination starts, very little can be done to check it except a total ban on pumping. But this is very difficult. The contaminant that exists in groundwater in India are nitrates, arsenic, selenium, heavy metals, TDS, fluorides, etc.

Fluoride: The incidence of fluoride above permissible levels of 1.5 ppm occurs in 14 states of India to the extent of about 65% of Indian villages are exposed to fluoride risk.

Arsenic: High levels of arsenic above the permissible limits of 50 ppb (parts per billion) are found in the alluvial plains of India.

Heavy metals: Presence of heavy metals in groundwater is found in most of the states of India.

Effect of toxicity in agriculture: Irrigation water that contains certain ions at concentration above threshold values can cause plant toxicity problems. Toxicity normally results in impaired growth, reduced yields, changes in morphology and even its death. The degree of damage depends on the crop, its stage of growth, the concentration of the toxic substance, climate and soil conditions. The most common phytotoxic ions that may be present in municipal sewage water and treated effluents in concentration such as to cause toxicity are: boron (B), chloride (Cl), and sodium (Na). Hence the concentration of these ions willhave to be determined to assess its suitability of waste water quality for use in agriculture.

Total dissolved salts, (TDS): Dissolved salts increase the osmotic pressure of soil water and an increase in soil pressure of soil solution increases the amount of energy which plants must expend to take up from soil. As a result, respiration is increased and the growth and yield of most plants decline progressively as osmotic pressure increases. The TDS indicates that the use of this wastewater is slightly hazardous for agricultural purposes.

Cadmium, (Cd): It appears in the plant produce if available in supplied irrigation water. The sewage water contains Cd. It has been observed that non polluted soil having 0.4 and 0.5 ppm Cd, may produce about 0.08 ppm Cd in brown rice. A little increase upto o.82, 1.25 or 2.1 ppm of soil Cd has the potential to produce heavily polluted brown rice with 1.0 ppm Cd.

Sodium, (Na): High sodium ions in water affect the permeability of soil and causes infiltration problems. The problems to the crop caused by an excess of Na is the formation of crusting seed beds, temporary saturation of the upper surface soil, high pH and the increased potential for diseases, weeds, soil erosion, lack of oxygen and inadequate nutrient availability.

Chloride, (Cl): Sodium and chloride are usually absorbed by the roots. When the absorption is through leaves the rate of accumulation is bigger.

Boron, (B): The boron can be toxic at very low concentration levels. Boron concentration less than 1.0 mg/L is essential for plant development, but higher levels can cause problems. Most plants show toxicity problems when B concentration exceeds 2.0 mg/L.

Emerging Challenges

The importance of arresting groundwater from pollution has already realized. The issues concerned with the groundwater pollution have been highlighted in previous sections. The efforts are already being made to prevent groundwater from pollution or to treat polluted water for utilization. But in this endeavor, there are major challenges which we are facing. These are narrated in this section.

Qualified technical manpower

The available treatment systems work on the principles of physics and chemistry. Hence, their efficiency depends heavily on maintaining certain specified operating conditions. This would call upon qualified technical manpower for system operations, and regular operation and maintenance, which are mostly absent. As an example the Gujarat Water Supply and Sewerage Board set up 28 desalination systems since 1989. All of them became dysfunctional within a very short span of time. Most of the 117 desalination plants commissioned in eight states by government agencies became non-operational due to lack of technical manpower for maintenance and improper selection of membrane.

Social and economic concerns

Most of the treatment systems for drinking water have to be tried out at the community level to be cost effective and affordable. With no major revenues being accrued by government agencies from domestic water supply services, any additional investment for provision of safe water for drinking and cooking purposes would induce unprecedented financial burden. Therefore, it will be more appropriate to build and operate water treatment systems on the principle of full cost recovery. The water supplied from the system has to be affordable to all classes of the society as drinking is essential for survival. Therefore, unit cost of production should be minimized for commercial viability.

Efficient and sustainable utilization

The unit cost of production could be brought down considerably by running the plant at peak capacity, which means creating sufficient demand. Higher demand means lower selling price of water for commercial viability. Whereas increase in plant capacity can reduce unit cost, this also lowers the chances of running the plant at full capacity, which means higher operating costs. Hence, optimal plant design, proper selection of membrane, generating sufficient demand etc. are important for bringing down the cost of production. The level of professional inputs that go into management of public water supply systems would be far less than adequate to manage these systems. Over and above, operating costs for agency-run systems are likely to be high due to high administrative overheads. As a result, new techno institutional models need to be evolved to manage the system in order to make them self sustaining. Involving private sector in provision of clean and safe drinking water would be a major step towards achieving this.

Information system

It is ordinary people who raise the alarm about poor water quality. Civil society/institutions need to be strengthened to respond to water quality problems quickly. This is possible through better knowledge and information about the nature of groundwater contamination, potential sources of threats to groundwater quality in their region and degrees of vulnerability, the ill -effects of using contaminated water, and the possible preventive measures. The information system accessible to all need to be designed, developed at set up.

Formation of pressure groups

The pressure groups are necessary to put pressure on the line agencies to perform. Strengthening civil society institutions is particularly important because groundwater quality variations in nature are often sporadic. It is extremely difficult for monitoring agencies to establish an elaborate network of WQM stations due to the high costs and technical manpower involved. Given the absence of complete information about quality of water in various sources, it is also not possible for line agencies to identify appropriate treatment measures. Also, the willingness of people to pay for water is directly linked to their knowledge and awareness about ill-effects of drinking contaminated/polluted water. Credible and technically competent NGOs can play a big role in strengthening civil society, by generating the vital database on groundwater quality and provide the link between consumers and line agencies.

Institutional aspects

The challenges that water utilities would face are building technical and managerial skills to design, install, operate and manage water treatment systems, making people pay for treated water and building knowledge and awareness among communities about groundwater quality issues and treatment measures. For the long run, policies need to be focused on building scientific capabilities of line agencies concerned with WQM, water supplies, and pollution control; and restructuring them to perform WQM and enforcement of pollution control norms effectively and to enable them implement environmental management projects.

Alternatives

Preventive and curative measures against pollution and contamination of groundwater may continue to receive low priority for years to come, and technological measures to prevent the ill effects on human health will get priority in short term. Demineralization using RO system can remove all hazardous impurities from drinking water and would be cost effective in many situations where TDS, nitrate and fluoride in groundwater are above permissible levels. The cost of demineralization is falling rapidly. Saudi Arabia meets 20 per cent of its total water needs from desalinated sea water, and Saudi technologists believe desalination costs would fall so rapidly over the coming decades that desalination will be cheaper than pumping coastal aquifers. Low cost treatment methods are available for removal of arsenic from groundwater. Such type of alternatives needs to be investigated with minimal cost.

Pollution due to Sugar factory

The sugar factory is one of the important agro-base industries in the rural areas of Maharashtra State. This industry is supplemented by the incorporation of Paper Mill and Distillery for efficient use of its by-products. These industries together discharge effluents with high Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) and with a tremendous potential for carrying air, soil and groundwater pollution loadings that are obnoxious, colored and foul smelling. These effluents seriously affect the groundwater quality of wells in the adjoining areas and the farmers are forced to use these polluted water with restricted choice of crops. Mahatma Phule Krishi Vidyapeeth has conducted the studies on characterization of pollution due to sugar and allied industries and suggested remedial measures. These are discussed in this section.

Mula Co-operative Sugar Factory, Sonai, Maharashtra (Pawar et al 1998)

Analyses of 126 samples collected from 18 dug wells in the shallow basaltic aquifer over a period of 7 months have revealed spatial as well as temporal changes in the chemical properties of groundwater. While the temporal changes have been attributed to dilution and concentration phenomena governed by climatic factors, the spatial variations in the geochemical characteristics of groundwater appeared to be related to pollution due to effluents from the

Mula Co-operative Sugar Factory, Sonai, Maharashtra. The cause of groundwater pollution is the effluent carried by a stream flowing through the area.

Fluctuations in the groundwater table, influent water quality character of the stream, less capacity to accommodate large volume of effluent and occurrence of zero base flow (under natural conditions) in the stream are the factors favoring infiltration of constituents of waste water into the underlying weathered basaltic aquifer. Pollutants have entered into the shallow aquifer by downward percolation through the zone of aeration to form a recharge mound at the water table and, further, lateral movement below the water table. The plume of polluted groundwater has a lateral extent of a few meters in the upstream area and more than 400 m on either side of the stream in the downstream part. The zone of polluted groundwater has an aerial extent of more than 3.5 km2. Groundwater is the only source available for drinking and agricultural purposes. It was recommended that the base of the lagoons and the stream used for release of plant effluent should be waterproofed for the protection of groundwater in the Sonai area.

Shri Shivaji Sahakari Sakhar Karkhana, Rahuri, Maharashtra

The research studies conducted by Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar, MS, India on utilization of Shri Shivaji Sahakari Sakhar Karkhana, Rahuri sugar factory effluents and its allied industries revealed that wastewater from these industries can be utilized for crop production. The sugar factory effluent was acidic in reaction with total salt content of about 1660 mg/l. The chloride content was also on higher side. The COD was higher than BOD. The paper mill effluent was slightly alkaline in reaction with higher electrical conductivity (EC). The bi-carbonate was dominant over chloride and sulphate. Among the cations, sodium was dominant followed by calcium, magnesium and potassium. It also contained iron and manganese as trace elements.

The existing wells in the areas approximately at distance of 200 m were marked as observation wells. The reduced levels were found with dumpy level. The water samples from 23 wells located along the lagoons were collected for analysis. Similarly soil samples were also collected from these fields. The standard procedures were adopted for chemical analysis.

Aquifer Characterization: The MPKV, Rahuri studied that the polluted aquifer in Ahmednagar district of Maharashtra for the aquifer characteristics such as depth to water table, transmisivity, hydraulic conductivity and specific yield. These parameters were determined by pumping test.

The transmissivity values obtained were in the range of 20.36 m2/day and 32.38 m2/day. The average value of transmissibility was obtained as 26.37 m2 /day. The values of transmissibility calculated by the Papadopulous-Cooper method were more as compared to the values calculated by Theim's equation. The determined values were in conformity with values specified for the basalt formation in India. The values specified are in the range of 0.02 to 140 m2/day (Karanth, 1992).

The hydraulic conductivity of the aquifer is found by using transmissivity values and depth of aquifer. The values of the specific yield obtained were 0.003 and 0.0383 per cent respectively for well

Table 2. Hydraulic Conductivity by Theim's and Papadopulous Cooper methods

Method	Hydraulic Conductivity, m/day		
	Well No. 1	Well No.2	Average
Theim's	9.75	5.538	7.664
Papadopulous-Cooper	28.156	6.16	17.158

No. I and Well No.2. The average value of specific yield obtained was 0.021 per cent. The value of specific yield obtained was on lower side than the value specified (Michael, 1991) for the unconfined aquifer.

Extent of groundwater pollution due to sugar factory effluent

The deterioration of groundwater quality near the lagoons wherein the treated effluents from the sugar factory and distillery are discharged was due to the presence of Mg++, Na+, HCO3-, CO3---, Cl- and TDS. The analysis of the well water and soil samples from the study area showed that as the distance from lagoon increased, the quality of groundwater and soil improved. The analysis of well water and soil which is irrigated with the well water was carried out before and after monsoon for 23 selected wells. The values of parameters like EC, pH, Na, HCO3, Cl and RSC were reduced after monsoon (1998-2004). The SAR values were not influenced. EC and pH values of the soil were reduced after monsoon season (1998-2004). It was found that the concentrations of the ions in groundwater were reduced after monsoon due to dilution of water as a result of rainfall. However after monsoon until the before monsoon of next year, the movement of pollutants continued to groundwater and hence the ionic concentrations were higher before monsoon. The concentrations of ions in soil were reduced after monsoon, probably due to leaching by rains during the monsoon and after monsoon, the salts continued to add in the soil due to irrigation from the well water, as a result of which the ionic concentrations were higher before monsoon. The extent of the polluted area due to different sources is presented in Table 3 and 4 and Figure 1.

Horizontal extent of pollution

It was observed that the horizontal extent of ground water pollution was 1900 m from the lagoons. This was observed on the basis of availability of HCO3 in ground water before monsoon. This means that the wells in the area of 1900 m and 1100 m from the lagoon in the direction of natural stream flow are affected by the lagooning of effluents from sugar factory, paper mill and distillery before and after monsoon respectively.

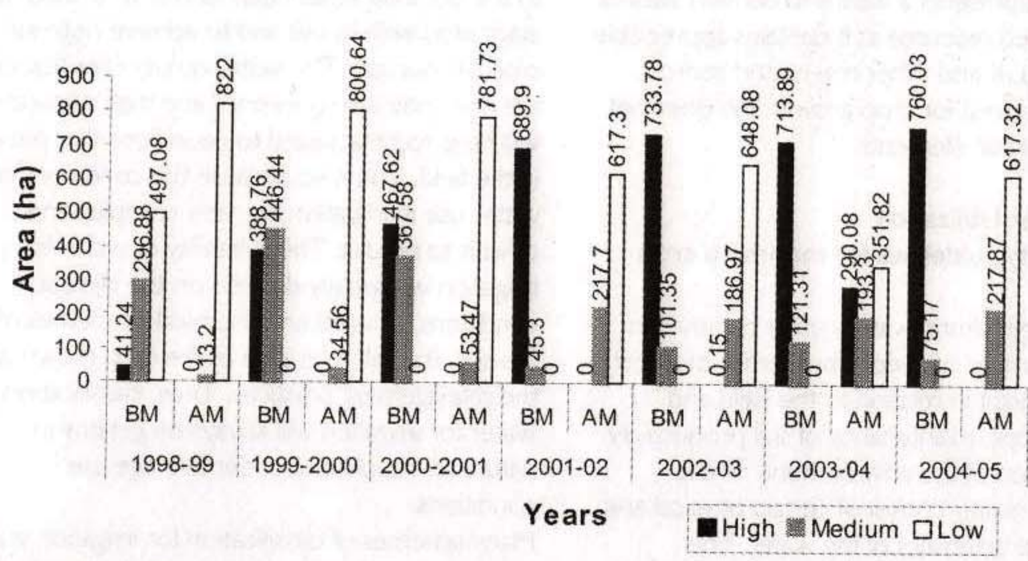
Table 3. Extent of groundwater pollution according to EC

Sr. No.	Degree of pollution	Area affected (ha)
1	Highly polluted zone	69.5
2	Medium polluted zone	825.5
3	Less polluted zone	The lowest permissible limit of EC is 0.2 dS/m. However everywhere in the study area EC was seen above 0.2 dS/m.

Table 4. The distribution of polluted area according to the concentration of different elements.

Sr. No.	Element	Area (ha) under different zones			Total affected
		Highly polluted	Medium polluted	Less polluted	area (ha)
1	Mg^{++}	0.5	50	149.5	200
2	Na^{+}	1.0	37	94	132
3	HCO_3^-	98	102	-	200
4	Cl^-	71.0	29.5	47.0	147.5
5	TDS	49	38	113	200

Figure 1. Area under high, medium and low ranges of EC values of ground water



Use of groundwater polluted due to sugar mill for wheat

In order to know the feasibility of using polluted waters with different modes of application, a field study was undertaken with wheat crop at Rahuri. The quality of water used for irrigation was analysed. The data were recorded on the soil properties viz. pH and EC at different depths. The irrigation with polluted well water recorded highest EC (1.64 dS/m) and pH (8.52), followed by irrigation with canal water (i.e. one irrigation with canal water followed by two well water irrigations). The irrigation with canal water observed lowest EC (1.3 dS/m) and pH (8.24). The application of alternate irrigation with polluted water and canal water recorded less EC (1.523 dS/m and pH (8.32). The study indicated that these polluted waters can be used with alternate irrigation of canal water without affecting the soil properties.

Use of spent wash in Sugarcane

Spent wash is a by-product of sugar mill. Department of Soil Science & Agricultural Chemistry, MPKV, Rahuri studied the use of spent wash for crop production. Its use in adsali sugarcane showed that the yield and CCS percentage have increased by 10.15 % and 6 % respectively.

Pollution due to paper mill

The effluents from the paper mill in the basaltic aquifer at Tuppa, New Nanded, Maharashtra, India over a period of three years revealed that groundwater from this region shows higher content of TDS, Cl, pH, Ca, Mg and S04. The geochemical characteristic of groundwater related to pollution was discharged in a stream flowing through this area. The effluent was also discharged in the injection wells. As a result the pollutants have entered into the aquifer system and flowed farther in the eastern direction. The zone of pollution has an aerial extent of more than 38 km2.

Pollution due to distillery waste

Dongale and Sawant (1978) stated that the spent wash was as good as a source of potassium for sorghum (M35-1). Application of vinasse with barley stubbles at 1.6 and 3.2 t/ha increased the yield of Phaseolia, which was 1.7 and 13.2 t/ha dry matter, respectively.

Phatak et al. (1999) reported that distillery effluents contain a considerable amount of plant nutrients. In field study, soil amendment with distillery effluent increased the yield of wheat and rice grown in sequence. Organic carbon and available potassium content of post harvest soils were also found increased.

According to Kaushik et al (2006), utilization of anaerobically digested distillery effluent in agriculture represents a means to convert wastes to value added resource as it contains appreciable amount of N, K and other macro and micro nutrients required for crop growth and does not posses any toxic elements.

Waste Water Utilization

Water quality guidelines for maximum crop production

Important agricultural water quality parameters include a number of specific properties of water that are relevant in relation to the yield and quality of crops, maintenance of soil productivity and protection of the environment. These parameters mainly consist of certain physical and chemical characteristics of the water. The recommended values of different parameters for use are presented in Table 5.

Traditionally, irrigation water is grouped into various quality classes in order to guide the user to the potential advantages as well as problems associated with its use and to achieve optimum crop production. The water quality classifications are only indicative guidelines and their application will have to be adjusted to conditions that prevail in the field. This is so because the conditions of water use in irrigation are very complex and difficult to predict. The suitability of water for irrigation will greatly depend on the climatic conditions, physical and chemical properties of the soil, the salt tolerance of the crop grown and the management practices. Thus, classification of water for irrigation will always be general in nature and applicable under average use conditions.

Many schemes of classification for irrigation water have been proposed. Ayers and Westcot (FAO 1985) classified irrigation water into three groups

Table 5: Recommended water quality guidelines of agricultural significance

Sr. No.	Parameters	Units	Recommended maximum concentrations
1	pH	--	6.5-8.5
2	EC	dSm^{-1}	<0.7
3	TDS	mgL^{-1}	<450
4	Ca^{2+}	mgL^{-1}	400
5	Mg^{2+}	mgL^{-1}	60
6	Na^{+}	mgL^{-1}	<3
7	SO_4^{2-}	mgL^{-1}	1000
8	Cl^{-}	mgL^{-1}	600
9	HCO_3^{-}	meL^{-1}	1.5
10	SAR	$(mmol\ L^{-1})^{1/2}$	15
11	RSC	meL^{-1}	<1.25
12	BOD	mgL^{-1}	100
13	NO_3-N	mgL^{-1}	5
14	Fe	mgL^{-1}	5
15	Mn	mgL^{-1}	0.2
16	Zn	mgL^{-1}	2
17	Cu	mgL^{-1}	0.2
18	B	mgL^{-1}	2
19	Cd	mgL^{-1}	0.01
20	Cr	mgL^{-1}	0.1
21	Ni	mgL^{-1}	0.2
22	As	mgL^{-1}	0.1
23	F	mgL^{-1}	1.0

(Source: National Academy of Science, 1972, FAO, 1985)

based on salinity, sodicity, toxicity and miscellaneous hazards. These general water quality classification guidelines help to identify potential crop production problems associated with the use of conventional water sources. The guidelines are equally applicable to evaluate wastewaters for irrigation purposes in terms of their chemical constituents, such as dissolved salts, relative sodium content and toxic ions. Several basic assumptions were used to define the range of values in the guidelines and more detailed information on this is reported by Ayers and Westcot (FAO 1985).

Dissolved salts increase the osmotic potential of soil water and an increase in osmotic pressure of the soil solution increases the amount of energy which plants must expend to take up water from the soil. Although most plants respond to salinity as a function of the total osmotic potential of soil water, some plants are susceptible to specific ion toxicity.

The effect of sodium ions in irrigation water in reducing infiltration rate and soil permeability is dependent on the sodium ion concentration relative to the concentration of calcium and magnesium ions (as indicated by SAR) and the total salt concentration, as shown in the guidelines. For a given SAR value, an increase in total salt concentration is likely to increase soil permeability and, for a given total salt concentration, an increase in SAR will decrease soil permeability. This illustrates the fact that soil permeability (including infiltration rate and surface crusting) hazards caused by sodium in irrigation water cannot be predicted independently of the dissolved salt content of the irrigation water or that of the surface layer of the soil.

Many of the ions which are harmless or even beneficial at relatively low concentrations may become toxic to plants at high concentration, either through direct interference with metabolic processes or through indirect effects on other nutrients, which might be rendered inaccessible. Morishita (1985) has reported that irrigation with nitrogen-enriched polluted water can supply a considerable excess of nutrient nitrogen to growing rice plants and can result in a significant yield loss of rice through lodging, failure to ripen and increased susceptibility to pests and diseases as a result of over-luxuriant growth. He further reported that non-polluted soil, having around 0.4 and 0.5 ppm cadmium, may produce about 0.08 ppm Cd in brown rice, while only a little increase up to 0.82, 1.25 or 2.1 ppm of soil Cd has the potential to produce heavily polluted brown rice with 1.0 ppm Cd.

Effect of treated wastewater on soil chemical and physical properties

Abedi-Koupai et al. conducted the study to investigate the effect of treated wastewater on soil chemical and physical properties. They conducted the field experiment conducted with two water treatments of wastewater and groundwater under sprinkler and surface irrigation systems for three crops of sugar beet, corn and sunflower. Soil samples were collected upto 120 cm depth to determine concentration of lead (Pb), manganese (Mn), iron (Fe), cadmium (Cd), nickel (Ni), cobalt (Co), copper (Cu) and zinc (Zn). They found that

-:- Irrigation systems had no significant effect on extractable heavy metals in soil. The accumulation of Pb, Mn, Ni and Co in the soil increased significantly in the wastewater treatment as compared to the groundwater treatment.
-:- The accumulation of Pb, Mn, Ni, Co, Cu and Zn decreases with the soil depth.
-:- Treated wastewater showed no effect on the increase of Fe, Cd, Ni, Cu and Zn during growing season.
-:- The irrigation system had a significant effect on infiltration rate, bulk density and total porosity. Under sprinkler irrigation system the infiltration rate increased significantly.

The physical and mechanical properties of the soil, such as dispersion of particles, stability of aggregates, soil structure and permeability, are very sensitive to the type of exchangeable ions present in irrigation water. Thus, when effluent use is being planned, several factors related to soil properties must be taken into consideration. The effect of wastewater on soil physical properties studied by several researchers are reported below:

Infiltration rate: For the wastewater treatment the average infiltration rate at the beginning and end of growing season were 2.1 and 2.9 cm/h, respectively. Therefore, the application of wastewater caused an increase in the infiltration rate. The average of infiltration rate at the beginning and end of growing season were similar for the groundwater treatment.

Saturated hydraulic conductivity: Application of wastewater caused a decrease in the saturated hydraulic conductivity. Suspended solids including organic matter in wastewater may have filled up some of the soil voids decreasing hydraulic conductivity of the soil. Also, in the wastewater treated plots, growth of microorganisms in the soil pores may result in the reduction of saturated hydraulic conductivity.

Soil bulk density: Soil bulk density increased significantly in both water treatments. This was due to the particles dispersion and sedimentation of clay particles although the wastewater contains considerable organic matters.

Porosity: The wastewater irrigation caused a reduction in the soil porosity; however there was no significant difference between the wastewater and groundwater irrigation treatments. The average soil porosity, in the wastewater and groundwater treatments is 48.6 and 48.4 percent, respectively.

The effect of irrigation system on soil physical properties as studied by different researchers is reported below:

Infiltration rate: The average final infiltration rate for sprinkler system was higher compared to surface irrigation system. Using the sprinkler system with wastewater, the final infiltration rate increased for sugar beet.

Soil bulk density: The soil bulk density for surface irrigation system was higher as compared to the sprinkler system. This was probably due to the movement of some soil fine particles to the soil pores.

Porosity: The surface irrigation system reduced the soil porosity for both irrigation water treatments more than sprinkler irrigation system.

The study on characterization of municipal waste water of Rahuri town

The studies were conducted by Mahatma Phule Krishi Vidyapeeth, Rahuri showed the total salt concentration of municipal wastewater sample was found in the range of 646.40 to 908.80 mgL-1 with an average value of 791.47 mgL-1. It indicates slight hazard (TSS between 500-1000 mgL-1) for use of this water for agricultural purpose. The EC value of wastewater ranged from 1.01 to 1.42 dSm-1 with an average value of 1.24 dSm-1 with low SAR. It means the water can be reused for irrigation purpose without treatment. The pH value ranged from 6.48 to 8.01 with an average value of 7.38 indicating that this water is of normal quality. The sodium was dominant cation observed in all samples ranging from 12 to 15 mgL-1 with an average value of 13.67 mgL-1. The calcium, magnesium and potassium content varied from 2.30 to 3.50 mgL-1, 0.30 to 2.40 mgL-1 and 0.26 to 1.23 mgL-1 respectively. The average values of the calcium, magnesium and potassium content were found 3.10 mgL-1, 1.30 mgL-1 and 0.66 mgL-1, respectively. The cations were observed in the order Na+ > Ca++ > Mg++ > K+. The normal cations in irrigation water are Ca++ > Mg++ > Na+ > K+, but this water dominated by Na+ cations which may have detrimental effect on soil which affects the germination of seeds of Bajara, Wheat, Soyabean, etc in black soils. The chloride was dominant anion observed in all samples ranging from 3.60 to 9.80 mgL-1 with an average value of 6.07 mgL-1. The bicarbonate and sulphate content varied from 3.10 to 4.50 mgL-1 and 0.80 to 5.70 mgL-1, respectively. The average value of the bicarbonate and sulphate content was found 3.70 mgL-1 and 2.60 mgL-1, respectively.

The anions were observed in the order Cl- > HCO3- -> SO4- -. The carbonates are absent in water. Chloride type salinity was observed in water which reflects the accumulation of salts of chloride on surface of soil which affect the plant growth. The toxic ions viz. boron concentration in water ranged from 0.056 to 0.185 ppm with an average value of 0.108 ppm. This indicates that the boron concentration in wastewater has low hazard for its use as irrigation water. The chloride was dominant anion observed in all samples ranging from 3.60 to 9.80 mgL-1 with an average value of 6.07 mgL-1. As the concentration of chloride in wastewater sample is in between 4-10 mgL-1, it may cause the problem for its use as irrigation water. The sodium was dominant cation observed in all samples ranging from 12 to 15 mgL-1 with an average value of 13.67 mgL-1. As the concentration of sodium in wastewater sample is greater than 9.0 mgL-1, it may cause the severe problem for its use as irrigation water. The wastewater also contained Fe, Mn, Cu and Zn as trace elements.

The average values of Fe, Mn, Cu and Zn were 0.140, 0.642, 0.027 and 0.011 mgL-1, respectively. As per the classification suggested by WHO (1971), the concentration of these trace elements is within the permissible limit for its use for irrigation. The overall analysis of wastewater indicated that the wastewater is of C3S1 class which indicates the marginal salinity and safe use for irrigation purpose and required controlled use of water in combination with salt tolerant crops.

Desai et al (2005) studied the influence of city sewage water irrigation on soil properties, nutrient and heavy metal accumulation by cabbage at Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra. She reported that the soils under long term use of sewage water showed relatively lower bulk density (1.2 to 1.39 g/cc), improved hydraulic conductivity (1.10 to 1.33 cm/hr), higher water stable aggregates (46 to 52%) and more soil water retention (44 to 49%). The sewage irrigated soils were alkaline in reaction (pH 7.83 to 8.73) with high EC (0.4 to 1.65 dS/m), high organic carbon (1.41 to 1.51%), higher exchangeable cations and high cation exchange capacity. Total as well as available NPK status of sewage irrigated soil were higher as compared to those in the sewage free soils. The total concentration of Fe Mn Zn Cu B Cd Cr Ni and As was comparatively higher in sewage water irrigated soils and found below permissible limits. The concentration of these elements was observed approaching their critical limit and may lead to soil concentration in few years if the same level of sewage water is applied.

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USE OF INDUSTRIAL EFFLUENTS IN AGRICULTURE

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ABSTRACT

A critical review on the use of industrial effluents in agriculture indicated that the waste water of paper mill, sugar factory, spent wash, urea factory and pharmaceutical factory are less hazardous and can be used for irrigation with appropriate precautions. The nutrient contents of spent wash and urea factory suggest that the inorganic fertilizer dose can be reduced by 25 to 50 per cent with the use of these. The effluents slightly increase the soil salinity but increase the nutrient availability of N, P, K and S considerably. As the industries are increasing day by day, systematic survey and study should be taken up to identify usefulness of industrial effluents in agriculture and develop appropriate technology to reduce the environmental pollution and increase the crop production.

INTRODUCTION

With linear increasing trend in industrialization and urbanization, there is tremendous increase in the production of industrial effluent and sewage waters. Many times, these become source of soil and water pollution. Though, most of the industrial wastes byproducts may act as pollutant, yet some of them may be used profitably in agriculture provided they are used scientifically and judiciously. At present the wastes are disposed off through open surface water and land system taking it granted that land is a neglected waste tank. Oflate, considering the ever increasing demand for irrigation water. Some workers have tried to use industrial effluent profitably in agriculture giving due consideration to the quality and quantity of effluents, soil type and crop (Bahirat et al., 1989; Singh et al., 1995; Zalawadia et al., 1997). Many effluents byproducts have been found to contain nutrient elements including organic carbon. Efforts have been made by several workers to use such byproducts/effluents for partial substitution of chemical fertilizer and improving soil productivity. An attempt is made in this paper to compile the work on uses of industrial effluents in agriculture.

CHEMICAL COMPOSITION OF INDUSTRIAL EFFLUENTS

Spent Wash: This is the distillery effluent coming from alcohol/acetone distilleries. The work has been mostly reported from Maharashtra, Punjab, Uttar Pradesh and Gujarat (Table-1). The pH ranged widely from 4.0 to 8.0. Basically this is acidic effluent and the higher pH values are due to neutralization treatment during lagooning. Except at Ludhiana, where the conductivity is comparatively less, in Maharashtra and Gujarat it was around 22.0 to 31.0 dS/m. Considering the Total Dissolved Solid (TDS) none of the waters can be disposed off without any treatment.

The heavy metal contents have been estimated only at Gujarat and it indicated that they are under permissible limits as prescribed by ISI. On the other hand, considering the high amount of K (around 1.0 %), P (around 0.1 %) and N (around 0.1 %), there is good scope to use this effluent for partial substitution of inorganic fertilizers.

(A) Sugar Factory Effluent: In comparison to the spent wash, the analytical report from three different states on sugar factory effluent indicated this to be less problematic. Though, the BOD values were either on the border or slightly higher for disposing off as irrigation water, it can be brought down through appropriate measures. On the other hand the manurial values of these waters are very less (Table-2).

Table-1. Location wise chemical composition of spent wash

Properties Unit= mg/l Except OC, EC, pH	Maharashtra				Punjab	UP	Gujarat
	Rahuri	Rahuri	Phulenagar	Sangali	Ludhiana	Janshi	Navsari
pH	8.0	-	4.1	4.0-5.4	5.0	-	7.20
EC(dSm^{-1})	31.0	-	22.1	-	7.5	-	29.0
Total Ca	100	2100-3300	1798	500-600	800	19200	1550
Total Mg	1700	2000-3300	1171.2	-	1440	21000	1060
Total K ('000)	13.6	8-13	9.31	12-15	10.0	9.08	10.15
HCO3	10000	-	-	-	-	-	9560
Cl	3500	5000-6500	5616	4000-5000	-	-	5100
COD('000)	13	90-110	-	65-85	-	-	6
BOD('000)	-	45-55	-	35-45	-	-	2.5
TDS('000)	45	80-90	-	52-86	-	-	85.73
Mineral matter	26000	-	-	-	-	-	-
Total –N	1400	1200-1400	-	1200	-	1140	1200
Total-P	1225	800-1200	-	1000	-	2190	900
OC%	-	-	3	-	-	1.33	-
Fe	–	50.75	–	50.80			61.26
Mn	–	–	–	–	–	–	4.00
Zn	–	–	–	–	3.7	–	1.17
Cu	–	–	–	–	–	–	0.78
Pb	–	–	–	–	–	–	0.68
Ni	–	–	–	–	–	–	0.70
	Jadhav& Savant, 1975	Patil et al., 1987	Somawanshi & Yadav., 1990	Subba Rao, 1971	Singh et al., 1980	Bajpai & Dua., 1972	Raman & Zalawadi a., 1997

Table – 2. Location wise chemical composition of sugar factory effluents

Properties Unit = mgl^{-1} Except pH	Uttar Pradesh			Maharashtra	Gujarat
	Valchand nagar	Aligarh	Buland Saber	Ambergaon	Bardoli
pH	7.9	7.9	8.1	4.8	7.9
BOD	550-715	368	560	800-1000	85
COD	-	712	1096	1280	298
TDS	-	356	970	1160	-
TSS	58	242	416	200	230
SO_4	528	120	95	-	290
Total N	-	0.6 (NH_4.N)	8.0	-	19
Total P	25	0.4	0.35	-	8.7
Total K	-	24	43	-	92
	Chatterjee et al., 1975	Ajmal & Khan, 1983	Ajmal & Khan, 1983	Karmarkar & Kanawada, 1986	Raman & Zalawadia, 1997

(B) Other Effluents: Among the different effluents Total Suspended Solids (TSS) is the major constraint in cotton mill effluent (Table-3). High content of Cr in tannery, Zn in Zinc-smelter and high BOD and TDS in soap factory effluents are the limiting parameters for using them as irrigation water. The effluents from paper mills, urea, pharmaceutical and vegetable ghee factories seem to be less hazardous.

Textile effluent had high pH and EC while the effluent in steel factory was acidic and high EC. Dissolved oxygen was absent in steel effluent whereas it was highest in textile unit. The chemical oxygen demand (COD) and total dissolved solids (TDS) were high in textile factory effluents and above the permissible limits (Table-4). The anaerobic swine lagoon effluent have water soluble P and inorganic N (NH4+ + NO3-) comprise the greatest proportion of total N and P concentration, indicating that swine effluent is chemically similar to commercial fertilizer. An effluent quality survey from 17 different factories of Surat and Valsad districts (Table-5) indicated that the sugar and paper factories effluents pose fewer problems for use as irrigation water.

Table-3. Product wise chemical composition of effluents

Properties	Cotton mill	Urea factory	Tannery effluents	Pharmaceutical factory	Vegetable	Soap factory	Zinc smelter	Paper mill
pH	6.5-9.5	8.9	-	7.8	7.8	1.83	3.2-8.8	7.6-8.9
EC (dsm^{-1})	NIL	0.3	-	0.72	-	-	2.9-7.7	2.2
BOD (mg/l)	80-720	-	-	-	560	1656	-	187
COD (mg/l)	800-952	-	-	-	736	2113	-	1181
TDS (mg/l)	-	-	-	-	2100	9880	-	-
TSS (mg/l)	2180-3600	25	-	-	300	984	-	148
Na (mg/l)	475-941	5	147.2	-	-	-	88-800	18.3
Total –N (mg/l)	-	35	89.6	14.10	22	178	-	-
Total – P (mg/l)	-	-	5.16	5.30	3	13	0.24 - 50.9	-
Total –K (mg/l)	-	-	78	11.0	10	25	4-20.0	0.4
Zn (mg/l)	-	-	4.67	0.33	-	-	59.8	-
Cr (mg/l)	-	-	9.0	-	-	-	-	-
	Jhala et al., 1981	Bahirat et al. ,1989	Pande, 1987	Singh et al., 1995	Ajmal & Khan, 1984a	Ajmal & Khan, 1984b	Totawat, 1991	Palaniswami & Ramulu, 1994

Table-4. Chemical characteristics of different effluents

Characteristics	Textile effluent	Steel effluent	Swine effluent
pH	9.5	1.4	79
EC (dSm^{-1})	4.3	7.86	-
TSS ($mg\ L^{-1}$)	2000	3500	2.9
DO ($mg\ L^{-1}$)	12.80	Nil	-
COD ($mg\ L^{-1}$)	300	74830	-
K ($mg\ L^{-1}$)	40	3	364
NH_4-N ($mg\ L^{-1}$)	0.03	0.02	335
PO_4-P ($mg\ L^{-1}$)	16.39	4.23	62
Cu ($mg\ L^{-1}$)	Nil	91	0.054
Fe ($mg\ L^{-1}$)	Trace	320	0.336
Mn ($mg\ L^{-1}$)	Nil	280	0.672
Zn ($mg\ L^{-1}$)	Nil	375	0.336
	Singh and Bhati (2005)		Adeli et al., (2008)

IMPACT OF INDUSTRIES ON WATER AND SOIL POLLUTION

An attempt is made here to present the impact of industries on pollution of surface and groundwater as well as soil through some references.

Surface water pollution: A study reported by Joseph (1989), showed that in the Tungbhudra water near Gwalior Rayon Silk Manufacturing Unit, The pollution load depends upon the nearness to the factory. The Dissolved Oxygen (DO) got reduced at the mixing point from the value of upper stream and again increases at the down stream. On the contrary, COD values were within permissible limit both the up and down streams while point. Though, Zn content was found to be higher at the mixing point. Chromium could be detected only at the mixing point and it was below detectable limit at the up and down streams (Table-6).

Table-5. Physico-chemical characteristics of the effluent waters of different factories of South Gujarat

Sr. no	Type of factory	pH	EC (dS/m)	BOD (mg/l)	COD (mg/l)	Total N (mg/l)	Total P (mg/l)	Total K (mg/l)
1	Textile-1	8.1	3.4	180	405	16	2.2	4
2	Textile-2	10.4	4.2	165	225	27	3.8	27
3	Textile-3	9.1	1.9	16	60	31	4.4	4
4	Papermill-1	6.1	2.1	65	170	33	2.8	16
5	Papermill-2	6.1	0.9	138	418	37	3.5	18
6	Sugar factory	7.9	1.8	85	298	19	8.7	92
7	Sugar distillery	7.2	29.0	2500	6000	1200	900	6681
8	Pharmaceutical Ind.	9.0	1.9	233	442	18	3.6	23
9	Chemical fcat-1	7.7	11.6	7	20	32	14.3	11
10	Chemical fcat-2	4.6	52	70	320	10	1.9	34
11	Electroplating	8.9	2.2	11	31	-	1.2	4
12	Metal strip	7.4	3.1	4	30	-	-	-
13	Rubber factory	9.9	2.5	11	31	29	4.4	6
14	Oil product	8.8	6.0	310	870	24	2.4	11
15	Dairy Ind.	8.7	0.9	760	240	47	8.9	15
16	Rice mill	7.6	2.7	1700	4200	180	29.8	267
17	Dying factory	9.5	6.5	310	960	65	50.8	9
18	Plastic factory	9.3	1.8	1300	3	7	1.2	5

Zalawadia and Raman (1999)

Table-6. Characteristics of surface water of the Tungabhadra river (Near Gwalior Rayon Silk manufacturing unit)

Properties	Station-1 US	Station-3 D	Station-5 DS
Dissolve Oxygen (ppm)	6.4	3.0	6.8
pH	7.2	7.0	7.1
Alkali (ppm)	110	340	160
COD (ppm)	18	370	32
TSS (ppm)	NA	78	NA
Zn (ppm)	40	2300	100
Cr (ppm)	BDL	80	BDL

US=Upper stream BDL= Below Detectable Level Joseph (1989)
D=Mixing point
DS=Down stream

Table-7. Ground water composition of the well adjoin the effluent* carrying stream.

properties	Effluent Water	Location (lateral distance in meter)		
		I (100-180)	II (40-210)	III (40-100)
pH	8.7	8.60	8.60	8.80
EC (dSm^{-1})	5.4	4.33	4.75	3.35
Zn (ppm)	7.0	1.90	1.20	5.0
Fe (ppm)	0.90	0.40	0.30	0.40
SO_4 (ppm)	3000	3099	3223	1923
F (ppm)	6.60	3.6	3.0	2.0
Cl (ppm)	480	390	376	335

*Zinc smelter Totawat (1993)

Table- 8. Effect of continuous flow of paper factory effluent in a channel on adjoining soils

Soil properties	Distance from the channel (m)				
	0	7.5	15	22.5	30
EC (dSm^{-1})	13.9	0.61	0.88	0.71	0.70
O. C. (mg kg^{-1})	5.9	0.63	0.9	0.86	0.85
Avai. N (kg ha^{-1})	213	235	274	263	260
Avai. P (kg ha^{-1})	4.66	5.09	6.73	8.40	8.45
Avai. K (kg ha^{-1})	205	243	288	325	337
Avai. Mn (mg ha^{-1})	11.4	11.5	10.6	7.1	6.7
Urease*	28.4	32.8	41.0	35.7	36.4

*Urease activity expressed as μg of NH_3 liberated per gram per 24 hours Palaniswami and Ramulu (1994)

Table-9. Effect of effluent irrigation on soil properties

Properties	After 15 years
pH	7.8
EC (dSm^{-1})	1.5
Org.C (%)	0.4
$CaCO_3$ (%)	1.7
Available nutrient (kg ha^{-1})	
N	243
P	12.9
K	328
Available micronutrient (ppm)	
Fe	20.1
Mn	23.6
Zn	2.9
Cu	0.5
Urease activity*	33.40
Acid phosphorus **	123.5
Alkaline phosphatase*	88.9

* = mg of NH_4 liberated/ kg in 24 hrs. Palaniswami and Ramulu (1994)

** = mg of p-nitrophenol released/kg/hrs.

Ground water pollution: Effect of Zn smelters effluent stream on the groundwater pollution was surveyed by Totawat at three longitudinal viz. 100- 180 m (I), 40 210 m (II) and 40 -100 (III). The data indicated that the waters at all the locations were polluted as Zn, SO4, Cl and F levels were above the permissible limit. (Table-7). As contrary, Palaniswami and Ramulu (1994) reported that most of the salts and micronutrients of the continuous flow of paper mill effluent in earthen channel have not moved more than a short distance from the site of channel (Table-8).

Soil pollution: Not all the effluent are pollutants. Some factory effluents may be used for irrigation purpose. In Tamilnadu, farmers were using paper mill effluents for 15 year in about 650 blocks. At the end of 15 years not much change was observed in the soil characteristics except increase in Fe content (Table-9).

EFFECT OF INDUSTRIAL EFFLUENTS ON CROP PRODUCTION

Considering the limitations of various technologies in achieving adequate treatment of the effluent before its discharge into the water courses, the application of effluent on land as irrigation water as well as source of plant nutrients offers a promising alternative. The results of Chatteerjee et al. (2003) showed that addition of paper mill and distillery effluents to the soils significantly increased the growth and yield of rice crops at IARI, New Delhi. Addition of effluents to the soil enhanced the availability of nitrogen, phosphorus and potassium (Table-10). In a field experiment conducted by Bahirat et al. (1989) at Maharashtra where a urea factory effluent was applied to clayey soil on N concentration basis, a curvilinear response was observed in grain yield of rice crop (Fig.-1).

Table-10.Effect of effluent treatment on yield of rice (Var. CSR 10)

Treatments	Test weight (g)	Grain yield (g pot^{-1})	Biomass yield (g pot^{-1})
Control	18.0	16.1	72.5
50% paper mill	22.0	16.8	76.8
20% distillery	22.4	17.5	79.3
50% paper mill + 20% distillery	22.8	18.0	83.4
25% paper mill + 20% distillery	22.3	17.3	79.8
CD (p=0.05)	0.4	0.5	1.3

Chatterjee et al., (2003)

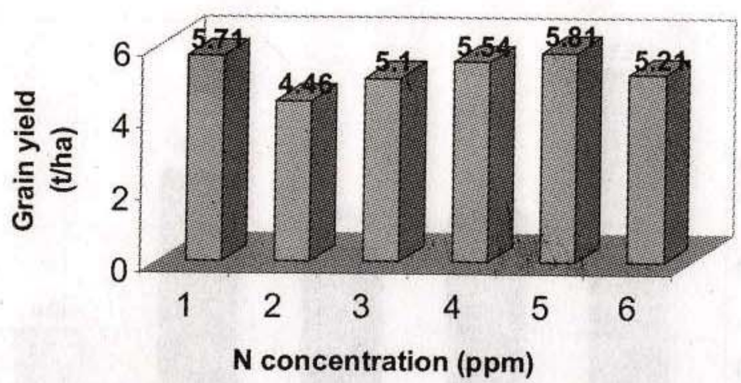
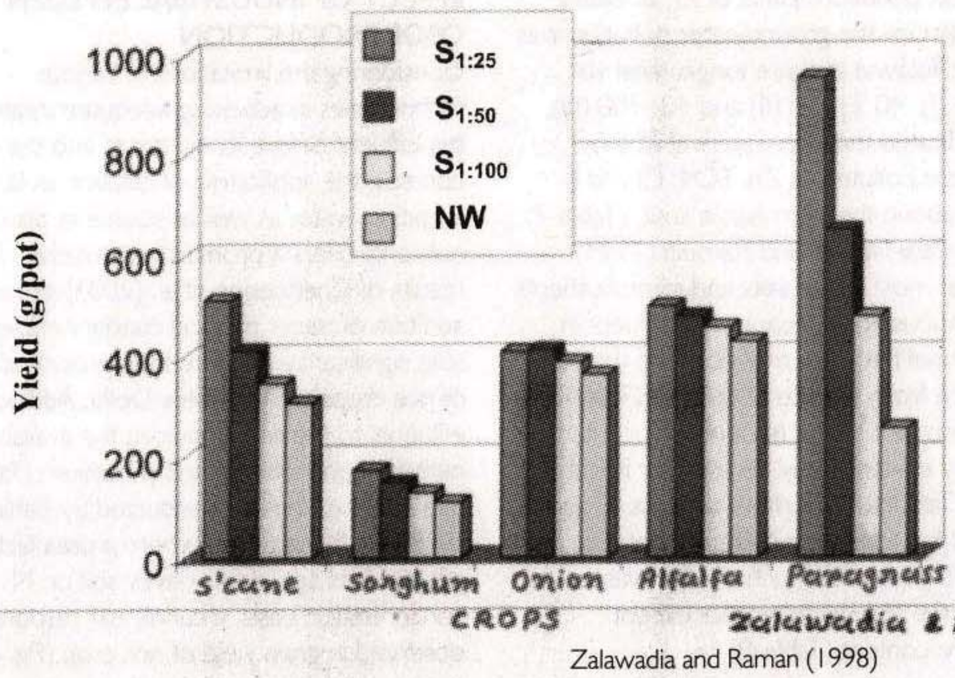


Fig.-1. Effect of urea factory effluents on paddy yield

Bahirat et al., (1989)

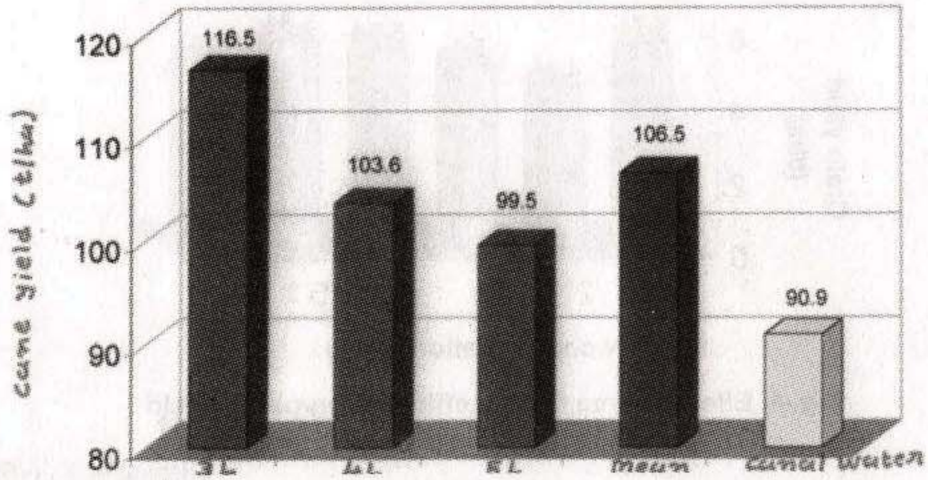


Zalawadia and Raman (1998)

Fig. 2 Effect of diluted spent wash on crop yield

In the heavy clayey soil of South Gujarat, Zalawadia and Raman (1998) showed a considerable variation in the response of sugarcane, sorghum, onion, alfalfa and paragrass to the application of spent wash at varying dilutions. With an exception of onion, there was regular increased in the yield with decreased in the dilution of spent wash (Fig.-2). The results of four years (1986-87 to 1989-90) of experimentation at Chalthan sugar factory have clearly shown the beneficial effect of 50 times diluted spent wash application on cane yield (Raman and Zalawadia, 1997). The mean increase in cane yield was of the order of 17.4 per cent with diluted spent wash irrigated crop over the canal irrigated one (Fig.-3). Zalawadia et al., (1997) reported that the total biomass production of sugarcane was found to increase in the proportion of spent wash application through irrigation water in comparison to the channel water (Table-11).

A field experiment was conducted by Singh et al. (1995) at Rishikes (U. P.), to explore the possibility of pharmaceutical factory effluent for irrigation and to study there effects on the fodder



Navsari

Raman and Zalawadia (1997)

Fig. 3. Mean sugarcane yield (t/ha) due to spent wash application (1986 87 to 1989-90)

Table-11. Effect of irrigation with diluted spent wash on biomass yield of sugarcane crop

Treatment	Yield of biomass (g/pot)	
	Fresh	Dry
S_0	578.6	209.9
S_{25}	849.8	276.9
S_{50}	717.8	244.3
S_{100}	635.0	228.0
SEM ±	10.2	3.9
CD (p=0.05)	31.7	11.7

Zalawadia et al., (1997)

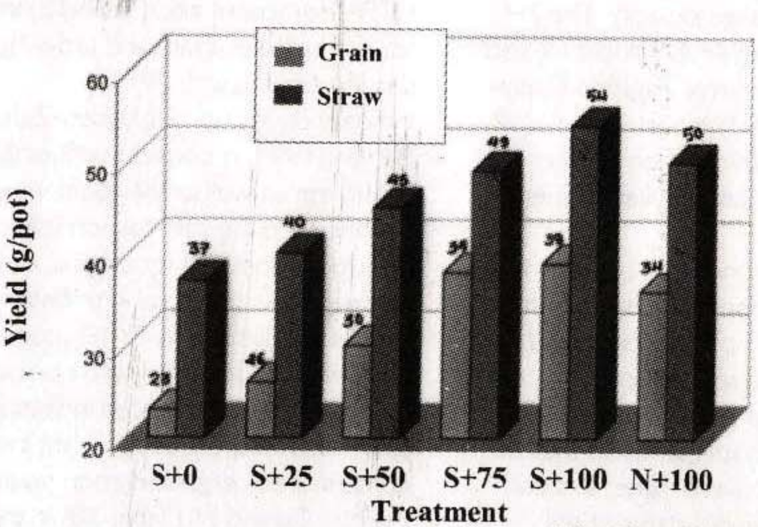
Table-12. Effect of effluent water with fertilizer levels on fodder yield of cereal crops

Fertilizer levels (kg ha^{-1})	Sorghum (q/ha)		Maize (q/ha)	
	Tube well	IDPL effluent	Tube well	IDPL effluent
$N_0P_0K_0$	57	122	33	90
$N_0P_{60}K_{40}$	71	163	42	87
$N_{50}P_{60}K_{40}$	95	132	63	76
$N_{100}P_{60}K_{40}$	100	172	90	74
$N_{150}P_{60}K_{40}$	158	72	82	94
CD at 5%	Water	27.1	Water	27.3
	Fertilizer	24.3	Fertilizer	23.2
	W x F	NS	W x F	11.8

IDPL- Indian Drugs and Pharmaceutical Ltd

Singh et al., (1995)

yield with and without fertilizers. In both the cases, the yield of maize and sorghum crops was significantly higher with pharmaceutical factory effluent over tube well water irrigation. The results indicated that in sorghum, 75 per cent substitution can be made and it was to the tune of 50 per cent in maize crop (Table-12). Zalawadia and Raman (1994) observed that 100 per cent of the recommended fertilizer application with normal water irrigation yielded .- statistically same as 75 per cent recommended dose of fertilizer application with distillery waste water irrigation. Thus, the use of effluent water has clearly indicated that 25 per cent of the fertilizer nutrient can be saved in this way (Fig.-4). The zinc content in seed of wheat and gram crop (Table-13) significantly increases with increasing concentration of zinc smelter effluent in sandy loam soils of Udaipur (Totawat, 1991).



Zalawadia and Raman (1994)

Fig. 4. Effect of spent wash with fertilizer levels on sorghum crops

Table-13. Effect of Zinc smelter effluent on the zinc content in seed and stover of wheat and gram (mg kg^{-1})

Zinc smelter effluent diluted with water	Wheat		Gram	
	Seed	Stover	Seed	Stover
I_1- 0:1	69.3	47.8	89.5	111.0
I_2- 1:1	92.5	58.3	96.5	137.0
I_3- 2:1	104.0	74.0	114.5	153.0
CD (p=0.05)	7.5	8.65	4.6	18.80

Udaipur (Rajsthan) Totawat (1991)

Table-14. Effect of fertilizer factory effluent on soil properties (after harvest of corn crop)

Conc. (%) effluent	pH	EC dSm^{-1}	CEC (meq/kg)	Available nutrients in soil (mg/kg)			
				N	P	K	Ca
0	7.1	0.512	127	106	213	128	23
2.5	7.2	0.520	132	138	213	127	27
5.0	7.4	0.532	141	180	210	127	32
10.0	7.6*	0.564*	167*	216*	215	125	41*
25.0	7.9*	0.598*	190*	252*	214	126	49*
50.0	8.3*	0.635*	231*	297*	214	125	59*

*significantly different from control at $P< 0.05$ Singh (1999)

EFFECT OF INDUSTRIAL EFFLUENT ON SOIL PROPERTIES

Results emanating from the study of Singh (1999) showed that addition of fertilizer factory effluent to the soil significantly improved the availability of nitrogen and cation exchange capacity. The pH and EC value observed higher in effluent treated soil as compared to the normal irrigation (Table-14). Chatterjee et al. (2003) reported that N, P and K availability and organic carbon content were enhanced by paper and distillery effluent irrigation (Table-15).

A Field experiment was conducted by Singh and Bhati (2005) at the Arid Forest Research Institute, Jodhpur to monitor the impact of textile and steel effluents on the change in soil properties. Addition of textile effluent positively improved available P and K status in soil, whereas the Fe, Mn, Zn and Cu contents were higher in steel effluent treated soil over initial status of soil (Table-16). Adeli et al. (2008) observed higher values of pH, EC and available N, P and K content in long term swine effluent treated soil compared with the non-irrigated soils (Table-17). When irrigated with smelter's diluted effluent, there was a several hundredfold increased in the DTPA-extractable zinc (Table-18) in the surface soil under maize-gram and urd-wheat cropping sequences (Totawat, 1991).

In heavy clayey soil of Navsari, Zalawadia and Raman (1994) reported that the different levels of fertilizer as well as the spent wash water did not influence the soil reaction values while electrolyte conductivity, organic carbon, available nitrogen, phosphorus and potassium were affected significantly, with the usage of effluent water when compared with normal water (Table-19). With increased in concentration of spent wash there was significant increased in content of soil organic carbon, available N, P, S, Fe, Mn, Cu and Ni (Table-20) in the soil over normal water irrigated soil after harvesting of sugarcane (Zalawadia et al., 1997).

Table-15. Effect of effluent treatment on soil pH, EC and organic carbon (%) (After harvest of rice)

Treat.	O.C (%)	pH	EC (dSm^{-1})	Avai. N (mg kg^{-1})	Avai. P_2O_5 (mg kg^{-1})	Avai. K_2O (mg kg^{-1})
Control	0.46	7.96	0.44	63.69	10.32	140.00
50% paper mill	0.52	8.01	0.49	68.46	11.76	152.50
20% distillery	0.47	8.11	0.48	70.00	12.01	210.00
50% paper mill + 20% distillery	0.63	8.23	0.59	75.77	13.87	222.00
25% paper mill + 20% distillery	0.56	8.16	0.54	71.49	12.29	217.20
CD (p=0.05)	0.01	0.05	0.02	2.12	0.53	4.78

Chatteriee et al., (2003)

Table-16. Average soil physico-chemical properties under tree seedling irrigated with effluent waters (E. Camaldulensis tree).

Soil properties	Initial status	Textile effluent	Steel effluents
pH	7.60	8.86	4.50
EC (dSm^{-1})	0.65	3.82	0.25
NH_4-N (mg L^{-1})	6.00	4.14	2.80
PO_4-P (mg L^{-1})	5.00	12.50	4.20
K (mg L^{-1})	0.08	0.20	0.06
Mn (mg L^{-1})	3.30	3.20	135.5
Fe (mg L^{-1})	2.36	2.23	190.5
Cu (mg L^{-1})	0.26	0.16	45.62
Zn (mg L^{-1})	0.57	0.50	90.52

Note: ANOVA indicated significant variation due to effluent treatment over initial status of soil

Singh and Bhati (2005)

Table-17. Effect of swine effluent on soil properties

Soil type	Soil physico-chemical properties						
	pH	EC μScm^{-1}	K	P	NO_3^-	Cu	Zn
			---mg kg^{-1}---				
Non irrigated soil sites							
Brooksville	4.68	92.5	0.15	17.4	10.7	0.94	0.92
Okolona	6.82	458	0.19	15.0	13.2	0.64	1.77
Vaiden	4.10	92.8	0.16	10.1	9.2	0.58	1.57
CD 5 %	1.3	0.11	0.08	3.4	1.8	0.44	0.18
Swine effluent irrigated soil sites							
Brooksville	5.93	424	1.01	67.8	37.2	2.3	2.0
Okolona	7.39	510	0.18	7.4	17.4	2.6	1.9
Vaiden	4.52	401	1.20	48.5	27.4	2.3	3.6
CD 5 %	0.42	0.03	0.50	7.1	4.3	0.2	0.6

Adeli et al., (2008)

Table-18. Effect of zinc smelter's effluent on the Zn content in the soil under varying cropping sequences

Zinc smelter effluent diluted with well water	DTPA- extractable Zn (ppm) in soil			
	Maize-Gram		Urd-Wheat	
	0-15 cm	15-60 cm	0-15 cm	15-60 cm
I_1- 0:1	5.0	1.9	5.1	2.0
I_2- 1:1	18.3	3.5	23.2	3.9
I_3- 2:1	22.1	3.6	12.3	3.9
CD (p=0.05)	7.2	1.7	14.84	0.57

Udaipur (Raisthan)

Totawat (1991)

Table–19. Effect of spent wash on soil properties after harvest of sorghum

Treatments	EC(dS/m))	pH	OC (%)	N (ppm)	P (ppm)	K (ppm)
SW + 0	1.25	8.2	0.67	267	7.80	1346
SW + 25% RD	1.34	8.2	0.72	284	9.52	1512
SW +50 % RD	1.48	8.1	0.73	314	10.55	1608
SW + 75% RD	1.56	8.1	0.76	363	12.54	1678
SW + 100% RD	1.59	8.1	0.80	405	13.78	1738
Normal Water + 100% RD	0.54	8.3	0.58	367	12.43	603
CD at 5%	0.23	NS	0.9	12	0.59	101

Navsari — Zalawadia and Raman (1994)

Soil type=Typic chromustert

Table-20. Effect of diluted spent wash application on soil characteristics after harvest of the sugarcane crop

Soil properties	Spent wash diluted with water				
	S_0	S_{25}	S_{50}	S_{100}	CD (p=0.05)
pH (1:2.5)	8.18	7.63	7.85	7.93	NS
EC (dSm^{-1})	1.05	2.06	1.75	1.23	0.14
O.C. ($g\ kg^{-1}$)	6.4	9.8	8.7	7.7	0.50
N ($mg\ kg^{-1}$)	123	240	188	174	16
P ($mg\ kg^{-1}$)	5.08	10.18	8.14	6.26	1.31
K (C mol (p^+) kg^{-1})	0.80	3.46	2.03	1.52	0.16
Fe ($mg\ kg^{-1}$)	29.4	41.3	36.5	33.5	4.90
Mn ($mg\ kg^{-1}$)	66.2	85.5	81.9	75.1	5.80
Zn ($mg\ kg^{-1}$)	0.63	1.73	1.33	0.84	0.10
Cu ($mg\ kg^{-1}$)	4.13	6.98	5.60	4.62	0.25
Pb ($mg\ kg^{-1}$)	0.98	1.22	1.11	1.05	NS
Ni ($mg\ kg^{-1}$)	1.03	1.64	1.46	1.25	0.16

* Spent wash 0, 25, 50 and 100 times diluted with water — Zalawadia et al., (1997)

Soil and water management project, Navsari Agril. Uni. Navsari (Gujarat)

Kundu et al. (2001) conducted an investigation to study the effect of soil application of post-methanated spent wash on urea hydrolysis rates and urease activity in a Typic Haplustert soil at Indian Institute of Soil Science, Bhopal. The results indicated that the application of 2.5, 5.0 and 10.0 ha-cm of spent wash to the soil 37 days before sampling showed 46.1, 63.3 and 98.0 per cent increased in urease activity over control (Table-21). The magnitude of increase in urease activity due to easily oxidizable C added to the soil through spent wash might have resulted in the increased microbial activity vis-a-vis urease activity in soil. The long term swine effluent application increases microbial biomass C by 12, 23 and 55 per cent at the 0-5cm depth compared with non-irrigated plots in Brooksville, Okolona and Vaiden soils, respectively (Adeli et al., 2008). Soil microbial biomass N followed the same pattern as microbial biomass C (Table-22.)

Table-21. Urease activity of the soil as affected by the rate and time of spent wash application

Treat.	EC (dSm^{-1})	O.C. (%)	Urease activity (mg urea kg ha^{-1})
T_1- 2.5 ha-cm of spent wash applied 37 days	0.52	5.61	77.00
T_2- 2.5 ha-cm of spent wash applied 22 days	2.30	6.13	115.4
T_3- 2.5 ha-cm of spent wash applied 7 days	2.50	6.54	106.6
T_4- 10 ha-cm spent wash applied 37 days	4.90	8.36	95.9
T_5- 10 ha-cm spent wash applied 22 days	6.20	10.73	156.5
T_6- 10 ha-cm spent wash applied 7 days	6.50	11.41	137.0
CD (p=0.05)	0.77	0.56	9.5

Indian institute of Soil Science Bhopal

Kundu et al., (2001)

Table-22. Effect of swine lagoon effluent application on soil C and N concentration in the top 5 cm soil

Soil type	Non irrigated		Irrigated	
	MBC (mg kg^{-1})	MBN (mg kg^{-1})	MBC (mg kg^{-1})	MBN (mg kg^{-1})
Brooksville	330	51.8	370	95.6
Okolona	639	58.4	489	88.4
Vaiden	429	50.5	665	62.4
$LSD_{(0.05)}$	26.2	2.7	38.7	6.2

MBC= microbial biomass C

MBN= microbial biomass N

Adeli et al., (2008)

FUTURE STRATEGIES

- Careful waste water irrigation schedule must be done for different crops, keeping in view the nitrogen requirement of crops.
- Stringent quality control measure will have to be enforced on agricultural produce particularly the vegetables, raised with waste water in order to avoid health hazards to consumers.
- Scientific and accurate analysis of waste water should be carried out for the chemical, physical and biological composition, before use of such waters for irrigation and other agricultural purposes.
- More research efforts are needed to ascertain the long term impact of waste water irrigation on soil and crops.

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AIR POLLUTION: SOURCES AND CONSEQUENCES

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Riight from the beginning of the civilization humans have been consciously or unconsciously instrumental in the deterioration of their environment there are number of significant dates in the history of air pollution occurrences in the world. One of the first recorded event was about in 1300 AD, when King Edward-I issued a proclamation prohibiting the use of sea coal during sessions of the English parliament . The first paper on the health effects of air pollution was presented in 1866 and in 1875 cattle deaths in London were shown to be due to an air pollution episode. In the early 1900's the smog began to be used and since then a number of disastrous air pollution episodes occurred in the world (Rao and Rao, 1999). The details of which are given as under:

Some Major Air Pollution Episodes of the World

S.No	Months and Year	Place	Mortality
1	December, 1930	Meuse Valley (Belgium)	63
2	October, 1948	Donora (Pansylvania)	20
3	November, 1950	Poza Rica (Mexico)	22
4	December, 1950	London (England)	1000
5	December, 1952	London (England)	4000
6	November, 1953	New York (USA)	220
7	January, 1956	London (England)	1000
8	December, 1957	London (England)	750
9	December, 1962	London (England)	700
10	January, 1963	New York (USA)	300
11	November, 1966	New York (USA)	168
12	December, 1984	Bhopal (India)	2000

Human population is the main source of pollution as more people will create more sewage, solid wastes and will use more food, fuel, fertilizers, chemicals and automobiles (cars, vans, trucks, scooters etc.). Environmentalists are of the opinion that rapid industrialization , deforestation, oil spillage, exploitation of natural resources, unplanned construction of roads, houses, drains and human population are the key factors for environmental pollution in this universe. The adverse effects of large scale deforestation, destruction of ozone layer and climate change are progressively becoming the subjects of concern, debate and controversy today.

The main atmospheric pollutants are gases like CO2, CO, SO2, H2S, 03 liquid droplets of sulphuric acid and nitric acids, heavy metals, mists, dust and soot particles.

Source of air Pollution

(i) Thermal Power Plants: The coal based Thermal power plants are the main source of SO2 Cox, NOx and flyash.

(ii)Fertilizer Complexes: The fertilizer complexes releases oxides of N and dust particles whose size ranges from submicron to 1000 microns. Dust particles may be evolved from the process as drying, burning, grinding, screening, mixing, conveying or packaging. The major sources of dust emission can be listed in table 2

iii) Sulphur acid industry and other industries: The Industries producing sulphuric acid either by contact process or by lead chamber process discharge large quantities of SO2 in the air pollute the atmosphere upto a few kilometers.

iv) Cement Industries and Brick Kiln: The cement dust is common air pollution around cement factories and construction sites; chemically it is a mixture of Calcium, Aluminum, Potassium, Silica and Sodium etc. Brick kiln coal also emit various gases and fly ash into the atmosphere.

v) Automobiles: With the growing trend of having different types of automobiles, their number has also increased to an alarming extent. In major cities and townships of the world the air pollution is now mainly related with the emission from different types of vehicles. The chief air pollutants in the vehicular emission are NOX, SoX, CoX and hydrocarbons.

Table-2

S.No	Product	Dust emitting Particles
1	Urea	Urea dust from milling towers
2	Ammonia	Coal and Coke dust
3	Ammonium Sulphate	i) Sulphur and pyrite dust(ii) Gypsum dust
4	Calcium ammonium nitrate	Lime Stone and product dust
5	Phosphate fertilizers	i) Pyrite and sulphur ii) Rock Phosphate
6	Mixed fertilizer	i) product dust due to the granulation process

Table: 3 gives approximate emission from various Combustibles

	EMISSIONS			
Fuel	Particulates (kg/ton)	SO2 (Kg/ton)	NOX (kg/ton)	Remarks
Fire wood	31	20	4	Highest in particulates
Coals	5-25	6-150	7-9	Emission very widely depending on ash content
Oil	1-3	6-76	3-13	
LPG	0.38	0.0002	2-1	Cleanes fuels for stationery system
Natural Gas	0.30	0.2	2-12	
Mobile Systems				
Petrol	2	0.54	7.5-10	—
Diesel	2.4	5-6	11	

Source: Kudesia, V.P.2002

Impacts of Air Pollution on Plants

-:- Forms of Damage to leaves

i) Chlorosis: Loss of green pigments in the plants
2) Necrosis: Killing or collapse of tissues
3) Abscission: Dropping of leaves
4) Epinasty: Downward curvature of leaves

-:- Kinds of Injury to Plants

Acute Injury : It results from short time
Chronic Injury: It results from long term low level exposure and usually causes chlorosis or leaf abscissions .
Growth or Yield reductions: Due to the impact of various air pollutants the growth and yield of plant has been reported to get decreased for example in West Bengal it has been reported that air pollution caused a financial loss of Rs 38 crores to various sectors (Rao & Rao, 1999). According to the study the loss to agriculture is Rs. 11 crores annually. Corossion of metals cost Rs. 5 crores, medical expense for the affected people accounts for Rs. 6.75 crores, damage and repair of building Rs 2 crores, damage to textiles, Rs. 5 crores and laundary charges Rs. 3 crores.
Impact of Air Pollution on Human Health

1. Many air pollutants cause irritation of eyes, Nose and throat.
2. Gases like H2S, NH3 and mercaptons cause odour nuisance even at low concentration.
3. Increase in mortality rate and morbidity rate.
4. Bronchitis and asthma aggravates by high cone of SO2 and NO2
5. CO combines with the haemoglobin in blood and consequently increases stress on those suffering from cardiovascular and pulmonary diseases.
6. HF causes disease of bone (flurosin) and mottling of teeth.
7. Dust particles from cement factories and brick kilns etc. cause severe respiratory ailments.
8. Heavy metals may enter the body and cause damage to various vital organs

Air pollution problems in Kashmir Valley

The air quality of Kashmir valley which was thought to be soothing, refreshing as well as spiritually inspirational has deteriorated to an alarming level in the recent past. The known anthropogenic sources of air pollution in the valley are, automobiles, brick kilns, cement factories, stone crushers, burning of timber in chullahs and coal in hard coke stoves, burning of garbage and fallen leaves, bomb blasts, firing and land mines, etc. Apart from this, there are some natural pollutants such as allergic pollen particularly in spring season, the dispersal of cottony/feathery seeds of populus (from late April to ending May) and natural dust due to wind storms etc.

Air pollution due to Automobiles

According to recent estimates (Greater Kashmir dated 12-06-2004) Srinagar city has recorded 160% increase in the vehicular traffic during the past decade. The data reveals that about 46510 diesel run commercial vehicles, 23224 non-commercial vehicles and 6000 two wheelers stand registered in Kashmir province till January, 2004. Further on an average (according to 2003 estimates) about 821672 tourist vehicles and goods carriers are plying annually on different routes of Kashmir valley. The concentration of Suspended Particulate Matter (SPM), Nitrogen Oxides (NOx) and Respirable Suspended Particulate Matter (RSPM) recorded at different polluted sites of Srinagar city is given in table 4 and 5.
The data reveals that SPM (ug/m-3) level at Athwajan was recorded as 651 ug/m-3 in the year 2001 which is much higher than the WHO standards. Such SPM concentrations in the air environment is likely to cause various respiratory ailments in human beings particularly in infants, school going children and old aged persons. The higher SPM concentrations in the air are mainly due to two reasons (i) dilapidated conditions of the roads, (ii) inferior fuel and old engines operating in the automobiles. The use of plants as monitors of air pollution has long been established and this concept has been backed by the proponents of "green belt" as an aid in protecting urban environment from pollution.

The role of vegetation as scavengers of many air borne particulates from the atmosphere can not be underestimated. However the ornamental species planted on the road side for aesthetic purposes should be screened for their pollution absorbing capacity so that better sinks could be recommended for plantation along the roads in this direction.

About nine tree species of Kashmir Himalayas where screened for their relative response to vehicular pollution (Lone & Khan 2007a,b) and it was found that Platinus orientalis suffered least reductions in polluted atmosphere followed by Morus serrata, Populus alba, Salix alba, Ficus carica, Ulmus wallichiana,Robinia psuedoacacia and Celtis australis.

Environmental Degradation due to Brick Kilns

The brick kilns are mostly operational in district Budgam of Kashmir valley, though district Pulwama and Anantnag too have a scanty number of these units in certain areas. In district Budgam about 103 kilns are operational scattered in various villages of the region. Some of the prominent villages with number of operating brick kilns are: Nassarullah Pora (12); Batpora, Chandapora and Patli Bagh (12), Sumarbugh Shalina (20), Gudasut (15), Chattergam (8), Sangam (6), Hee Wudar (6), Waterwani, Dadina (6), Bogam(2)Chadoora (2), Sholipora (4), Gondipora and Beerwah (8-10). These kilns producing indigenous bricks remain operational from May-October every year depending upon weather conditions. Rain in May is likely to delay the manufacturing process and dry warm summer is usually beneficial for the kiln owners for which approximately 135 tons of coal is used in one season. It has been estimated that during operational season 62.5 kg of coal is being burnt in one minute in district Budgam emanating noxious gases (viz., SO2, Nox, CO2, CO), fly ash and soot. Moreover about 25 tons of timber mostly of Robbinia psuedoaccia is used by each kiln is an additional supportive fuel for coal burning in one season. In addition each klin utilizes 50 litres of kerosene and litres of petrol per day.

The brick kilns also play an important role in the deterioration of our land resources. It has been estimated about 50-100 kanals of land are under

TABLE-4 Concentration of SPM and NOx (ug/m^{-3}) at different polluted sites of Srinagar city (Estimate based on eight hourly observation from june-oct,2001)

S.No	Site	SPM (ug/m^{-3})	NOx (ug/m^{-3})	Area class
1	Athwajan	651	42.0	Commercial area
2	Jahangir Chowk	391	46.0	Commercial other area
3	Tourist Reception Centre	366	32.0	-do-
4	Iddghah	328	15.0	-do-
5	Lal Chowk	300	35.5	-do-
6	Nehru Park	251	14.0	-do-
7	Hazratbal	227	-	Residential area
8	Zewan	217	42.0	Commercial area
9	Botancial Garden	177	4.0	Commercial other area
10	Zakoora	176	5.0	-do-
11	Jawahar Nagar	136	10.0	Residential area
12	Khunmoh	128	11.0	Commercial other area
13	Bagi Ali Mardan	121	6.6	Residential
14.	Zainakoot	96	3.0	Commercial area

Source: State Pollution Control Board Rajbagh Srinagar.

Table-5. Concentration of Suspended Particulate Matter (SPM) and Respirable Suspended Particulate Matter (RSPM) at different polluted sites of Srinagar city (Estimation based on 5-6 hourly observations from 18-9- 2002 to 27-9-2002

S.NO	Site	Area Class	SPM Ug/m $^{3)}$	RSPM (ug/m ^{3})
1	Athwajan	Commercial area	494	127
2	Jahangir Chowk	Commercial area	391	146
3	Hazratbal (KU)	Residential area	227	49
4	Jawhar Nagar	-do-	175	72
5	SKIMS Soura	Commercial other area	152	62
6	Zainakoot	Industrial area	148	60
7	Nehru Park	Commercial other area	113	28

Source: Member Secretary, SPB, Communication No. DIPK-NB-1365 Published in Daily Alsafa on 10-10-2002

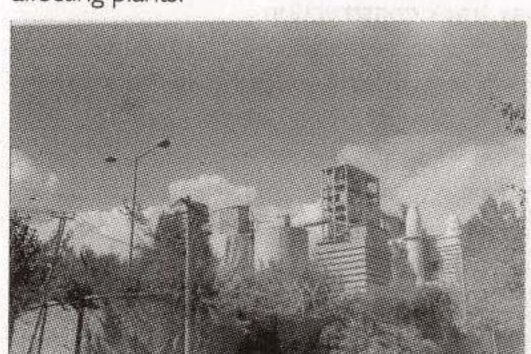
the occupation of each kiln and for establishing one brick-kiln about 50-5000 small and big trees are being chopped off after every 3-4 years. These make shift brick kiln are operational on karewa lands where intensive soil digging not only results in the formation of ugly burrows in the land but also deprives us of the natural land resources for ever. A stretch of 1 kanal of land (4 inches thick) yields 28,000 bricks in utilizing about 5210 kanals of top soil (4inch thick) for making 15 crore of bricks in one season.

Though the role of brick kiln in the developmental works by way of providing necessary raw material in the form of bricks has its own positive economic dimensions, the environmental degradation at the same time can not also be ruled out.

The karewa lands are known for determining the micro-environment of a particular place in general and that of our valley in particular as they act as natural barriers for winds and also support a varied proportion of different floristic, faunal and microbial species. Their ruthless degradation by way of digging soil and the loss of aesthetics is irrepairable and devastating for the generations to come. Various noxious gases coming out from tall chimneys have rather no further exit from the valley environment due to the presence of high mountain peaks. These gases at high altitude undergo condensation with clouds due to temperature prevailing at such sites, thus can prove harmful to the aquatic ecosystem of the valley which is beyond the scope of discussion.

Cement dust pollution

The cement industry is one of the basic industries on which the industrial development of a country depends.Cement is the most widely used building material throughout the world and in India both production and consumption has increased in recent years. In Kashmir valley also there is a great potential to produce sufficient cement and presently several factories are in operation in the areas like Khrew, Wuyan (district Pulwama) and Khunmoh (district Srinagar). These factories release an enormous amount of cement dust in the atmosphere causing severe ecological damage to all life forms including flora, fauna and humans. The dust settles on the vegetation in the form of hard crust blocking stomata and bringing about changes in the morphology and physiology of the various metabolic processes. Since plants are being constantly exposed to the environment, they absorb and accumulate pollutants on the foliar surfaces. Consequently they undergo changes which if properly quantified can serve as measure of pollution level affecting plants.



Cement factory at Khrew (district Pulwama)

Deposition of cement dust on Ailanthus altissima

According to recent estimates (Lone, 2005) the dust fall measured at a distance of 1 and 2 km from the Khrew cement factory (district Pulwama) has been found to be 2.08 and 1.19 g/m-2 day-1 respectively. The dust coming out of the plants has virtually transformed the entire agricultural land (near the vicinity of the factory) into baren land.

It has also been observed that around such sites, saffron, the most prized crop of Kashmir valley is the worst victim and has suffered to a large extent in terms of its production as well as its physio-morphological parameters (Lone, 2005). Significant losses have been reported in its length and biomass of the stigma (saffron of commerce). Further higher reductions in the yield have also been reported in the fields situated nearer the factory experiencing more dust fall. Zargar et al.,(1999) have also reported significant reductions in height, number of leaves and biomass of Brassica oleracea affected by cement dust. On the basis of these reports it is highly desirable that more research should be carried out so as to quantity the losses with respect to other crops in relation to cement dust pollution.

Railway track construction

The laying of railway track from Qazi Gund to Baramulla though could be attributed to a step in the developmental process of the State has significantly deteriorated the environmental quality of the valley in general. Most of the soil used for filling the railway track has been obtained from the ruthless digging of karewas. Such a practice has resulted in the loss of top soil, eco-degradation of biodiversity besides creating ugly and shabby topographical changes all over the valley. During transportation huge amount of dust goes in the atmosphere. The worst sufferers are the people residing near the railway tack. The losses due to chopping off of age old trees might lead to genetic erosion hardly to be compensated in future. A significant proposition of agro-horticultural land has been utilized for this project thereby depleting the valley's viable production land which has been further reduced by uncontrolled urbanization.

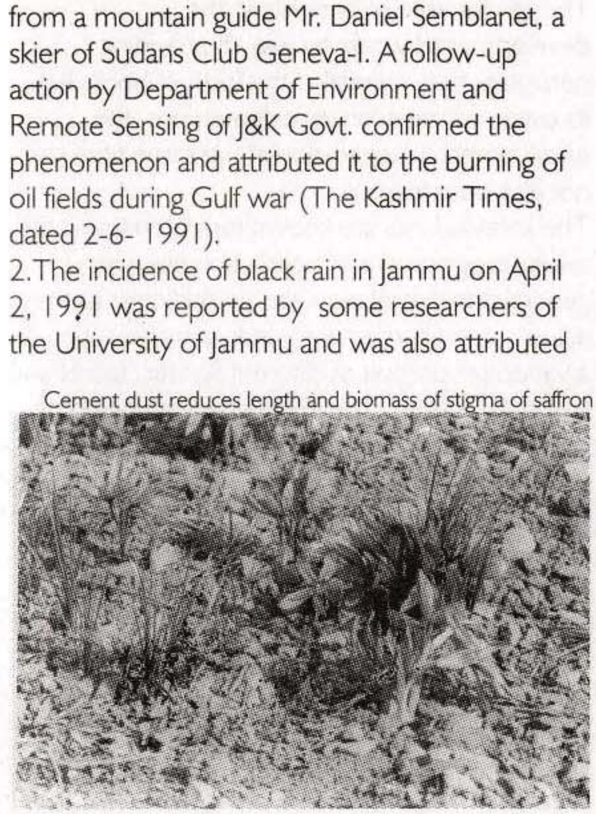
Mystery of Muddy/black precipitations in Kashmir valley

Kashmir valley in the recent past has witnessed some unique environmental manifestations in the form of black/muddy precipitations which spectacularly attracted the attention of common people, media and environmentalists etc. While as some believed that it is the wrath of Almighty Allah on Kashmiri people, the others could however understand and perceive the scientific reasons behind such happenings. These environmental manifestations are briefly discussed as under (Lone and Khan, 2004).

1. A report about the occurrence of "Black Snow" on the mountain peaks of Gund Songmarg (Kashmir) in local print media on 30th March, 1991 came for the first time from a mountain guide Mr. Daniel Semblanet, a skier of Sudans Club Geneva-I. A follow-up action by Department of Environment and Remote Sensing of J&K Govt. confirmed the phenomenon and attributed it to the burning of oil fields during Gulf war (The Kashmir Times, dated 2-6- 1991).

2. The incidence of black rain in Jammu on April 2, 1991 was reported by some researchers of the University of Jammu and was also attributed

Cement dust reduces length and biomass of stigma of saffron



to fall out of Gulf war (The Kashmir Times, dated 2-6,1991).

3. Showers of muddy rains were witnessed in different regions of the Kashmir valley on 28th April, 2002; in the intervening night of 30th April and May Ist, 2003; on April 20th, 2004; 7th April, 2005 and 29th May, 2005 (Personal observation).

4. Muddy snow was also observed during May 2002 on the Afarwat Glacier of Pir Panjal range surrounding Gulmarg (studies carried out by Lone and Khan, 2004b).

5. A dust storm swept different areas of Kashmir valley especially in Srinagar, Pulwama, Budgam, Baramulla and Kupwara on 4th May, 2003. The entire atmosphere seemed laden with dust from 08.20 hrs in the morning upto 18.30 hr. The dust fall estimated in the Shalimar Campus, SKUAST-K was 0.116 x 10-6 kg m-2 sec-1. A thick crust of dust was deposited on the foliage of the vegetation building roofs, vehicles and the surface waters. Reportedly, many people complained of eye and throat infection. The origin of dust storm was speculated to be in the northern States of India; on the basis of the fact that such dust storms were simultaneously observed to prevail in Rajasthan, Punjab and Delhi.

Regarding the origin of dust it is speculated that the clouds loaded with particulate matter might have travelled from some northern States of India with south westerly monsoon winds or from northern countries including Pakistan, Iran, Iraq and Afghanistan .After reaching higher peaks, the contaminated cloud droplets (crystals) condense due to the low temperature usually prevailing at higher altitudes.

It is also speculated that the dust emission from cement factories/brick kiln operating in various parts of the valley could be another source of these muddy precipitations. Since the Kashmir valley is surrounded by mountains, there are little chances of suspended particulate matter undergoing dispersion to far off place. Such unique physiographic characteristics renders Kashmir Himalayan valley more susceptible to ravages of changing environmental scenario.

Management Practices

-:- Tall trees should be planted in rows around industrial complexes like cement factories and brick kiln which shall act as natural sinks for various gases and particulate pollutants and thereby shall not allow the pollutants to dissipate to far off places.

-:- Cement factories should be fitted with modern equipment like Electrostatic precipitators so that emission of the dust from the chimneys is minimized.

-:- The traditional practice of making bricks by using clay and subsequent processing them in coal fired chimney should be shifted to modern technique like making hollow bricks made of sand & cement.

-:- To minimse the vehicular pollution, all the vehicles should be run on CNG rather than petrol and diesel, since CNG is more energy efficient as well as less polluting.

-:- Roads should be planted with Avenue trees which can act as natural sinks for the various types of pollutants.

Utilization of Agricultural Solid Wastes for Soil Amendments

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Introduction

Food security of India remains at risk due to continued population growth, stagnation in farm level productivity in intensive farming areas and globalization poverty, low income, under nourishment and gradual deterioration of agri-environments. Despite frequent surplus food stocks in recent times, there is a need to produce more. This additional quantity will have to be produced from same or even shrinking land due to increasing competition for land, water and other resources by non-agricultural sector. National Academy of Agricultural Sciences (1997) projected that 30-35 Mt of fertilizer nutrient would be required to meet food grain demand by 2020. Demand will stretch by almost 15 Mt it requirements of horticultural crops, thus managing the total NPK requirement at least 45 Mt. The all India fertilizer nutrient demand projections for food grain production targets during 10th and 11th five year plans are given in Table-1.

The greatest challenges facing mankind in the 21st centaury is to produce the basic necessities of food, feed, fuel and raw materials from 0.14 ha or less land per caput, while the use of mineral fertilizers is the quickest and surest way of boosting crop production, their cost and other constraints frequently deter farmers from using them in recommended quantities and in balanced proportions. As a consequence of this and other constraints there seems to be no option but to fully exploit potential alternatives sources of plant nutrients.

Indiscriminate use of chemical fertilizers and pesticides for maximization of yield has created several problems, which are associated with the soil health, crop management and the environment. The necessity of having an alternative agriculture method, which can function in an eco-friendly method in sustaining and increasing the crop productivity is realized now. It is a system, which encompasses the natural resources i.e. agricultural solid wastes

Table-1 All India demand projections of fertilizer nutrients ('000 tonnes)

Tenth Five Year Plan (2002-07)	N	P_2O_5	K_2O	Total
2002-03	12297	5505	1864	19666
2003-04	12718	5907	1948	20573
2004-05	13116	6277	2026	21419
2005-06	13514	6646	2104	2264
2006-07	13923	7027	2183	23133
Eleventh five Year Plan 2011-12)				
2007-08	14347	7432	2266	24045
2008-09	14783	7855	2351	24989
2009-10	15231	8303	2441	25975
2010-11	15693	8780	2534	27007
2011-12	16171	9284	2630	28085

Source: Fertilizer Statistics 2000-01, FAI, New Delhi utilization for maintaining the soil health including quality and fertility.

Concept

India has become self reliant in food production after independence, thanks to the green revolution technology Undoubtedly India is proud of it's 'Green Revolution", since if enabled a nearly four fold increase in food production in the last fifty years But this achievement has been followed by browning and loud protests concerning the environmental effects. Projected population, food grain production, consumption, fertilizer use by the end of the 11th plan pose a great challenge for the policy- makers, scientists, industry and farmers (Table-2).

occurrence of sulphur and micronutrient deficiencies. Thus, conservation and efficient use of natural resources such as organics through agricultural wastes are the means to achieve sustainable high yields in food and nutritional security as well as environmental safety. Some projections on availability of organic resources for agriculture in India during 2000-25 are given in Table-3.

As estimated, about 25% of the nutrient needs of Indian agriculture can be met by utilizing various organic resources (Table-4).

Table-2 Projected population, food grains production, consumption, and input use by the end of the 11th plan (2011-12)

Items	2011-12
Population, M	1,196.4
Per capita food grain consumption, kg	223.4
Food grains, Mt	337.3
Rice Mt	128.2
Wheat Mt	130.4
Course cereals Mt	48.9
Pulses Mt	29.8
Oilseeds Mt	58.6
Sugarcane Mt	679.6
Net area sown, M ha	142.0
Gross area sown, M ha	219.2
gross irrigated area, M ha	105.5

Source: IX th Five year plan, Planning Commission, GOI, New Delhi

Of late, there is a increasing realization among scientists, farmers and administrators that the system is unsustainable and there is every likelihood of decline in soil health and environment, if we don't take urgent steps to remedy the situation. The excessive use of fertilizers and insufficient use of organics has led to a decrease in soil fertility and health. Agricultural chemicals including pesticides, hormones and antibiotics leave residues in soil that eventually get into the food chain causing the health and environmental problem Fertilizer nutrient costs are increasing day by day beyond small and marginal farmers are detrimental effects posed by imbalanced use of fertilizers. The continued high analysis NPK fertilizer has led to

Availability of Agricultural Solid Wastes:

The success of organic agriculture depends upon the development and the integration of various activities of farm in a way that availability of organic resources for recycling nutrients is not a constraint. Organic material are valuable by products of farming and allied industries, derived from plant and animal resources. The importance of agricultural solids wastes in general and agro-industrial wastes in particular has been recognized during the recent years.

Organic Resources:

India has vast potential of major manurial resources

Table 3: Some projections on the availability of organic resources for agriculture in India during 2000-2025

Generators	2000	2010	2025
Human population (Million)	1,000	1,120	1,300
Livestock population (million)	498	537	596
Food grain Production(million t)	230	264	316
Nutrients (theoretical potential)[1]			
Human excreta (million t$N+P_2O_5+K_2O$)	2.00	2.24	2.60
Livestock dung (Million t $N+P_2O_5+K_2O$)	6.64	7.00	7.54
Crop residues (million t $N+P_2O_5+K_2O$)	0.21	7.10	20.27
Nutrient (Considered tapable)[2]			
Human excreta (million t $N+P_2O_5+K_2O$)	1.60	1.80	2.10
Livestock dung (million t $N+P_2O_5+K_2O$)	2.00	2.10	2.26
Crop residues (million t $N+P_2O_5+K_2O$)	2.05	2.34	3.30
Total	5.05	6.24	7.75

1. All data pertaining to nutrients in dung and in residues are counted twice to the extent these are fed to the animals
2. Tapable = 30% of dung 80% of excreta, 33% of crop residues

Source: Tandon (1997)

Table-4 Organic sources required to meet 25% of India's nutrient in 2000 and 2050

Resource	2000	2050
FYM (Mt)	200	400
Crop residues (Mt)	30	50
Urban/Rural wastes (Mt)	10	15
GM (Mt)	25	50

Source: Tandon (1997)

1. Live Stock Wastes:
   -:- Cattle-shed wastes such as cattle and buffalo dung (FYM and compost)
   -:- Other Live stock
2. Crop Residues, Tree wastes and Aquatic weeds:
   -:- Crop Waste of cereals, pulses and oilseeds (wheat, paddy, bajra, jowar, gram, moong , urd, cow pea, pigeon pea, lentil, groundnut and linseed).
   -:- Stalks of corn, cotton, coffee, tobacco, sugarcane, trash leaves of cotton, jut, water hyacinth and forest litter.
3. Green Manure:
   Sunhemp, dhaicha, cluster beans, senji, cowpea, horse gram and berseem.
4. Agro-Industrial Products:
   -:- Oil cakes
   -:- Paddy husk and bran
   -:- Bagasse and press mud
   -:- Fruit and Vegetable Wastes
   -:- Cotton wool and silk wastes
   -:- Tea and tobacco wastes
   -:- Marine algae and sea weeds
   -:- Fruit, Vegetables produce and plantation crop wastes
   -:- Fermentation Industry wastes

Potential of Agricultural Solid Wastes

Farm Yard Manure (FYM):

It is an important source of plant nutrients FYM is composed of dung urine, bedding and straw FYM contains approximately 5-6 kg N, 1.5-2 kg phosphorus and 5-6 kg potash ton-1. It builds up the soil health considerably. It is obvious from the Table-5 that BD, total Porosity, Organic carbon available N and P of soil are affected by the application of FYM and augment the soil fertility status of the soil.

N ratio was reduced to 14.1 and 12.0 during 1st month and 2nd month after inoculation, respectively.

Green Manuring :

Green manuring with leguminous crops is a well accepted practice for augmenting nutrient supply, particularly with the nitrogen and organic matter, under the use of agricultural solid wastes, the practice is widely utilized for not only improving the nutrient and organic matter supply, but also a

Table -5 Physical and chemical Properties of the surface soil as affected by FYM

Nutrient sources	BD (Mg m^{-3})	Total Porosity (%)	Organic carbon (%)	Available N ($Kgha^{-1}$)	Available P ($Kgha^{-1}$)
Control	1.41	46.79	0.98	35.80	19.30
FYM @ 500 g/plant	1.28	51.70	1.05	42.70	25.70
VC@200 g/plant + FYM @250 g/plant	1.24	53.21	1.21	43.10	25.90
CD 5%	0.006	1.65	0.005	6.05	5.75
Initial	1.38	47.90	1.05	42.10	23.40

Source: Chaudhary et al. (2003)

Compost

Compost manures are the decayed refuse likes leaves, twigs, roots, stubble, bhusa, crop residue and hedge clippings, street, refuse collected in towns and villages, water hyacinth, saw-dust and bagasse. A large number of soil micro-organisms feed on these wastes and convert it into well-rotted manure The final product is known as compost.

Low-Cost Technology for Enrichment of Compost

Recent experiments conducted at IARI have shown that inoculation with Azotobacter chroococcum and phosphate solubillising microorganism improved the manorial value of compost. The results indicated that 31.5 per cent carbon was decomposed in control during the first month whereas, the loss in different treatments ranged between 33.3 to 41.5 per cent. This was further increased during second month showing maximum loss of 52.4 per cent of organic carbon in rock phosphate, and P-solubiliser inoculated series. In this treatment C

to manage weeds and pests. Improvements in soil properties and productivity due to the incorporation of green manure crops are observed in soils under the different agro-ecological zones. The most commonly grown green manure crops are sesbania aculeata (Dhaicha) and Crotolaria juncea (Sunhemp) having the potential to provide 4-5 t ha-1 of try biomass and 80-100 kg of N ha -1 within 50-60 days of plant growth (Table-6). This also amends the Soil health by incorporating its carbonaceous materials Thus soil health is augmented as a result of decomposition of cellulolytic materials.

Data presented in Table-7 indicate that the physico-chemical properties of soils changed after incorporation of green manure in soil, it improves the soil organic carbon and available nutrients like nitrogen, calcium and magnesium etc. The application of GM and various organic manures are very useful practice for reclamation of salts affected soils. Besides source of plant nutrients produced favorable effects on soil physical properties. It counteracts the unfavorable

Table 6: Addition of plant nutrients through green manuring

Crops	Average yield of GM Mt ha^{-1}	N%	N added (kg ha^{-1})
Sunhemp	9.96	0.48	75.0
Dhaicha	9.40	0.42	68.9
Green Gram	3.76	0.53	34.6
Cowpea	7.05	0.49	50.4
Guar	9.40	0.34	55.0
Berseen	7.29	0.43	54.0

Table-7 Changes in Soil Physico-chemical properties of the experimental soil after cropping

Cropping	Organic carbon (%)		available nitrogen (Kgha^{-1})		Ca (%)		Mg (%)	
Alley Cropping	BC	AC	BC	AC	BC	AC	BC	AC
Green leaf manuring	0.36	0.75	182	410	0.89	1.05	0.42	0.55
No green leaf manuring	0.36	0.78	182	385	0.85	0.98	0.39	0.48
Sole Cropping								
Green leaf manuring	0.28	0.74	180	378	0.81	0.96	0.39	0.47
No green leaf manuring	0.38	0.65	180	321	0.76	0.96	0.37	0.47

effects of ex-changeable sodium. Decomposition of organic materials improves soil permeability and bacteria present in it. It increases stable aggregates.

Oil-Cakes

Oilseeds are generally rich in manurial ingredients after oil extractions; the oil cakes are rich in nitrogen and also contain phosphorus and potash. The percentage of nitrogen ranges from 2.5 in mahua to 7.9 decorticated safflower cakes. The P2O5 contents in oil cakes vary from 0.8 to 3% and K2O from 1.2 to 2.2 per cent Oil cakes need to be well powered before application so that they can be spread evenly and are easily decomposed by micro organism. They can be applied quite in advance of sowing time. Oil-cakes are more effective in moist soil and in wet germinating seeds or young plants as they become permeated with fungi and molds in the soil.

The use of oil-cakes on food grain crops like wheat and rice is not recommended now on economic grounds. Cake, especially ground-nut and coconut, are extensively applied for top dressing of sugar-cane crop. Farmers growing betel leaves also use oil-cakes.

Mahua-cake is the poorest of oil-cakes with a nitrogen content of 2.5 per cent and has been found to be much less effective than other even when applied in larger quantities. The efficiency of the manure can be increased by moistening, it and allowing it to ferment for sometime to decompose the toxic substances. An effective treatment worked out at the IARI involves treatment of enables the original nitrogen to be effectively mineralized and utilized by plants.

Water Hyacinth:

Water hyacinth (***Eighhornia crassipes***) is a free floating weed plant which grows luxuriantly in ponds, lakes and water reservoirs. It is estimated that total acreage under this weed is about 292,000 ha in Bengal, Bihar, Assam, Eastern UP, Andhra Pradesh, Tamil Nadu, Orissa and Kerala. The adverse effects of such uncontrolled growth on agriculture, fisheries, transport and human health are obvious and the necessity for its collection and consequent disposal are needed.

Source of Mulch and Manure:
Water hyacinth can be used as soil mulch, green manure and compost. Recently attempts have been made to use water hyacinth for biogas production without loss of plant nutrients. Water hyacinth is used as mulch in tea gardens during dry season for conservation of soil moisture and regulation of temperature.

Forest-litter Manure:
It is estimated that about 15 million tonnes of compost can be obtained from forest litter annually without in any way adversely affecting the natural regeneration of the forests. If a portion or the surface litter is removed in a regular manner, the manurial value of forest-litter is as good as from compost. Fifteen million tonnes of forest litter manure may contain 0.075, 0.03 and 0.075 million tonnes of N, P_2O_5 and K_2O, respectively. At present, however, considerable amount of leaf litter is burnt and huge quantities of plant nutrients allowed to go waste.

Garbage
It is household wastes, road sweeping and vegetables market wastes and all other dry wastes from shops and offices etc. Application of city garbage has resulted into beneficial effect in improving the yield of many crops besides improving soil properties. It decreases bulk density, WHC increases from 70 to 150%. Compost of garbage provides slow release N for several years after application. More than 80% garbage is indigestible. Compost from city garbage contains 0.8%N, 0.3% P_2O_5 and 1.5% K_2O with the garbage collection of 12 mt from Indian cities every year. It is possible to progress 4 to 4.3 mt compost containing 32000 t N, 12000 t P_2O_5 and 60000 K_2O for the use as manure in agriculture.
Effect of Organic manures on Soil Properties:
It is well known that organic manures influence physical, chemical and biological properties of the soil.

Physical Effects:
It is the humus fraction which improves the soil physical condition. The addition of compost improves soil structure, texture and tilth. The better soil structure provides better environment for root development and aeration. The water holding capacity of the soil increases as compared to soil receiving no manure which provides protection to the crops against drought.
Compost has been found to be very useful in control of soil erosion. Several studies on the impact of organic manures on improvement in soil structure were reviewed. Aggregation is quite often improved which is attributed to the action of gum compounds, polysacharides and fulvic acid component of organic matter. The type of organic material, the rate and frequency of application are important determinants in this respect.

Chemical Effects:
Organic manures add nutrients to the soil thus reducing total dependence on fertilizers which involve greater energy / expense. The humic substances increase P availability as they have a very high cation exchange capacity. Humus enhances the utilization of fertilizer nutrients by plants and helps in reducing leaching losses by promoting greater water retention

Biological Effects:
Organic manures contain a very large population of bacteria, actinomycetes and fungi. Through them not only millions of microorganisms are added but those already present in the soil are stimulated by the fresh supply of humic material. The application of organics helps the microorganisms to which build up better soil structure N-fixation and P-solubilisation is also increased due to improved microbiological activity in organic matter-amended soil Besides, the above effects, role of compost in the control of plant nematodes and in mitigating the toxic effect of pesticides have been adequately documented.

Benefits of added organic matter:

-:- Improves tilth, condition, and structure of soil, providing better aeration and temperatures
-:- Supports living soil-organisms

-:- Improves ability of soil to hold water and nutrients
-:- Helps dissolve mineral form of nutrients
-:- Buffers soil from chemical imbalances
-:- Maintains a steady supply of plant nutrients
-:- May contribute some degree of biological control of certain soil pests
-:- Helps recycle organic wastes, thus keeping them out of landfills and waterways
-:- Cheap energy source, replacing manufactured nitrogen

Crop residues recycling as soil amendment:
Crop residues are the plant parts or crop remains left after-harvesting and or processing of the produce. These are tremendous natural resources having diverse effect on soil quality Nearly 355 million tonnes (Table-8) of crop residues are annually available in India of which 180 million tonnes can be utilized to supply 3.54 m tonnes of plant nutrients.

Table-8 Crop residues available for utilization in India

Crops	Total available crop residues (Mt)	Crop residue available for utilization (Mt)	Total NPK (Mt)	Nutrient potential available for utilization (Mt)
Rice	119.2	39.7	2.59	0.86
Wheat	93.9	31.3	1.71	0.57
Sorghum	19.9	6.6	0.41	0.14
Sugarcane	28.0	28.0	0.52	0.52
All pulses	17.9	6.0	0.59	0.19
Others	76.7	58.3	1.62	0.76
Total	355.6	169.9	7.44	3.54

Source : Hegde and sudhakarbabu (2001)

Rice, wheat and sugarcane are potential crops which ensure availability of large amount of crop residues. Crop residue in rice and wheat crops as such is not the problems, however, in the event of mechanization; large amount of crop residues is left in the field during the course of harvesting and needs to be properly managed. A good sugarcane crop, leaves about 6-8 t ha-1 of trash. A rice and wheat crops in sequence leave about 10 - 12 t ha-1 of crops residues in the mechanically harvested field. These residues can be used as fuel, feed or recycled as compost or used as mulch or incorporated in soil or removed and used for industrial purpose. Burning of crop residues is another practice to quickly dispose the crop residues. However, it is wasteful practice as there is loss of nutrients apart from environmental pollution.

Crop residues and soil quality:

Physical quality

Crop residues act as perfect cover and may protect soil or land from being physically degraded through wind/water erosion. It was observed that incorporation of sugarcane trash and mustard straw improved the soil physical conditions in terms of low bulk density, more pore space and water holding capacity in acid clay soils of Palampur. It is reported that crop residues @ 2.0 t ha-1 applied as mulch reduced soil loss by 75% through wind erosion in arid conditions and incorporation of rice and wheat residues in soil led to lowering of bulk density from 1.4 g cc-1 in residue removed plot to 1.44 g cc-1 in residues incorporated plot and increased infiltration rate for 37.1 mm ha-1 in residue removed plot to 39.4 mm ha-1 in residue incorporated plot. Das et al. (2001) reported that incorporation of wheat and rice straw @ 5 t ha-1

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Table 9 Effect of residue management for seven years in rice- wheat rotation on chemical properties of a sandy loam soil

Treatment	pH	Bulk density ($g\ cc^{-1}$)		Hydraulic conductivity ($cm\ hr^{-1}$)	Water holding capacity (%)	OM (%)
No residue	5.5	1.43	1.53	9.58	36.76	1.21
Wheat Straw ($5t\ ha^{-1}$)	5.4	1.34	1.44	11.66	50.60	1.47
Rice residue ($5t\ ha^{-1}$)	5.5	1.33	1.49	11.99	51.06	1.47
CD (P=005)	NS	0.03	0.02	0.59	3.07	0.04

Source : Das et al (2001)

lowered soil bulk density, improved hydraulic conductivity, water holding capacity and organic matter content of the soil.

Chemical quality:

Incorporation of residues in rice - wheat crop sequence improved soil organic matter from 0.43 to 0.48%. From long term experiment on rice-wheat crop residues management concluded that residue incorporation improved OC, available N, P, K over residue removed or burned (Table-10).

Burning of residue led in complete loss of nitrogen, 20% loss of P, 20% loss of K and 90% loss of S. It may not be prudent, therefore, to burn the huge quantities of crop residue which could otherwise be converted to value added manures like; co-composting of poultry litter/manure, Phospho-compost etc or other with bio-degradable wastes effective methods to conserve the nutrients for commercialization of indigenous organic residue for the organic farming (Table-11).

Biological quality

Crop residues have tremendous effect on soil biological health. Study of the effect of crop residues on microbial population observed that fungal, bacterial population and soil water content decreased immediately after residues burning. It is observed that earthworm population increased from 0.3 to 1.8 million ha-1 when banana leaves were used as mulch. Studies made at IISR, Lucknow revealed that sugarcane trash used as mulch exhibited higher soil microbial population (Table 12).

Crop yield

Crop yield is another important index of soil health. Several workers indicated that incorporation of crop residues improved the crop growth and yield of both rice and wheat crops grown in sequence (Table-13).

Table 10: Effect of residue management for seven years in rice- wheat rotation on chemical properties of a sandy loam soil

Parameters	Residues		
	Incorporated	Removed	Burnt
pH	7.7	7.6	7.6
EC ($mmhos\ cm^{-1}$)	0.18	0.13	0.13
Organic C (%)	0.75	0.59	0.69
Available N (ppm)	154	139	143
Available P (ppm)	45	38	32
Available K (ppm)	85	56	77
Total N (ppm)	2501	2002	1725
Total P (ppm)	1346	924	858
Total K (ppm)	40480	34540	38280

Table 11: Composition of manures prepared from Co-composting of Poultry litter with rice straw

Treatments	N (%)	C/N ratio	Total mineral N (ppm)	Total P2O5 (%)	Citrate soluble (P) (g kg^{-1})
T_1: Poultry waste (PW)	1.85	12.05	2.15	2.55	17.03
T_2: PW + Rock Phosphate (12.5% W/W) + Pyrites (10% W/W)	2.46	16.00	4.95	4.95	13.21
T_3: PW + Rice residue + Water hyacinth 1:0.5:0.5 ratio)	2.0	11.80	2.75	2.75	18.0
T_4: T_3 + Rock Phosphate (12.5% W/W) + Pyrites (10 % W/W).	2.0	13.40	4.35	4.25	14.0
T_5: PW + Rice residues + Water hyacinth (1:2:2)	1.75	11.80	2.75	2.75	18.0
T_6: T3 + Rock Phosphate 12.5% W/W) + Pyrites (10% W/W)	2.15	12.50	3.50	3.25	14.19

Table 12: Effect of residue management for seven years in rice-wheat rotation on chemical properties of a sandy loam soil

Microbes	Population/ g soil	
	No trash	Trash Mulch
Bacteria	21±6	43±10
Fungi	23±4	36±10
Actinomycities	65±10	72±15
Azotobactor	4±2	25±6
Azospirilum	2±1	25±8

Source: IISR, 1995

Table 13: Effect of wheat crop residue on rice crop yield

Treatment	Rice grain yield (q ha^{-1})	
	Jorhat	**Bareilly**
No residue incorporated	23.8	4.70
Residue incorporated	28.3	51.4
CD at 5%	1.4	2.6

Limitations of crop residue incorporation:

- o Physical removal of crop residues is not cost effective.
- o Burning of crop residues leads to loss of nutrient, environment pol l ution and damage to soil bio-life.
- o Incorporation of crop residues improves soil physical, chemical and biological conditions.
- o It leads to nutrient immobilization, accumulation of toxic substance, harboring of pests, hinder in sowing / transplanting of crop.
- o Incorporation of crop residues in to deep soil layer needs use of heavy machines.
- o Residues from legume are fast decomposing and have little or no lock up period.

Agro-Industrial wastes:

Agro-industries are based not only on crops, such as rice, sugarcane, jute, tea, coffee, fruits and vegetables but also based on forest products (non-edible oilseeds, wood, lac, etc). Agro-industries wastes are available in substantial quantities at processing sites whereas, animal wastes and crop residues are available at farms and in a scattered way.

Oil Seed Industry wastes:

Major oilseeds occupy an important position in the agricultural economy and are grown in area of about 16 million hectares. Groundnut is the most important crop followed by rape-mustard, sesamum, linseed and castor Oilseed crops are essential part of human diet as well as provide important industrial raw material. Oilcakes obtained as by products are mostly used as cattle feed and manure.

Non-edible Oil cakes:

Oilcakes are the residues left after extraction of oil from oilseeds About 0.3 Mt of non edible cake is produced annually. Non-edible cakes such as neem, karanj, mahua, castor etc are used as organic fertilizer.

The manurial value of these cakes lies mainly in its nitrogen content although it contains small quantities of P2O5 and K2O. The nitrogen content varies from 3 to 9 per cent, depending on the nature of oilcake. The C N ratio is low ranging between 3 and 15 for different types of oilcakes. Due to low C N ratio its decomposition rate is faster than cereal and legume residues and other bulky organic manures. This nitrifies very quickly and about 60 to 80 per cent of its nitrogen is converted in available form within 2 to 3 months time Castor, groundnut, cottonseed, mahua, rape-seed , neem karanj oilcakes are used as organic manures. Castor cake is supposed to be good vermicide against white ants (termites). Recent investigations at IARI have shown that due to application of oilcakes to soil the population of plant parasitic nematodes was decreased.

Rice Milling Industry wastes

Rice Husk and Rice Bran:

Rice husk is the largest product of the rice milling industry comprising 20 to 25 per cent of paddy. Paddy yields about 5 to 7 per cent bran. The availability of rice husk is about 15 Mt annually. A typical paddy husk sample contains 42.6 per cent cellulose, 20.1 per cent lignin, 18.6 per cent pentosans and 18.7 per cent ash. It is a poor source of manure and its N content varies from 0.3 to 0.4 per cent, P2O5 0.2 to 0.3 per cent and K2O 0.3 to 0.5 per cent. There is a problem of its disposal in certain areas. It is used as fuel and for improving physical conditions of saline and alkali soils. It can be used as bedding material for animals and in composting.

Rice bran yield is about 2.5 Mt annually. It has limited scope as fertilizer since this is exploited for production of rice bran oil.

Sugar Milling Industry wastes:

The chief byproducts of sugar industry are bagasse, pith, molasses, and tillage and presumed a multi ingredient and vital source of macro and micro nutrients, matrix for microbes, source of phytosteroides, and protectinstoriodes.

Bagasse:

The fibre content of Indian sugarcane is 12 to 17 per cent and 33 per cent is bagasse About 5.3 million tonnes of dry bagasse is annual produced. The bagasse produced in the country is almost entirely used as fuel in boilers of sugar factories. Recent investigations have shown that bagasse is a valuable material for production of pulp paper, boards etc However, a portion of bagasse could be utilized as both for fuel and manure if it is processed through biogas plants. The nitrogen and P_2O_5 per cent of bagasse is approximately 0.25 per cent and 0.12 per cent and compost produced out of it will have a nitrogen of 1.4 per cent and 0.4 per cent of P_2O_5. It is estimated that about 1.4 million tonnes of organic manure per year can be produced from this by product. A pilot plant is in operation at the National Sugar Institute, Kanpur which utilizes bagasse and sugarcane trash for production of biogas. A composted fertilizer/manure is obtained within 40 to 45 days by this anaerobic process against longer period, normally required in compost pits. The approximately composition of each charge is 80 per cent cellulosic materials (bagasse), 12 per cent animal dung, 5 per cent bone meal or super-phosphate and 3 per cent calcium carbonate with moisture of about 70 per cent. The aerobic decomposition is allowed for 5 days by blowing compressed air resulting in rise of temperature to 60-800c followed by anaerobic digestion for methane production on dry basis, spent slurry contains 1.5-1.8 per cent N, 1.0-1.3 per cent P_2O_5 and 0.6-0.8 per cent K_2O. About 200 cu metre of biogas are obtained per tonnes of organic matter contained in agricultural wastes.

Pressmud:

About 3.2 m tonnes of press mud are produced annually from the sugar factories; it contains about 1.25 per cent N, 2.5 per cent of Phosphorus, 2 % K and 2.0 to 2.5 per cent organic matter. Compost prepared from press contains 1.4 per cent nitrogen and 1 to 1.5 per cent P_2O_5. Since it is very high in lime (up to 45 per cent), its application is useful in acidic soils.

Forest Mill Wastes:

Sawdust:

The total of sawdust waste in the country from saw mills and plywood manufacture is estimated about 2.2 million tonnes. Saw mills alone account for 2.0 million tonnes of sawdust, It has a wide C N ratio material (500:1) low in nitrogen (0.11 per cent) and also low in phosphate (0.20 per cent). It has limited scope to use as such as fertilizers, although some investigations have shown that it can be used as organic manure in tropical soils. Dried sawdust has good liquid absorbing capacity and can absorb 2-4 times more moisture than cereals straw/residues. Thus, it can be used as a good absorbent for soaking urine in cattle sheds and as bedding materials for cattle which can be composted and converted in valuable organic manure. Its value as mulching material and for control of parastic nematodes has also been recently reported.

Vegetable and Fruit processing Industry wastes:

Vegetable and fruit wastes:

India produces around 33 million tonnes of fruit and 50 million tonnes of vegetable annually. It is estimated that roughly 10 to 15 % of total produce is available either as residues or bio-degradable wastes for recycling in agriculture. In addition, the processing of fruits and vegetable results in production of around 5 million tonnes of solid wastes. Most of these wastes are lignocellulosic in nature and contain macro and micro-nutrients. If we manage the waste of plantation crops, it will provide 165 thousand tonnes of $N+P_2O_5+K_2O$ which will definitely provide help for using indigenous materials for maintaining sustainable agriculture. There is a wide scope for utilization of these wastes as fertilizer. The total quantity available from this industry is more than 25,000 tonnes from mango, pineapple, citrus fruits, apples, green peas, tomato etc annually. It is estimated that about 10,000 tonnes of compost could be produced out of these wastes.

Cotton Mill Wastes

Cotton Wastes/Byproducts:

Cotton is an important commercial fibre crop of India. The present area under the crop is about 8 million hectares and production is about 6.5 million bales, valued at about rupees 800 crores. The main products of cottonseed are oilcake or meal, linters and hulls Out of these, cotton oilcakes can be used as feed and fertilizer and the main wastes/byproducts arising from cotton are (1) cotton stalks, (2) cotton linters and hulls (3) cotton leaves and other plant parts (4) cotton dust, Rainfed cotton crop yields two-and-a-half tonnes of cotton-stalks per hectare and under irrigated crop the yield of cotton stalks is about 5 tonnes ha^{-1}. The necessary technology for converting it into manure should be developed.

Cotton Dust:

Cotton textile mills mainly in their blowing rooms produce a large quantity of this waste, textile mills in India are expected to produce 30-33 tonnes waste per year.

The chemical analysis of the cotton dust in per cent is given below: Moisture 8% organic matter 70, carbon 41, nitrogen 1.4, P_2O_5 0.6, K_2O 1.2 and pH 6.2. This material is ideally suited for composting and application to soils. The waste has plant nutrients (NPK) in greater proportion than routine city refuse. Its CN ratio is ideal for composting. One tonne of raw material is estimated to give 0.6 to 0.7 tonne of finished compost.

Tea Industry:

During the course of tea production, processing and storage, about 10 million kg of tea waste becomes available in the form of fluffs, stalks and sweepings. It is an important for extraction of coffein. The decaffeinated tea wastes can be used as manure or an animal feed. Spent tea waste has 0.28 to 3.5 per cent N, 0.4 per cent P_2O_5 and 1.5 per cent K_2O with C N ratio of 9 to 11.

Tobacco Wastes and Tobacco Seed-cake:

It is estimated that out of total of about 62,000 tonnes of such waste available annually, nearly 41,000 tones are used for manurial purposes. The tobacco wastes used for manuring contain 0.5 to 1.0 per cent N, 0.8 per cent P_2O_5 and 0.8 K_2O. About 10,000 tonnes of tobacco seed-cake is also available for manurial purposes and it contains 4 to 4.5 per cent N, 7 to 15 per cent P_2O_5 and 5 to 5.5 per cent K_2O.

Jute Sticks:

The total quantity of jute sticks produced in India is about 2.5 Mt. It is generally used for thatching, hedging and for fuel purpose. Cellulose content of jute stick is quite high as compared to bagasse, rice and wheat straw. It may be utilized in biogas after pretreatment or by chopping it to smaller size.

Marine Algae and Sea weeds:

Marine algae and sea weeds form a good source of organic manures amounting to about 10,000 to 15,000 tonnes annually. A sea weed contains 1 to 2 per cent P_2O_5 and 2 to 7 per cent K_2O and a number of trace elements. It can be used as source of organic matter for soil amendmends.

Fermentation Industry wastes:

India has made rapid progress in the production of drugs and other chemicals through fermentation processes of different substrates. After production of useful products, the left out materials contain large amount of organic matter and mineral in solids and liquid form. It is estimated that one kg of antibiotic produced through fermentation, there is generation of around 7000 to 8000 litres of waste water with solid content ranging between 40-50 g L^{-1} and BOD load about 30000 to 60000 mg L^{-1}. For commercialization of indigenous organics i.e. fermentation Industry wastes should be used for enriching the compost or other bio-solids like crop residue and agro-industry wastes to make value addition manures.

Challenges

Collecting and transporting agricultural solid wastes poses many serious challenges. For agro-industries unable to compost their residues on-site due to limited space or resources, they need to be able to transport their materials to an independent composting facility off site. Feasibility for this depends on the haulers. Companies that haul residuals and compost need to have the right equipment, a dense route of industries located within a short distance of each other and a nearby composting facility. Composting fees need to be lower than alternative disposal options, although in many cases they are not. However, there are still limited markets and available land space for using composted materials in land application, Facilities are often forced to landfill a large percentage of the by products they composted because they have no where else to place them. Degraded soil ecosystems need organic matter supplements to stimulate microbial populations, which in turn will be able to support higher plant growth and reduce erosion from bare soils. Recycling them back into the soil directly or as compost is an effective and fairly safe way to restore soil eco-system.balance.

Conclusion

-:- Agricultural solid wastes can be used an alternative sources of fertilizers to save the national economy.

-:- Organics as agricultural solid wastes utilization improves not only its physical condition but also maintains soil health including quality and fertility.

-:- Replacement of O.M. within a soil is a means of amending degraded soils.

-:- Organics obtained from agricultural wastes stimulate microbial populations that are essential to the stability and resilience of the soil ecosystem as a whole

-:- Organics also help in soil re vegetation and erosion control.

-:- Agricultural solid wastes all provide fairly in expensive, natural and benign organic materials for soil amendments.

-:- Recycling these wastes been into the soil is an environmentally favorable alternative to land filling.

-:- These wastes help to achieve sustainable high yields in food, nutritional security and environmental safety.

-:- Mass awareness among the farmers about the significance of soil health and serious hazards resulting from the misuse and essential prerequisite.

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ASSESSMENT OF SOCIAL AND CULTURAL IMPACT OF ENVIRONMENTAL POLLUTION IN INDIA

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Introduction

Man inhabits in two worlds one is natural world of plant and animals, soils and waters, and the other one, the world of social institutions and artifacts, his tools, machines, science, technology and an environment of his dream in the direction to fulfill his materialistic purpose.

'Environment' may be defined as the sum total of all conditions and influences that affect directly or indirectly the development and life of all organisms. It includes not merely the biophysical natural environment, but also the anthropogenic physical environment as social, cultural, political, technological, economical and aesthetical environment. Thus, the environment must be conceived in a holistic manner as the sum total of all conditions and influences physical, chemical, biological, social and cultural which affects the development and life of all organisms on this planet.

"Environmental pollution' may be considered as evil of all developments of man-made modern society. 'Pollution' in broad terms refers to undesirable change in the physical, chemical and biological characteristics of air, water and soil that may or will harm our life, industrial progress, living condition and cultural assets or it may also be defined as those activities of human being, which deviate /detract from the enjoyment of environment and the ability to derive full benefit out of that. When, as a result of anthropogenic activities, enough of such substances are generated in the environment as to create harmful effects, it is called pollution. And those substances are named as 'pollutants' which aversely alter the environment by changing the healthy growth of humans / animals /organisms, interfere with health, comfort, property values, social values and cultural values of the people. Today, the cry of "environmental pollution" is heard from all the nooks and corners of the globe, and the pollution has become a major threat to the very existence of mankind on this earth.

Necessity of Impact assessment of environmental pollution:

The response of people to environmental alteration or contamination is often emotional and subjective and these reactions may carry over into political actions and policy formulations. To counteract such emotionalism, there is a special need to assess the environmental consequences of human activities using objective rigorous scientific approaches, either in predicting the potential alterations (ecological risk assessment) or in 'post-ducting' the consequences of environmental changes or accidents that have occurred (environmental risk assessment).There are three types of design by which evaluation should be done for any environmental problem. 1) Time-based design, which based on comparisons of the same sites at different times. If measurements of environmental components of interest (say, social and cultural) are made at a site before the environmental pollution occurred, these values may be compared with measurements taken at one or more times after the pollution has started.2) Spatial designs, which based on comparisons of different locations at a single time instead of making comparisons over time. Here, of course the unpolluted site is not true control and so it would be appropriate to refer to this as impact reference design. If the degree of pollution can be measured as a continuous rather than a discrete variable then use of gradient design which takes care of sampling from sites across the pollution gradient.3) Time-space design, which incorporates both temporal and spatial dimension by variation on the base line design for making these assumptions more explicit and testable one. Several sites are surveyed as initial base line of pollution; these sites are categorized by pollution levels and re-sampled after certain period under question. In this pre-post design the pre and post samples are paired for each site and the analysis conducted on differences between the time periods.

Different kinds of mathematical models are available for assessment of environmental impact on different aspects. But that being beyond the scope of the subject, author do not intends to go into details here.

Sources of Environmental pollution

The advancement of science and technology on one hand have added to the human comfort by giving us automobiles, electrical appliances, supersonic jets, spacecrafts, better medicine, better chemicals to control harmful insects and other pests etc. but on the other hand, they have given us a very serious problem to face "Pollution". Pollutants may exist in three states solid, liquid, gaseous and that too in visible and invisible form and impart multivariate adverse effect on human being particularly in urban ecosystem. Environmental pollution may be categorized into three groups a) Air or atmospheric pollution, b) Water pollution and c) Soil pollution / degradation. Pollutants, whenever found mixed in air to affect adversely the life of plants, animals and human health, we regard it a case for" air or atmospheric pollution". When water in its physical, chemical and / or biological characteristics of its quality deteriorates for balanced functioning of the aquatic ecosystem, the situation is referred to as "water or aquatic pollution ". When the resource quality of a land or soil is impaired by way of dumping solid wastes and receiving the discharge of chemicals , destruction of normal trees and bushes and putting it exposed to sun and rain and / or kept under some non- judicious use, the situations is called as " land or soil degradation / pollution.

Various kinds of air pollutants:

Primary (emitted directly from identifiable sources):

Carbon compounds--- Carbon dioxide (CO_2), Carbon monoxide (CO)

Sulphur compounds---carbonyl Sulphide (COS), carbon disulphide (CS_2), dimethyl Sulphide [$(CH_3)_2 S$}, hydrogen Sulphide (H_2S), sulphur dioxide (SO_2) and Sulphate (SO_4^{2-})

Hydrocarbons: Benzene, Benzpyrene and methane; Metals: Zinc, Cadmium, Lead, Mercury

Particulate matter

Toxic substances: Arsenic, Asbestos, Carbon tetrachloride, Beryllium, Chromium, Copper, Nickel, Polycyclic aromatic hydrocarbons

Secondary:

Ozone, Photochemical products (olefin, aldehydes, PAN etc.), PAN and Photochemical smog

(ozone, Nitric oxide ,Nitrogen dioxide , Hydrogen peroxide, organic peroxide etc.)

Natural pollutants:

Dust, temperature, forest fire, smoke, particulates, Carbon dioxide (CO_2), Carbon monoxide (CO),hydrocarbons, sulphur compounds, bacteria, fungi, viruses, etc.

Artificial pollutants:

These are mainly found in highly urbanized and industrial areas. Emissions from varying industrial/ factory chimneys, dumps of decomposing wastes, acids ,especially sulphuric(H_2SO_4) ,hydrochloric(HCl), Nitric (HNO_3), hydrofluoric(HF) & ammonia (NH_3) fumes / vapour, smokes, grit & dust, gases like, carbon dioxide (CO_2), carbon monoxide (CO), fluorine gas, particulates, sulphur dioxide (SO_2), trioxide (SO_3), hydrogen Sulphide (H_2S), nitrous oxide (N_2O), Nitric oxide (NO), Nitrogen dioxide (NO_2) and trioxide (NO_3) , hydrocarbons, fly ash heavy metals , Chromium (hexavalent) ,cyanide(as CN), Vanadium as V, Arsenic as As, suspended solids, oil and grease, Ozone (O_3) other oxidants and noise.

Stationary and mobile sources:

Single or point sources: Industrial process chimneys of all plants, factories, refineries etc. Multiplier area sources: Domestic combustions, Hospitals, hotels, institutes, commercial heating, open burning, etc.

Line sources: Highway vehicle, Trains, vessels, etc.

Arial sources: Air crafts, vehicles (light, medium and heavy duty), rail yards, locomotives etc

Carbon monoxide:

The principal sources of this gas being the exhaust products from motor vehicles as are common in busy common arterial routes in Delhi, Kolkata, other cities and charcoal fire in Kashmiri hut in India. High concentration causes

Effects of some air pollutants on human and environment

Pollutant	Sources	Effects
Carbon dioxide (CO_2)	Coal, petrol, oil, diesel combustion	Greenhouse effect
Carbon monoxide (CO)	Coal, petrol, oil, diesel limited combustion	Causing headache, drowsiness ,becomes fatal at high concentration, combining with hemoglobin deprives body of oxygen
Lead compounds	Leaded petrol in car	Slows development of neural tissue in children
Oxides of nitrogen- Nitric oxide (NO), Nitrogen dioxide (NO_2)	High temperature combustion in car , factories, industries	Causes irritation of lung tissue, enhance susceptibility to viral attack, acid rain , exacerbates asthma
sulphur dioxide (SO_2)	Coal combustion in power station, factories, industries	exacerbates asthma ,acid rain causing damage to planes, trees, buildings, lakes
Nuclear waste	Nuclear power plants, nuclear weapon testing	Radioactivity, contamination of locality, mutation, cancer, death

unconsciousness for an hour or so and may kill the person quickly at concentration above 1000 ppm. Even at concentration of 30 ppm, it may be toxic and.may cause headache and dizziness. It is estimated that this gas accounts for about half of the total air pollutants added to atmosphere in highly populated urban areas. There are reports (Purohit & Agrawal, 2004) that in the city Kolkata 450 tons of CO is discharged everyday.

Individuals working in underground garages, at loading platforms, tunnels are seriously affected by this gas. Under Indian condition, drivers of vehicles, cars, workers / laborers working under such kind of areas often get affected by this gas and require immediate medical care which leads not only to economic loss of their daily earnings, but also causes sufferings to his family ,near and dear one . It is also reported that in highly populated market yards during peak emission period, its content rises very much and causes suffocation and serious health problems causing oxygen dependent disorders to persons present therein, irrespective of his status, race, caste and creed.

Carbon dioxide:

. In Urban areas two important human activities, (i) burning of fossil fuels and organic matter at alarmingly high fate, (ii) destruction of flora and natural vegetation indiscriminate proportions are reducing the CO2 absorbing capacity of nature and as a consequence have resulted in imbalances in CO2 cycling. Its content in urban y air is rising due to higher release and lower utilization. Rise in CO2 accompanied with decrease in 02 in air has triggered the so-called green house warming and climate change which with its limited beneficial effect has more harmful effects on the entire planet with all its habitats including human beings with all its social, cultural, political, technological, economical and aesthetical fabric. Of course the impact of carbon dioxide along with other green house gases (methane, ozone, nitrous oxide and chlorofluorocarbons) would vary with time and space. As long term impact it is predicted by the scientists of Inter Governmental Panel on Climate Change(IPCC) that there will be rise in sea level between 10 and 30 cm by the year 2030 and 30 to 100 cm by the end of this century as a result of polar ice sheet melt through global warming .Rainfall pattern will drastically change inviting flood or increase in drought/ arid areas in developing countries including India .Low lying areas of India would become under water calling for shifting or rehabilitation of human races particularly those who lead their livelihood on fishing, boating, sailing ,hotels , tourism etc. on the sea shore or coastal areas. This includes causality of human lives, loss of huge property, belongings, assets and other economical losses under such ecological disaster. Agricultural crop scenario, food habit of human society, economy, ethics, incidence of chronic, communicable and seasonal diseases and culture might get altered drastically under the changed climate

.Modification of human response factors like, use of air conditioning, the availability of medical and nursing care, and the changing age-structure of the population , with increasing number of elderly people would be visible. High temperatures overload the thermo-regulatory system of the body and may result in frank heat-stroke. The scientists of IPCC mentioned that epidemics may sweep through refugee camps and settlements, spilling over into surrounding communities. These would be jointed by countless millions displaced from the land as aridity and biotic impoverishment spread.

Ozone:

Thinning of ozone layer due to prolonged effect of chlorofluorocarbons, may lead to an increase of skin cancer and eye cataract. Yield of crops may also decrease causing imbalance in public demand-supply system and as a result there might be price hike of some essential commodities which may go beyond poor-people- reach. All these impacts ultimately compel the human society to expense more on medical cure and at the same time have to take the burden of economical loss on food grain.

Major Chemical Accidents

The environmental pollution is responsible for release of many toxic chemicals and many accidents have been experienced during the last century. Accidents always create panicky in the human society apart from immediate medical attention, loss/ risk of job and money and sufferings to the entire family for shot to long duration. Further, one accident of any kind makes the entire working group aware of the fatality and at the same time more cautious which ultimately changes the working culture of the working group. When the accidents are massive and causalities of human life are more many workers even stop work or flew away in fear. Polluted air suffocates man; contaminated water makes him sick; industrial emissions irritate him and toxic vehicular fumes agitate him. Chemicals, both natural and synthesized, are the yardstick of rapidly industrializing and technologically advancing society. All chemicals, when in high concentration and out of proportion become, toxic time bombs.

Industrial Emission

The emission of sulphur dioxide is injurious to man, animals and crops. Indian Petro-chemicals had to shell out Rs. 28.0 lakhs to the villagers of Dhanora near Baroda to compensate for the damages done to them and their crop. The Chembur area of Mumbai is nicknamed as "Gas Chamber" due to high concentration of sulphur and nitrogen oxides and aerosols. The acid rains in 1974 in Chembur and Trombay showed a pH of 4.8 and 4.5 respectively. Acid rains can travel thousands of kilometers away from their origin. All these occurrences not only cause crop-grain and economic loss to the farming society, but also affect adversely on their health and also become instrumental to disintegrate the peace of their family which restricted them to comply with their social and cultural obligation in time. \

Impact of Suspended Particulate Matter (S.P.M.) on human

These are dust and carbon particles or aerosols covered with toxic gases emitted from automobiles and factories (as referred above) and cause respiratory infections, asthma etc. The safe limit is only 200 mg/m3. Delhi and Calcutta have already touched 460 while Kanpur and Jaipur have 350 and 230 SPM. A man inhales 20,000 c.c. of air per day and along with it he also takes 1600 million of dust particles. The conversion of pig-iron to one tonne of steel produces 22 kg of dust particles. The incurable diseases as 'asbestosis' in Roro in Bihar, silicosis in slate pencil manufacturing units in Mandsore in Madhya Pradesh and innumerable stone crushers in the country are the results of these particulate matters. About 40 x 106 tonnes of fine fly-ash is generated every year from our coal-fired thermal plants. Particulates act as slow poisoning for the surrounding people /workers and after long exposure or inhales the person gradually becomes the victim of that disease .

Toxic Chemicals in Environment

The Manufacture, Storage and Import of Hazardous Chemical Rules, 1989 under the Environment (Protection) Act, 1986 lays down controls for 629 chemicals [Low level for 433 chemicals, medium level for 179 chemicals and high level for only 17 chemicals]. The toxic chemicals include sulphur, carbon, nitrogen, fluoride, benzenepyrene, methane compounds, cadmium, lead, mercury, nickel, chromium, arsenic, photochemical products (olefin), photochemical smog, acid rains, carbon tetrachloride, chloroform, C.F.C.- chloroflurocarbons, 1,4-Dioxane, 1,2, Dibromethane, vinyl chlorides etc. Detergents, pesticides, plastics, solvents, fuels, paints, varnishes, dyes, polycyclic aromatic hydrocarbons, medicines, food additives are some chemicals, useful to man but these also cause injury and damage.

Bhopal MIC gas tragedy:
The worst industrial disaster in the history of India occurred on December 3, 1984 in Bhopal India. Forty five tones of methyl isocyanides (MIC) gas along with traces of phosgene leaked from three storage tanks of the Union Carbide Factory exposing several thousands of inhabitants. Inhalation of MIC causes burning sensation in eyes, removes oxygen from the lungs and death due to chocking. According to then M.P. minister for gas relief and rehabilitation death toll reached to 4037; 1500 died in the first week after disaster, while 2537 died afterwards owing to after effects. Another 2000 to 3000 persons lost their lives as gas leakage but they were not counted as gas victims. Many persons go blind and there have been causality of animals, birds and insect life, too. The impact of MIC pollution was so pronounced on the economical, social, cultural, political, technological and aesthetical environment of India that it is written in red words in the history of India.

Chlorine accident:
At petrochemical plant, chembur, Bombay, 2 t of chlorine spilled in august 1985 resulting in one fatality and injuries to about 200 people.

Oleum leakage in Delhi:
This accident took place on December 4, 1985 at Sriram Foods and Fertilizer Industries, Delhi. About 55 t of oleum gas spilled from the industry.

Effect of air pollutants on materials:
Air pollution damage to property covers a wide range corrosion of metals, soiling and eroding of building surfaces, fading of dyed materials, rubber cracking. The processes responsible for the effects of air pollution on materials are: 1)Abrasion 2) Chemical action 3)Absorption 4) Corrosion 5) deposition and removal and the effects depends on various factors such as 1) Temperature 2)Precipitation 3) Sunlight 4)Humidity 5) Air movement 6) Stability of atmosphere 7) concentration and duration. In industrial belt where oxides of Carbon, Nitrogen, sulphur, acid gases, hydrogen Sulphide, ammonia, chlorine gases as well as chromium, iron , manganese are the dominant as air pollutants and exist in appreciable concentration , papers, utensils / house belongings made of

Common Contaminants that cause IAQ problems

Contaminant	Sources	Health Symptoms
Asbestos	Insulation , Spackling, fire pooling material	Lung cancer, scarring of the lungs, mesothelioma
Bio -aerosols	Fungi, bacteria, viruses, spores, pollen , insects	Sneezing, watery eyes, dizziness ,fever, digestive problems, asthma
Carbon monoxide, nitrogen oxide (combustion by-products)	Automotive exhaust, heating devices	Dizziness, carbon monoxide poisoning, headache, nausea, ringing in the ear, damage to central nervous system, reduced lung capacity
Environmental tobacco smoke	Tobacco products	Cancer, respiratory illness, asthma, heart disease
Formaldehyde	Plywood, paneling , wall boards, adhesives, carpet, mobile homes	Eye, nose, throat irritation ,coughing, skin rash, fatigue, allergic reactions
Random	soil	Lung cancer
Volatile organic compounds	Gasoline, paints, refrigerants, cosmetics, building products, personal hygiene products, etc.	Respiratory distress, eye irritation, sore throat, drowsiness, headache, fatigue

metals , alloys etc of nearby societies are damaged within short period and causes economical loss to them .Pre and post assessment is always necessary for quantification of such impact and proper planning .

Indoor Pollution:

It has been realized recently that pollution inside home i.e. indoor pollution is equally dangerous. Concentrations of indoor pollutants sometimes are found to exceed the standards set for out door concentrations. Indoor air quality (IAQ) refers to the air quality of the building occupied space and IAQ is highly depended on ventilation system. Knowingly or unknowingly we do mistake and do not attach much importance to such issues and ultimately become victims of seasonal or chronic diseases, sometimes for the family as a whole even for the forthcoming generation. These not only leads to poor health and monetary loss on medical care, but sometimes also bring about isolation and degraded status within the same society and same cult. Ultimately persons become the victim of inferiority complex and demoralization. Individual family assessments are most useful for predicting the consequences of planned actions.

Environmental Water Pollution and impact on human society

Polluted waters are turbid, not tasty in drinking, often smelling bad and are not suitable for bathing, washing and other human activities. They often serve as carriers of water borne diseases.

Most of our water bodies, such as, seas, ponds, tanks, dams, lakes, rivers, streams, and even springs are getting polluted due to increasing industrialization, urbanization and other development activities like biocide application and fertilization in agriculture.

In India, all the 14 major rivers including Cooum, Ganga, Gomati, Cauvery, Damodar and Mini-Mahi are polluted. The Damodar, nicknamed as 'Sorrow of Bihar' in many sections, does not have any dissolved oxygen and so is almost dead for aquatic flora and fauna. Mini-Mahi River in Baroda is heavily loaded with industrial and petrochemical wastes. The river Cooum, flowing through Chennai, is rendered so polluted with sewage etc. that even zoo-planktons can't sustain themselves. One liter of Cooum water contains 900mg. iron, 275 mg. lead, 1313 mg. nickel and 32 mg. zinc besides very high levels of phosphates, silicate, and nitrate sulphate levels being the highest among Indian rivers. The 2480 km. long Ganges traversing particularly between Hardwar and Kolkata (with 27 major towns) is unfortunately the most convenient media to carry urban liquid wastes, half burnt dead bodies, carrion, pesticides, insecticides etc. These 27 cities dump 902 million liters of waste water to the river every day. (Kanpur alone contributing 270 million liters of untreated silage affecting 2.50 core people in the northern India, Agarwal, 1987). Tests have revealed that the "pious" Ganges water at many places contain 8000 coli

Toxic effect of some water pollutants on human

Pollutants	Sources	Health Symptoms
polychlorinated	Used for manufacturing electric appliances, as ingredients of soap, cream ,paint, paper waxes etc	Fatigue, vomiting, abdominal pain, disorders of intestine, temporary blindness, stillbirth
Vinyl chloride	Used in plastic	Damage to liver, bone ,circulatory system, cancer of lever, brain
Benzene	Used in detergents, moldings, insecticides	Anemia and leukemia
Aldrin /dieldrin	insecticide	Causes tremors, convulsions, damage to kidney
DDT	insecticide	Causes tremors, degradation of central nervous system
Dioxin	herbicide	Powerful carcinogen, causes chromosome malformation
Nitrates and nitrites	Septic tank, heavily fertilized crop, sewage treatment plant	Form methaemoglobin and subsequently produce serious disease 'methaemoglobinaemia'

form bacteria/100 cc. of sample, more than 2000 chemical substances have been identified in water bodies, of which 700 have been found in drinking water, all received from agricultural and industrial activities. About 50% of these are carcinogen (Attar Chand, 1986). It is tragic that 20 lakh persons die annually in India due to water borne diseases like typhoid, dysentery, cholera etc. These days' physical pollutants are also significant. The chemical industries, fossil fuel and nuclear power plants use lot of water for cooling purposes and return the hot water to the stream. This thermal pollution affects aquatic life adversely as the water contains less dissolved oxygen.

Water and Human Diseases

The pollution of water supplies is probably responsible for more human illness than any other environmental influence. The diseases so transmitted are chiefly due to microorganisms and parasites. Cholera, an illness caused by ingestion of the bacterium Vibrio cholerae, is characterized by intense diarrhea, which results rapidly in massive fluid depletion and death in a very large percentage of untreated patients. Though its distribution in the past was virtually worldwide, it has been largely restricted during the twentieth century to Asia, Particularly the area of the Ganges River in India. During the nine years from 1898 to 1907, about 370,000 people died from this disease, and thousands of Indians continue to die each year even at present. It is, therefore, of great importance to remove from drinking or polluted water all the pathogenic organisms or parasites it may contain: this is called disinfection. These diseases are all social evil and compel rural People to spend huge amount of money on medical treatments either

Some diseases caused by water pollution

Source	Diseases	Reason
Water Borne		
Water which is contaminated by poor sanitation acts as vehicle for infecting agents	Cholera, Typhoid, infectious hepatitis	Poor sanitation, and water quality, water-washed
Insufficient available water (especially in desert) to allow people to wash regularly; infection develop.	Scabies, yaws, leprosy, trachoma	Less water use and low personal cleanliness
Water-based		
Essential part of life-cycle of infecting agent takes place in aquatic animals, person drinks and walks in water specially when stagnant, infection is carried by insects	Schistosomiasis, guinea worm From water related vectors and breed in water and bite near	Use of infected water and no provision for piped water

Classification of infectious diseases in relation to water supplies.

	Category	Examples	Relevant water improvement
1	Water-borne infection		
	(a) classical	Typhoid, cholera	Microbiological sterility
	(b) Non-classical	Infective hepatitis	Microbiological improvement
2	Water-washed infections		
	(a) Skin and eyes	Scabies, trachoma	Greater volume available
	(b) Diarrhoea diseases	Bacillary dysentery	Greater volume available
3	Water-based Infection		
	(a) Penetrating skin	Schistosomiasis	Protection of user
	(b) Ingested	Guinea worm	Protection of source
4	Infections with water-related insect vectors		
	(a) Biting near water	Sleeping sickness	Water piped from source
	(b) Breeding in water	Yellow fever	Water piped to site of use
5	Infections primarily of defective sanitation		
	Hookworm	Sanitary faecal Disposal	

by borrowing from others or at the cost of their essential requirements /development and as a result children education and care are highly neglected.

Soil Pollution:

There are number of ways through which soil receiving foreign matter (variety of organic and inorganic compounds) impairs its resource quality. Air borne sources such as fumes emitted by factory chimneys, fine grained raw materials/ fertilizers, by-product /Solid wastes blown by air and water, and soil and water erosion by gravitational transport. Details of pollutants are already discussed above. All such soil & water pollutions may be categorized into two types 1) Non-point sources, 2) point sources. As soil is the natural resource on which entire plant kingdoms including crops survive, contaminants/pollutants absorbed by plant directly or indirectly come to the food chain of human being and exhibit adverse effect on the human health.. Quality of water and soil are interlinked with each other so far as grain and fodder quality is concerned. Again use of high doses of fertilizer and pesticides are equally important in ascertaining the overall quality of grain and fodder.

Use of Fertilizers and Pesticides

Excessive use of fertilizers results in nitrate accumulation in water. In Haryana, the well water has shown 99.5 milligram of nitrogen while the safe limit is only 45 milligrams/liter. Excessive nitrates cause Meth-haemoglobinemia in which body turns blue. Some sheeps are believed to have died in Churu, Nagaur, Jaisalmer in Rajasthan because of drinking of such water from open ponds and stepped wells. Chemical insecticides could also be fatal for human beings as well. The first known tragedy in India is from Kerala, where 100 persons died by consuming floor mixed with parathion insecticide. D.D.T-a common insecticide goes to diet of an Indian to the extent of 0.27 g s-the highest in the world. B.H.C. has been noticed in 70% samples of breast milk in Coimbatore. Unfortunately we still use pesticides and fungicides like aldrine, B.H.C., D.D.T., chlordane, linden and heptachlor which have been banned in other countries. To safeguard vegetables and fruits from insects, insecticides like, dimecron, rogor, nuvar, metacystoxite etc. are sprayed on them and regrettably there is hardly any effective control on the sale of these eatables in their period of high toxicity of these chemical which is 2-3 weeks and thus we are consuming poisonous chemicals unknowingly.

Industrial Wastes

There are numerous hazardous wastes from different industries. The metal and electroplating workshops, foundries, leather tanneries also produce heavy metals like zinc, chromium, cadmium, lead, nickel and copper which are quite harmful.

Urban and Domestic Wastes

It is estimated that a city with 5 lakh population produces 112 tonnes of solid sewage. In Delhi,

Toxic effect of heavy metals on human health

Metals	Effects on human health
Mercury	Numbness of the limbs, lips and tongue ,may loose muscle control, cause deafness, blurring of vision, clumsiness and mental deterioration
Lead	Liver and kidney damage, mental retardation, reduction in hemoglobin formation, abnormalities of pregnancy, convulsions of children
Arsenic	Mental disturbance, liver cirrhosis, lung cancer, kidney damage, ulcers in gastro intestinal tract
Cadmium	Bone deformation, kidney damage, anemia, injury to central nervous system and liver, hypertension
Copper	Hypertension,uremia, coma, sporadic fever
zinc	Vomiting ,renal damage, cramps
Chromium (hexavalent)	Nephritis, cancer, gastro intestinal ulceration

the solid waste is 300 gm/ day/ capita. The garbage collected here is between 1600 to 1800 tonnes/day. In exposed garbage of 0.03 cu.m, there could be 70,000 flies. The night-soil encourages pathogens. The refuse workers showed that 62% had respiratory disease, 42% jaundice and 38% gastro-intestinal disorders in Trivandrum. Rodents like rats also get attracted to garbage and as vectors may spread epidemics including plague. Leachates from chemicals dumped in the garbage by one generation may haunt later generation. The arsenic poisoning of water in Kolkata is well confirmed. Drinking water of large area of West Bengal are infested with Arsenic poisoning and local people do not have much access to good quality of drinking water.. Poisoning in children is reported, where they used discarded pesticide tins as a glass for drinking water. The slaughter house waste is about 10% of the live weight of the animal and this contains potential pathogens. The use of plastic bags has its inherent dangers- it is non-bio-degradable and has a long life of 400 years. Its manufacture involves use of toxic benzene, vinyl chloride and often the used polybags contain detergents, chemicals as well. A very recent survey by Peoples for Animals, revealed that of the 500 animals that die, every day, in Rajasthan, 300 are those which had swallowed polybags. Environmentalists in America oppose its dumping and unfortunately a multi-national company at Tiruvellur is importing about 4500 tonnes of such waste to recycle it for a cold drink container.

Hospital Waste

The hospital toxic wastes , include radio-active substances used for tumor localization, expiry date medicines. Sharps like syringes are collected by drug addicts and they get infected.

Nuclear /Radiation Pollution

Nuclear power has proved to be a boon to us in many ways but its hazardous effects are equally alarming. The news item captioned "Birds classed as nuclear waste" in Hindustan Times, New Delhi dated 15.3.98 should be an eye-opener. The magnitude of their injurious effects is tremendously high as compared to ordinary organic poisons. Nuclear waste is capable of causing a wide range of immediate and long term health problem including radiation sickness, cancer and birth defects which takes away huge money for medical treatment. Highly affected person has to lead a secluded and painful life. He gradually get detached from frank social activities and ultimately becomes a victim of death.

Noise Pollution

Most leading sources of noise pollution will fall into the following categories: road traffic, aircraft, railroads, construction, industry, noise in buildings and consumer products. Hearing loss is one of the most and easily quantified effects of excessive exposure to noise which are significant among sport-shooters. Persons with impaired hearing are often avoided by the family members and the society when some important issues are to be communicated. Noise can mask important sounds and disrupt communication between individuals in variety of settings. This causes irritation to an accident or even a fatality owing to failure of warning sounds of danger. It disrupts telephonic conversation, enjoyment of radio and television, effective communication between teacher and pupils which has deep-rooted repercussion on the society as a whole. Persons with complete hearing loss should not walk alone in a road filled with traffic. Noise affect adversely on sleep and when sleep disruption becomes chronic it affects adversely on health and well-being. Noise pollution cause adverse effects on task performance and behaviour at work and in non-occupational and social settings. Extra auditory health effects ranging from hypertension to psychosis and potential elevation in blood pressure are also possible. Sound pollution affects human body in a number of ways- blood vessel gets constricted, breathing rate affected, muscle tension changes. Vision gets affected around 125 dB. In society and community, with people from different cult or religion/ race, collective feelings of annoyance are expressed, particularly in marriage or religious ceremonies, pujas, other stage shows etc. when mica-phone, loud speaker and other musical instruments are played at high decible and which creates not only tension over the area but also becomes an issue of long standing fighting between two parties/ groups/class/ race/religion. Other less direct effects noises are one's peace of mind and solitude. Assessments of field evaluation are most useful for predicting the consequences of planned actions in the above areas.

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STRATEGIES FOR MINIMIZATION OF ENVIRONMENTAL DEGRADATION

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Introduction

Global climatic changes can affect agriculture through their direct and indirect effects on the crops, soils, livestock and pests. Increase in atmospheric carbon-dioxide has a fertilization effect on crops with C3 photosynthetic pathway and thus promotes their growth and productivity. Increase in temperature, depending upon the current ambient temperature, can reduce crop duration, increase crop respiration rates, alter photosynthate partitioning to economic products, effect the survival and distributions of pest populations, thus developing new equilibrium between crops and pests, hasten nutrient mineralization in soils, decrease fertilizer use efficiencies, and increase evapotranspiration. Indirectly, there may be considerable effects on land use due to snow melt, availability of irrigation, frequency and intensity of inter-and intra-seasonal droughts and floods, soil organic matter transformations, soil erosion, changes in pest profiles, decline in arable areas due to submergence of coastal lands, and availability of energy. Equally important determinants of food supply are socio-economic environment including government policies, capital availability, prices and returns, infrastructure, land reforms, and inter-and intra-national trade that might be affected by climatic change.

There is a great concern now about decline in soil fertility, decline in water-table, rising salinity, resistance to many pesticides and degradation of irrigation water quality. Today, over-exploitation of groundwater is a serious problem in many regions. The water table in the north-western parts of India, for example, is receding at an annual rate from 0.2 to 0.5 metre. Soil Salinity and water logging are the other problems that have already spread to several parts of country. The problem of agricultural environment is getting further complicated due to other developmental activities. Rapid industrialization and urbanization in the different parts of the country is leading to the generation of untreated wastewaters, which are often disposed of as such in rivers, canals and lakes. Establishment of industries such as thermal plants in peri-urban areas results in emissions of large amounts of aerosols. All these are increasingly causing problems of soil, air and water pollutions, affecting structure and functioning of the agro-ecosystems.

Over the past few decades, the man-induced changes in the climate of the earth have also become the focus of scientific and the social attention. The most imminent of the environmental change of the earth is the increase in the atmospheric temperature due to the increased levels of carbon dioxide (CO_2) and other greenhouse gases. The quantity of rainfall and its occurrence has also become more uncertain. In certain places, climatic extremes such as droughts, floods, rainfall distribution and snowmelt have increased. The sea level has risen by 10-20 cm depending upon the region. Similarly snow cover is also believed to be gradually decreasing. The global mean annual temperature at the end of the 20th century was almost 0.5 to 0.7°C above the recorded at the end of the 19th century.

All these changes would have tremendous impact on agricultural production and hence food security of any region. Producing enough food for the increasing population against the background of reducing resources in adverse environmental changed scenarios, while minimizing further environmental degradation, is, therefore, the primary task of agriculture.

To identify the existing and emerging constraints limiting productivity and opportunities for sustainable increase in the future, it is important to understand agriculture-environment interactions in totality. This would include identification of the key environmental problems from an agricultural perspective, impact of these on agriculture, impact of agricultural activities on the environment, and restoration of environment by agriculture.

Current Environmental Issues in Agricultural and Their Remedial Measures:

Water Pollution:-

In some parts of our country, fresh-water resources are getting polluted due to discharge in them of effluents from industry and urban sewage as well as accordingly to a limited extent due to the leaching and runoff of chemicals used in agriculture. Such polluted waters when used for irrigation can be harmful to crops.

It is imperative that wastewater should not be allowed to discharge on land outside the framework of widely tested agronomic package supported by well-devised monitoring protocol. A suitable effluent irrigation system would identify the useful resources in effluents (such as water, plant nutrients and organic matter), and not make the quality of land and surface and groundwater deteriorate through soil-structure degradation, salinisation, water logging, or chemical contamination. Monitoring the water quality standards to the limits would ensure environmental balance in that area.

Pre-treatment of wastewater may be generally needed to ensure these criteria. The major considerations of treatment are to reduce odour, protect public health, and allow for proper operation of the irrigation equipment.

Soil health

Irrigation with poor quality water and presence of pesticide residues and heavy metals from applied nutrients are the major causes of soil pollution. The easy availability of the subsidized inorganic nutrients over time and its effectiveness in increasing yields associated with increasing cropping intensity has resulted in reduced use of organic and green manures and sometimes, even burning of organic residues in the fields. In such areas, there is a gradual decline in native soil fertility. It is, therefore, not surprising that farmers have to apply more fertilizers to get the same yield in these regions. The micronutrients such as sulphur, which are generally not replaced externally, could also be compounding the problems further.

Fertilizers undergo various transformation processes in soil. Phosphorus, for example, is either removed by crop or gets converted into various insoluble forms. Since, the use efficiency of P is low; a significant amount of P is lost from the soil through surface runoff and erosion resulting in eutrophication of water bodies and other environmental problems.

Many fertilizers, phosphatic fertilizers, in particular, contain varying amounts of trace elements such as arsenic, cadmium, chromium, mercury, nickel and lead. These potentially harmful elements may accumulate in soil and may cause long-term effects on crops' yields and quality, and may damage soil micro flora.

Through food and feed they may also get into human and livestock and cause health problems.

Due to intensive and often inappropriate tillage practices, there is an increase in the soil erosion, which lowers current and potential capabilities of the soil. It is observed that almost 60% of the total geographical area is affected by various land-degradation problems. The main causes of degradation are deforestation, over-grazing, inappropriate cultivation without soil- and water conservation, industrialization, poor management of irrigation and rainwater and other agricultural inputs. Shifting cultivation practiced in some parts of northeast hill states.

The environmental problem due to heavy metal accumulation can be rectified by bioremediation. Microbes are generally useful for assisting in reclamation of sites with heavy metal problems. Several fungi are also good in the accumulation of heavy metals.

The tools of genetic engineering are being employed for metal sequestering, transporting and modifying biomolecules for metal-sequestering proteins and peptides and for enzymes to enhance phytovolatilization.

Pesticide residues:

Nearly 60,000 tonnes of pesticides are entering the Indian environment each year of which one-third is used in public-health programmes and two-third in agriculture. Use of pesticides has greatly enhanced agricultural production. Part of the applied pesticides irrespective of crop, applicator or the formulation, ultimately finds its way into the soil, water and food chain. Many of the pesticides persist insole for a very long time.

Long-term effects of pesticides residues in the human body include carcinogenicity, reduced life span and fertility, increased cholesterol, high infant mortality and varied metabolic and genetic disorders.

The fungi are unique among microorganisms because they secrete a variety of extra-cellular enzymes that facilitate decomposition of some pollutants.

Bacteria are also good degraders of toxic pesticides such as halocarbons. Mono and dichlorobenzene can be degraded aerobically by various Pseudomonas and Alcaligenes strains.

Air pollution

Air pollution refers to the presence of various contaminants such as gases, dust, fumes, mist, soot, tar, vapours and suspended particulate matter in the atmosphere to the levels which affects the normal biological processes of humen, animals, plants and other microorganisms or interferes with comfortable enjoyment of life and property. The major air pollutants of concern in respect of their biological and agricultural effects are sulphur dioxide (SO_2), nitrogen oxides (N_2O), hydrogen fluoride (HF), peroxy acetyl nitrate (PAN), ozone (O_3), hydrocarbon (HC), ethylene (C_2H_4), ammonia (NH_3) and suspended particulate matter (SPM).

The growth, productivity and quality of vegetables and other crops including fodders grown near the cities and towns are likely to be affected more by the direct effect of dust particles and gaseous pollutants. Compared to other cereals and food grain crops, vegetables are more prone to gaseous and metallic pollution as most of the vegetables are succulents and physiologically more active. Another form of SO_2 injuries appear on the plants resulting from its conversion into acid rain and leafy and other vegetables are more affected than other crop plants. Amongst the vegetables, the leafy ones such as mustard, spinach, methi, cauliflower and tomato are more affected as compared to hardy vegetables, viz. brinjal and beans.

There are some common physiological disorders, which may be caused by air pollutants.

Global climate change :

Over the past few decades, the gaseous composition of the atmosphere has undergone a significant change mainly through increased industrial emissions, fossil fuel combustion, widespread deforestation and burning of biomass, as well as changes in land use and land management practices.

Emission of greenhouse gases

World agriculture contributes about 4% to total global carbon dioxide emissions, the most important greenhouse gas. Factors, such as soil texture, temperature, moisture, pH, available C and N, influence CO_2 emission from soil. The rate of CO_2 evolution is greater from clay-loam soil, which has a higher organic C content than

Table 1: Persistence of pesticides in the soil

Non-persistent (half life 1-2 weeks)	Slightly persistent (half life 2-6 weeks)	Moderately persistent (Half life upto 6 months)	Highly persistent (Half life above 6 months)
2,4-D, Diquat, Endothal	Dicamba, Dalapon, EPTC, Monuron, TCA	Atrazine, Monuron, Linuron, Simazin, Terbacil, Trifluralin	DDT, HCH, Endosulfan, Aldrin

Table 2: Pesticide residue identified in various food, fodder and feed items

HCH	Rice, milk, egg, meat, fish, vegetables, rice soils, poultry feed, livestock feed
DDT	Cooking oil, milk, butter, fish, feed mixture, eggs, livestock feed, human breast milk
Monocrotophos	Vegetables
Quinalphos	Fish, cooking oil
Aldrin	Fish, feed-mix, livestock feed, eggs, human breast milk, crop products
Endosulfan	Livestock-concentrated feed, fish

sandy soils. More CO2 emission occurs from a tilled than from an undisturbed soil (no till). Temperature has a marked effect on CO2 evolution from soil by influencing root and soil respiration and on CH4 by effecting anaerobic carbon mineralization and methanogenic activity. Methane is about 20 times more effective than CO2 as a heat-trapping gas. Primary sources of methane from agriculture include animal digestive processes, wetlands, paddy cultivation as well as manure storage and handling. Methane is also produced during manure management when animal waste is stored in anaerobic conditions and left to decompose in the field.

Water management plays a major role in methane emission; intermittent irrigation reduces the methane emission by one-tenth as compared to continuously submerged conditions.

Methane and nitrous oxide from Indian agricultural soils are responsible for only about 0.23% and 0.1%, respectively, of the global warming caused by world's methane and nitrous-oxide emission. Thus, overall greenhouse gas emission from Indian agricultural soils is a very small fraction of the total world greenhouse gas emissions.

Mitigating greenhouse gases emission from agricultural sources"

Mitigating methane and nitrous oxide:-

Enteric fermentation from ruminant livestock: Mitigation of methane emitted from livestock is most effectively approached by strategies that reduce feed input per unit of product output.

Rice cultivation: Altering water management practices, particularly mid-season aeration by short-term drainage can greatly reduce methane emission in rice cultivation. Improving organic matter management by promoting aerobic degradation through composting or incorporating into soil during off-season drain-period is another promising technique.

Agricultural Soils:

Site-specific nutrient management, fertilizer placement, timing, proper type of fertilizer are some of the practices that supply nutrients to the plant in a better way in accordance with plant demands. Plant uptake of N can be improved and total N losses can be reduced by deep fertilizer placement and by banding fertilizer within the crop rows.

Manure management:

Solid rather than liquid manure handling may reduce methane but promote nitrous-oxide formation. Applying manure to land as soon as possible reduces the emissions. Aerating manure during composting may reduce methane but increase H2O formation.

Mitigating carbon dioxide :

Carbon can be sequestered in soils by increasing C inputs and/or decreasing their decomposition. Carbon sequestration in soil can also be increased through manipulation of soil pH, soil-water content, temperature, setting aside surplus agricultural land, and restoration of soil carbon on degraded lands. This can also be enhanced by reduced tillage, and greater allocation of land to agro-forestry and bio-fuel crops.

Renewable sources of energy:

Renewable energy resources are the important means of supplementing the conventional fossil fuels, which are invariably accompanied with environmental problems of local and global dimensions. Bio-fuel, including wood fuel, charcoal, biogas, ethanol, agricultural wastes, crop residues and energy crops has been considered as the possible sources, which could be used as a substitute to the conventional fuels. The liquid bio-fuel, usually in the form of alcohol, can be produced from the plant carbohydrates after enzymatic hydrolysis and fermentation.

Item	CO_2 (Tg)	CO_2 (% of world)	CH_4 (Tg)	CH_4 (% of world)	N_2O (Tg)	N_2O (% of world)
World	26,400	100	375	100	8.96	100
India	585	2.1	17.7	4.7	0.26	2.8
World agriculture	-	-	167.5	44.7	3.5	39.1
Indian agriculture	-	-	11.8	3.2	0.24	2.7

Ethanol production from agri-resources:
The agri-resources constitute a vast resource of biomass consisting of sugars, starch, cellulose and lingo-cellulosic residues. The enormous quantity of carbohydrates in the available biomass has a considerable potential of ethanol production using appropriate enzymes/yeast.
Thirteen million tones of potato or 7 million tones of cassava tubers or 13 million tones of sugarcane can meet in full our current requirement of ethanol for 10% blending of gasohol provided technology for conversion of biomass into ethanol is cost-effective.

Biodiesel crops:
Bio-diesel, which consists of the fatty acid esters of simple alcohols, is a potential replacement for a portion of the diesel fuel used in transportation. Jatropha is a unique plant, which has largely remained unexplored as the source of bio-diesel although its potential had been known for more than 50 years. However, recently this non-edible oilseed plant commonly known as jatropha or ratanjyot has found prominence as a large project has been launched by the Government of India for its plantations.

Agricultural waste management:
Agricultural activities produce enough residues that are generally considered wastes. The sustainability concerns of agricultural land need for safe disposal of agricultural wastes, and increasing interests in organic farming have once again fuelled our interest in the management of residues. Besides incorporation into soils or conversion to farm yard manure, these can also be used for generating bio-gas.
The latter is a clear, non-polluting, smoke and soot free fuel, it contains 55 to 70% methane which is inflammable and the digested slurry obtained for the biogas plant, after drying is used as organic compost in agriculture.
Use of crop residues as compost, green manuring, non-edible cakes, FYM and bio-fertilizers reduces the consumption of fertilizers ultimately it reduces the soil and water pollution.
Genetically Modified Organisms (GMOs):
Modern biotechnology is being used to modify plants and animals to increase the equality and quantity of food, in the protection and management of environment (in the form of various genetically engineered crops), bioremediation, bio-treatment of waste wasters, bio-prospecting and bioconversion.
GMOs can also have several positive direct and indirect environmental impacts on agriculture. The environmental benefits associated with reduced pesticide use, soil conservation, increase in yield, and phytoremediation are noteworthy in this regard. The herbicide-tolerant crops may lead to environmental benefits by facilitating a shift to soil conservation tillage practices because these crops may allow farmers to shift to post-emergent control of weeds instead of pre-emergent control. Biotic stresses generally cause significant loss in crop productivity. Cultivation of pest resistant GMOs can significantly reduce this losses and thus, possibly assist in conserving land, water and other precious resources. Transgenic plants can also increase removal of toxic heavy metals from polluted soils and waters and sequester these into plant tissue available for harvest, or can transform pollutants into less toxic forms this aspect needs more exploration.

ARSENIC CONTAMINATION IMPLICATIONS FOR SUSTAINABLE AGRICULTURE AND FOOD SAFETY

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Abstract

The presence of arsenic (As) in water and its effects on human health through both drinking water and agricultural practices is of serious concern worldwide. Arsenic-rich groundwater, occurring in the Bengal Delta Plain (BDP), covers the state of West Bengal, the adjoining country of Bangladesh and extends to Jharkhand, Bihar U.P. Assam and other North-castern states of India. In the present condition of emergence of greater area with arsenic pollution, a brief review has been made of the geogenic processes involved in mobilization of As into groundwater, mobilization of As in soil and transfer of As from soil to crops. The review also discusses the implications of As contamination and some possible management options for mitigating As contamination with special emphasis on phytoremediation, as well as biotechnology potentials, for minimizing the environmental As problem.

Arsenic present in the sediment particles of the BDP have originated from the Himalayan Mountains. In the accumulating sediments that comprise modern Bangladesh and West Bengal, As occurs in iron oxide. As is likely to be found in groundwater where water wells tap the sub-surface in the vicinity of buried wet lands and peat deposits. It is the buried peat deposits that are the key to understanding As-pollution of groundwater because, the buried peat deposits in these ancient wet lands make the iron oxide unstable. Iron oxide and As are found everywhere in the soils and the sediments of the delta plains, but not in buried wet lands. Two such regions are in the BDP-Madhupur Tract and Barind Tract where there are no buried peat deposits and As is not a problem in those areas. The natural pool of As in the surface soil arose from the network of geological, hydrogeological and soil-forming biogeochemical processes. Three types of reactions contribute to desorption and mobility of As in soils, namely, reductive dissolution, oxidative dissolution and ligand exchange.

The form and behaviour of As varies greatly between flooded soils (such as paddy fields) and non-flooded soils. The most important As species are arsenate (As V) under non-flooded conditions and arsenite (As III) under flooded conditions. As (III) has higher solubility than As (V), resulting in a higher mobility of As in flooded soils. Soil texture is another important factor governing mobility of As. Clay soils have a much greater capacity to bind As than sandy soils. Generally, in natural soils concentration of As is around 5 mgkg-1, but this can very depending on the origin of the soil. Various reports indicate the soil concentration of As are increasing because of As input via irrigation water, and this is a major concern.
One of the major factors determining uptake and toxicity of As to plants is the form of As. The two most important forms, i.e., As(V) and As(III), are taken up by completely different mechanisms. Uptake, accumulation and toxicity vary within and between plant species. In general, more As in the soil leads to higher concentrations in plants, but this depends on many factors. It is not possible to predict As uptake and/or toxicity in plants from soil parameters.

The risks of land degradation are likely to increase with the accumulation of As in the soil. With the continuation of current agricultural practices, it is expected that As in the food chain will further increase. Entry of As into food chain poses a potential dietary risk to human health in addition to the risk from drinking contaminated groundwater. Less well known but potentially more serious is the risk of As to crop production. Continuous build up of As in the soil from As-contaminated irrigation water may reduce crop yields, thus affecting the nutritional status and incomes of rural farming communities. Management options for mitigating as contamination should, therefore, focus on:

(i) Optimizing water input to reduce As input to soil.
(ii) Aerobic growth conditions in paddy fields to reduce bioavailability and uptake of As in rice.
(iii) Breeding crops tolerant to As and/ or low accumulation of As in edible parts of crops.
(iv) Shifting from rice in dry season to crops that require less water.
(v) Phvtoremediation one of the popular methods used for remediation of As-contaminated soils. The brake fern (Pteris vittata) is an efficient As-hyperaccumulator. Research indicates that this fern accumulation an As concentration, in the above ground plant tissue, more than 200 fold higher then any other plant species.
(vi) Biotechnology potentials for minimizing environmental As problem.

It is possible that microbial metabolism (arsenite oxidase coupled with precipitation in mineral deposts) can be harnessed for practical bioremediation of As contaminated drinking water', although this prospect is just beginning to be recognized and no sustained efforts have been made in this direction. Microbial batch reactors to remove As by oxidation of As(III) to As(V) and the use of bacterial arsenate reductase genes in transgenic plants for potential phytotremediation by intracellular sequestration after reduction from As(V) to As(III).

Mitigation ways of water pollution in Agriculture

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ABSTRACT

Water pollution is a global phenomenon. In the context of the challenge of increasing food production with decreasing cultivable land demands heavy application of nitrogen is leading to increased nitrate leaching. The remedial measures to reduce water pollution and nitrate leaching from agricultural lands include safe use of waste water for irrigation, removal of pollutants from water, filtration technology for removing water impurity, controlled use of fertilizers, adoption of micro irrigation and fertigation technology, sprinkler irrigation, biotechnology, laser leveling, conservation agriculture, drainage and subsurface drip. Different management options for mitigating the effects of water pollution in agriculture are presented in this article. The effect of water pollution on human health status of nitrate contamination with point source and non-point source of pollutants and contributions of agricultural activities are also discussed.

1. Introduction

Water problems are emerging as the most compelling sets of issues facing agriculture. Acute water shortage in some areas, resulting from rapid population increase. Increasing shortage of fresh water, more and more polluted water is being used to irrigate food crops. Such contamination can have serious implications for environment, health and livelihoods of consumers of the produce. Various interventions can either reduce pollution at source, or in some cases, ameliorate the impact of pollution.
However, such interventions will require cooperation between local communities and various agencies. It will also require an enabling policy and regulatory body.
With population growth, the demand for land and water resources has been ever increasing all over the world. The over exploitation of these resources leads to a number of environmental problems including pollution of streams and water bodies. Non- point source agricultural pollution is one of the major factors in polluting surface waters in agricultural areas. Non-point sources are those which discharger into a catchment in a way that they depend upon the routes of the hydrological cycle to transport them to the stream system. They differ from the point sources due to their unidentifiable nature and the difficulty in control and management. The non-point agricultural pollutants are organic and inorganic materials including sediments, plant nutrients, pesticides and animal wastes entering surface and ground waters form non-specific or undefined sources in sufficient quantities to contribute to the problem of pollution.
It is well known that agriculture is the single largest user of freshwater resources, using a global average of 70% of all surface water supplies. Except for water lost through evapotranspiration, agricultural water is recycled back to surface water and/or groundwater. However, agriculture is both cause and victim of water pollution. It is a cause through its discharge of pollutants and sediment to surface and/or groundwater, through net loss of soil by poor agricultural practices, and through salinization and water logging of irrigated land. It is a victim through use of wastewater and polluted surface and groundwater which contaminate crops and transmit disease to consumers and farm workers. Agriculture exists within a symbiosis of land and water as the saying goes "... appropriate steps must be taken to ensure that agricultural activities do not adversely affect water quality so that subsequent uses of water for different purposes

are not impaired (WHO, 1993).

2. Water pollution as a global issue

Agriculture, as the single largest user of freshwater on a global basis and as a major cause of degradation of surface and groundwater resources through erosion and chemical runoff, is a cause of concern about the global implications of water quality. The principal environmental and public health dimensions of the global freshwater quality problem are highlighted below:

- -:- Five million people die annually from water-borne diseases.
- -:- Ecosystem dysfunction and loss of biodiversity.
- -:- Contamination of marine ecosystems from land-based activities.
- -:- Contamination of groundwater resources.

This "crisis" is predicted to have the following global dimensions:

- -:- Decline in sustainable food resources (e.g. freshwater and coastal fisheries) due to pollution.
- -:- Cumulative effect of poor water resource management decisions because of inadequate water quality data in many countries.

The real and potential loss of development opportunity because of diversion of funds for remediation of water pollution has been noted by many countries. There is concern that if the cost of remediation exceeds economic benefits, development projects may no longer be creditworthy. Sustainable agriculture will, inevitably, be required with a good planning to use available water sources.

3. Non-point and point source water pollution

Non-point source water pollution, once known as "diffuse" source pollution, arises from a broad group of human activities for which the pollutants have no obvious point of entry into receiving watercourses. In contrast, point source pollution represents those activities where wastewater is routed directly into receiving water bodies by, for example, discharge pipes, where they can be easily measured and controlled. Obviously, non-point source pollution is much more difficult to identify, measure and control than point sources. For point source there is an extensive permitting system for point discharge of pollutants in water courses. Therefore, non-point sources are defined as any source which is not covered by the legal definition of "point source":

"The term "point source" means any discernible, confined and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft, form which pollutants are or may be discharged. This term does not include agricultural storm water discharges and return flows from irrigated agriculture."

Conventionally, in most countries, all types of agricultural practices and land use, including animal feeding operations (feed lots), are treated as a non-point sources. The main characteristics of non-point sources are that they respond to hydrological conditions, are not easily measured or controlled directly (and therefore are difficult to regulate), and focus on water (Table 1).

Table 1 Classes of non-point source

Agriculture		
Irrigation and Drainage	Runoff from all categories of agriculture leading to surface and groundwater pollution. Irrigation return flows carry salts, nutrients and pesticides. Tile drainage rapidly carries leachates such as nitrogen to surface waters.	Phosphorus, nitrogen, metals, pathogens, sediment, pesticides, salt, BOD[1], trace elements (e.g. selenium etc).
Urban areas		
Solid waste disposal	Contamination of surface and groundwater by leachates and gases. Hazardous wastes may be disposed of through underground disposal.	Nutrients, metals, pathogens, organic contaminants.
Deep well disposal	Contamination of groundwater by deep well injection of liquid wastes, especially oilfield brines and liquid industrial wastes.	Salts, heavy metals, organic contaminants.

4. Agricultural activities causing water pollutions - Water pollution is becoming alarmingly important by the introduction of intensive farming methods, with increased use of chemical fertilizers and higher concentrations of animals in smaller areas.

The agricultural activities and their impact on water pollution are given in Table 2. Hierarchy of agriculturally-related activities and water quality problems is shown in Fig. 1.

Table 2 Agricultural activities and their impacts on water quality

Agricultural activity	Impacts	
	Surface water	Groundwater
Tillage/ ploughing	Sediment/turbidity: sediments carry phosphorus and pesticides adsorbed to sediment particles; siltation of river beds and loss of habitat, spawning ground, etc.	
Fertilizing	Runoff of nutrients, especially phosphorus, leading to eutrophication causing taste and odour in public water supply, excess algae growth leading to deoxygenation of water and fish kills.	Leaching of nitrate to groundwater; excessive levels are a threat to public health.
Manure spreading	Carried out as a fertilizer activity; results in high levels of contamination of receiving waters by pathogens, metals, phosphorus and nitrogen leading to eutrophication and potential contamination.	Contamination of ground-water, especially by nitrogen
Pesticides	Runoff of pesticides leads to contamination of surface water and biota; dysfunction of ecological system in surface waters by loss of top predators due to growth inhibition and reproductive failure; public health impacts from eating contaminated fish. Pesticides are carried as dust by wind over very long distances and contaminate aquatic systems.	Some pesticides may leach into groundwater causing human health problems from contaminated wells.
Irrigation	Runoff of salts leading to salinization of surface waters; runoff of fertilizers and pesticides to surface waters with ecological damage, bioaccumulation in edible fish species, etc. High levels of trace elements such as selenium can occur with serious ecological damage and potential human health impacts.	Enrichment of groundwater with salts, nutrients (especially nitrate).
Clear cutting	Erosion of land, leading to high levels of turbidity in rivers, siltation of bottom habitat, etc. Disruption and change of hydrologic regime, often with loss of perennial streams; causes public health problems due to loss of potable water.	Disruption of hydrologic regime, often with increased surface runoff and decreased groundwater recharge; affects surface water by decreasing flow in dry periods and concentrating nutrients and contaminants in surface water.

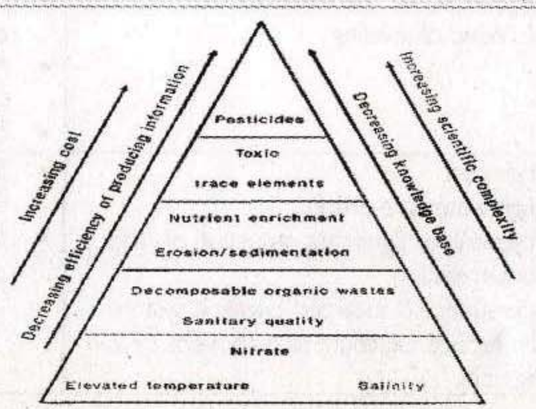

Fig. 1 Hierarchical complexity of agriculturally-related water quality problems

5. Nitrate pollution in water

Producing an adequate quantity of healthy food without polluting the environment is a formidable challenge for future agriculture in the world. About 260 million tones of atmospheric nitrogen are being fixed every year globally. The global mean N use efficiency is estimated to be about 50% (Rao and Puttama, 2006). The remaining quantity of nitrogen is lost into the environment. A large proportion of this nitrogen gets converted into nitrate which, being soluble in water and not retained by soils, gets leached into water bodies. Leaching of nitrate from agricultural land and from other sources to groundwater is a global phenomenon. Enhancing fertilizer N use efficiency by ensuring measures such as balanced application of nutrients, proper coordination of N and irrigation management and site specific and need-based nutrient management can substantially control the leaching of nitrate N beyond root zone of crops. There can be two general approaches to minimize environmental pollution arising due to N use in agriculture: one is the optimum use of the ability of crop plants to compete with other processes which lead to the losses of N from soil plant system to the environment and the other is the direct reduction of the rate, duration and extent of loss through the loss processes themselves. Balanced application of N, P and K can significantly reduce the amount of unutilized nitrate in the root zone (Rao et. al., 2006).

6. Mitigating ways for reducing water pollution

Safe use of waster water for irrigation

It is a well known fact that untreated wastewater contains heavy metals and myriad chemicals, especially in peri-urban areas because of the impact of industries. All major cities have this problem in India. Many a times it is a livelihood issue and cannot be avoided, since such wastewater provides nutrients and is often the sole source of water during lean periods. ISI guidelines are already in place for release of effluents into rivers and tanks to prevent surface and ground water contamination, but this is seldom implemented by the responsible agency (Kumar et. al., 2007).

There are few suggestions for use of waster water-

a. FAO has set up guidelines for using wastewater for cultivation with special reference to coliform and helementhic parasites. These guidelines should be followed in our country (FAO, 1991).
b. It may be better to use waste water peri-urban areas for Floriculture than for food crops.
c. Leafy vegetables accumulate more metals than others; therefore cultivation of these in contaminated waters should be banned through effective legislation.

The selections of waste water application technique are given in Table 3.

Table 3 Selection of wastewater application techniques

Irrigation Technique	Affecting factor	Special measures for wastewater
Flood	Lowest cost	Thorough protection for fieldworkers
Furrow	Low cost	Protection for fieldworkers
Sprinkler	o Medium water use efficiency o No need of leveling	▪ Fruit trees are more prone to contamination ▪ Minimum distance 50-100m from houses ▪ Odour problem
Surface and Subsurface drip	o High cost o High water use efficiency o Potential for significant reduction of crop contamination o Sub-surface & localized irrigation system can reduce exposure to pathogens by 2-6 log units	▪ Selection of non-clogging emitters ▪ Good filtration unit with automatic cleaning

ii. Removal of pollutants from water

There are various processes for removing pollutants from water.

a. In traditional canal systems, ponds and canals, water hyacinth and other live organisms may be introduced so that water can be treated naturally. A few plots have come up along the river, where first the waste is kept for few days and later allowed to flow into the river (Avcievala, 1991).

b. It should be made obligatory for industries to first install water purification technology in their plants, only after which the license and permission to start the industry should be given. Industrial area also need to be located far from habitations, and treat effluents before letting it into water bodies.

c. Awareness campaigns in the peri urban areas need to be done on the issue, since peri-urban are major contributors to pollution.

The quality of water that can be used for irrigation was described in class E with following properties (WHO, 1993)

I. pH - between 6 to 8.5
II. Maximum Electrical conductivity at 25 oC2250 micro mhos/cm
III. Maximum Sodium absorption ratio - 26
IV. Maximum Boron level - 2 mg/liter

iii. Filtration technology for removing water impurity

The technology for filtration is available, but leaves a wide gap between the product quality in the developing and developed world. There are many innovations to transform impure water to potable and irrigation water. There are good number of filterants to remove silts, microorganisms and also heavy metals. Ionization is another recent technique. In villages, charcoal is used to clear off impurity. Dried drumstick seed is also a good filterant. The National Innovation Foundation located at IIM, Ahmadabad maintains a registry of grassroots innovations for making water drinkable (Kumar et. al., 2007).

iv. Control use of fertilizers

The response to the need to control leaching and runoff of nutrients and contamination of soils and water by heavy metals has been mixed in Europe. Control measures are part of the larger issue of mineral and organic fertilizer usage. Following types of voluntary and mandated controls like in Europe can be applied to mineral fertilizers in India as follows:

-:- Taxes on excessive use of fertilizers.
-:- Use fertilizers sparingly. Test the soil to see the amount of fertilizer needed. Don't fertilize before a rain storm. Use organic fertilizers that release nutrients more slowly.
-:- Promoting and subsidizing better application methods, developing new, environmentally sound fertilizers, and promoting soil testing.

v. Other measures to reduce water pollution at field level

a. Rational nitrogen application: To avoid over-fertilization, the rate of nitrogen fertilizer to be applied needs to be calculated on the basis of the "crop nitrogen balance". This takes into account plant needs and amount of N in the soil.

b. Vegetation cover: As far as possible, keep the soil covered with vegetation. This inhibits build-up of soluble nitrogen by absorbing mineralized nitrogen and preventing leaching during periods of rain.

c. Manage the period between crops: Organic debris produced by harvesting is easily mineralized into leachable N. Steps to reduce leachable N includes planting of "green manure" crops, and delaying ploughing of straw, roots and leaves into the soil.

d. Rational irrigation: Poor irrigation has one of the worst impacts on water quality, whereas precision irrigation is one of the least polluting practices as well as reducing net cost of supplied water.

e. Optimize other cultivation techniques: Highest yields with minimum water quality impacts require optimization of practices such as weed, pest and disease control, liming, balanced mineral fertilizers including trace elements, etc.

f. Agricultural Planning: Implement erosion control techniques that complement topographic and soil conditions.

vi. Micro irrigation systems

The overall efficiency of the flood irrigation system range between 25 to 40%. To meet the food security, income and nutritional needs of the projected population in 2050 the food production in India will have to be almost doubled. Adoption of Micro irrigation, may help in saving significant amounts of water and increase the quality and quantity of produce. All these emphasize the need for water conservation and improvement in water-use efficiency to achieve More Crop per Drop. Micro irrigation system was found to result in 30 to 70 % water savings in various orchard crops and vegetables from along with 10 to 60 % increases in yield as compared to conventional methods of irrigation (Rajput et. al., 2005). Micro irrigation systems allow for a high level of control of chemicals applications. The plants can be supplied with the exact amount of fertilizer required at a given time. Water and nutrients are applied directly to the root zone which reduces in the total amount of fertilizer used. Micro irrigation is more economical, provides better distribution of nutrients throughout the season, and decreases ground water pollution due to the high concentration of chemicals that could ordinarily move with deep percolated water. Other chemicals, such as herbicides, insecticides, fungicides, nematicides, growth regulators and carbon dioxide can be efficiently applied through micro irrigation systems to improve crop production and reduce water pollution.

vii. Fertigation technology

Research studies conducted in India, suggest that groundwater pollution due to nitrate leaching is becoming a serious problem particularly in agriculturally developed states such as Punjab, Haryana, Andhra Pradesh, Maharashtra, where fertilizer applications are high (Agarwal et al., 1999). Nitrate leaching potential depends on soil properties, crops and crop rotation, irrigation methods, management practices and climatic parameters. This necessitates the development of appropriate water and fertilizer application strategies so as to maximize their application efficiency and minimize fertilizer losses through leaching (Rajput and Patel, 2004).

Fertigation is the process of application of soluble fertilizer along with irrigation. When fertilizer is applied through drip irrigation system, it is referred to as drip fertigation. Fertigation is the most widely used form of chemigation, being practiced on 33.5% of the sprinkled area and 60% of the drip irrigated area (Threadgill, 1985). Application of water and fertilizer through drip irrigation improves water and nutrient use efficiency and aims at maximizing farmer's income and minimizing pollution. Drip fertigation offers various advantages such as: easy application of amount and concentration of nutrients suited to the crop according to its stage of development and climatic conditions; reduces the salinization and groundwater pollution; decreases fluctuation in nutrient concentration in soil during the crop growing season; permits easy use of soluble solid as well as balanced liquid fertilizer and micronutrients (Bar-Yosef, 1999). It is recommended that fertilizer should be applied regularly and timely in small amounts. There is a direct relation between large NO3-N losses and inefficient fertigation and irrigation management. Improved nitrogen use efficiency under drip irrigation, by reducing percolation and evaporation losses, provides for environmentally safer fertilizer application through the irrigation water (Mmolawa and Or, 2000). Drip irrigation prevents wetting of crop foliage thus controls the attack of pathogens and reduces pesticides application. A properly designed drip fertigation systems delivers water and nutrients at a rate, duration and frequency, so as to maximize crop water and nutrient uptake, while minimizing leaching of nitrogen (5.5 % in sandy loam soil) from the root zone of onion crop (Ajdary et. al., 2007). It was observed that root nutrient uptake accounted for about 4060% of the total N added through fertigation (Gardena's et al., 2005). It was observed that 40 % of fertilizers can be saved in comparison to conventional method of fertilizer application (Rajput and Patel, 2006).

viii. Sprinkler irrigation

Sprinkler irrigation has been recognized as an efficient irrigation method with the application efficiency ranging from 55 to 90% (Martin et al., 1991). Sprinkler systems can also be used for applying nitrogen fertilizers. In recent years, sprinkler fertigation has gained popularity. For sprinkler fertigation, the uniformity of irrigation is one of the factors that impacts nitrate leaching. A higher uniformity could reduce nitrate leaching but may limit the use of sprinkler systems because the initial costs of these systems increase with increasing application uniformity. The seasonal averaged CU for fertigation varied from 71 to 85%. Sprinkler fertigation can be an efficient method of fertilizer application and minimizing deep percolation and nitrate leaching (Li et. al., 2005).

ix. Biotechnology

Biotechnology can be used to reduce the pollution of water. This technology is already developed by Chinese Scientist and used in cleaning of one of the river in China. The technology, named "CMF technology" consists mainly of a highly effective microbial thallus compound and oxygenating agents. When the microbial compound is injected into the water, the microbe activates within 30 minutes and duplicates in number every 15 minutes. Given that a gram of microbial compound contains between six and eight billion microbes, the organic substances are quickly eliminated. Upon completion of the process, which generates no pollution or waste products, the water is left clean. Kinds of microbes should be used in accordance with the ratio of organic or inorganic substances in the water. The initial investment for the treatment per square meter is Rs. 600 and the treatment is effective for a period of 20 years with no reinvestment. This technology has potential to meet our growing demand of water by treating the waste water.

x. Minimize Greenhouse gas emissions with micro irrigation

Agricultural operations emit large amounts of carbon dioxide and nitrous oxide, either directly or indirectly. Agricultural nitrogen comes at a high cost of carbon dioxide and nitrous oxide emissions during fertilizer production, and nitrous oxide emitted as a by product from excess nitrogen in the field, or in the runoff to surface water. Excess agricultural nitrogen is a major source of water pollution and nitrous oxide emissions, and the loss of soil organic matter is an important source of carbon dioxide emissions. The increase in water use and nutrients use efficiencies through micro irrigation would be partly compensated by the reduction in greenhouse gas emissions, reduced water pollution, and increased soil organic matter content, with its associated fertility benefits and measurable carbon offset value. To minimize adverse impacts of agricultural nitrogen, precision farming technology can be used to ensure that larger amounts are given only to the limited areas that need it, rather than applying uniformly over the whole field, in order to gets maximum yield (Xiaoxin et. al., 2007).

xi. Reduction of pesticide inputs

Mitigation strategies to reduce pesticide inputs into surface water and groundwater, and their effectiveness in reducing the ground water pollution (Isensee et. al., 1990). In one study, atrazine was found in groundwater all year, while cyanazine, alachlor, and carbofuran were present only for a short period (<3 months) after pesticide application. Fairly constant background levels of less than 0.5 □g L−1 atrazine were found under fields treated before 1986, while levels under continuously treated fields were less than 2.0 □g L−1 for 22 of 25 samplings. Pesticide residues in unconfined groundwater were usually higher (ca. 2 to 4×) than in confined groundwater (Reichenberger et. al., 2007). Rainfall timing relative to pesticide application was critically important to pesticide leaching. In catchments dominated by diffuse inputs at least in some years, mitigation of point-source inputs alone may not be sufficient to reduce pesticide loads/concentrations in water bodies to an acceptable level. Subsurface drains are an effective mitigation measure for pesticide runoff losses from slowly permeable soils with frequent water logging. There are many possible effective measures of spray drift reduction. Point-source inputs can be mitigated against by increasing awareness of the farmers with regard to pesticide handling and application, and encouraging them to implement loss-reducing measures of "best management practice".

xii. Enhancement of nutrient use efficiency through laser leveling

Improved use efficiency of the applied nutrients under laser land leveling is obvious consequences as uniform application of water under irrigated condition create an opportunity for uniform distribution of nutrients (Rajput et. al., 2004). In homogeneous seedbed, uniform distribution of nutrients improves crop growth (Rajput and Patel, 2004). The information on increased nutrient use efficiency resulting from laser land leveling demonstrated its beneficial effects. The uptake of applied nutrients in a sandy loam soil increased significantly under precision land leveling compared to traditional land leveling (Fig. 2). Choudhary et al (2002) observed higher fertilizer use efficiency (26.9%) under laser land leveling compared to conventional leveling (21.67%) in wheat crop. In on-farm investigations carried out at 71 locations in western Uttar Pradesh by the Rice-Wheat Consortium, significant improvement in nitrogen use efficiency in rice-wheat cropping system was recorded and increases in NUE were found from 45.1 to 48.4 and 34.7 to 36.9 kg grain kg-1 applied nitrogen in rice and wheat, respectively Laser leveling reduced the nutrients leaching by increasing the NUE (Fig. 3) (Jat et. al., 2003).

xiii. Weed control efficiency and control of weedicide inputs through laser leveling

Laser land leveling results in uniform water distribution to the entire field and allows uniform crop growth, thus resulting in lesser weed infestation. Unleveled fields, on the other hand, frequently exhibit patchy growth. The areas with sparse plant populations are zones of higher weed infestation because weeds are mostly C4 plants and possess the inherent genetic capability to suppress crop growth. The reduction in weed

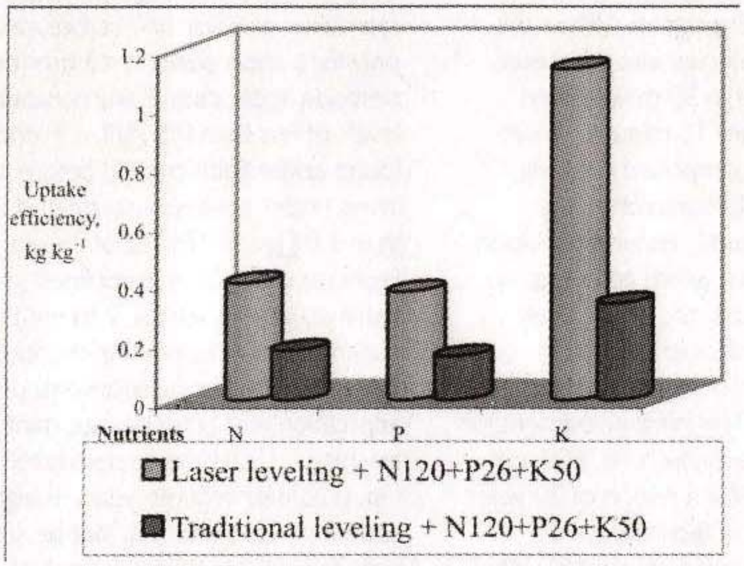

Fig. 2 Effect of precision land leveling on uptake efficiency of N, P and K in rice
Source: Precision Farming Project (NATP)

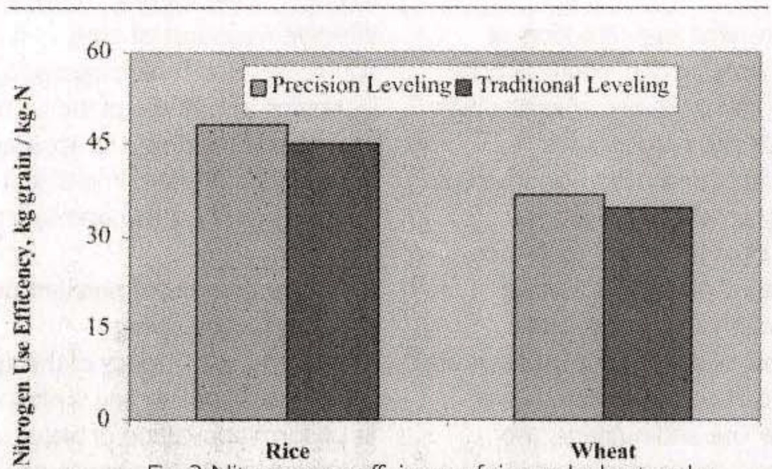

Fig. 3 Nitrogen use efficiency of rice and wheat under precision and traditional land leveling

population results in improvement in weed management efficiency as removal of less number of weeds manually requires less time. A reduction of 75 % in labour requirement for weeding was reported due to precision land leveling (Rickman, 2002) and consequently the amount of pesticides decreased. Reduction in weed population in wheat after 30 days of sowing was recorded under precisely leveled fields in comparison to traditional leveled field (Jat et al., 2003).

xiv. Conservation agriculture

Zero tillage is a 'cornerstone' of CA, and can be practiced in both large and small farming systems. With zero till (also termed no-tillage and direct drilling) the only tillage operations are low-disturbance seeding techniques for application of seeds and fertilizers directly into the stubble of the previous crop (Dumanski et. al., 2006). Zero tillage is conducive to promotion of the environmental integrity of the soil systems, and to maintenance of environmental services. Stability of the soil organic matter under zero tillage, due to enhanced soil aggregation and reduced erosion, enhances sequestration of carbon and contributes to mitigation of climate change. Soil carbon sinks are increased by increased biomass due to increased yields, as well as by reducing organic carbon losses from soil erosion (Derpsch, 2005). Fuel use and tractor hours are reduced up to 75%, with further reductions in greenhouse gas emissions. Other environmental benefits include reduced siltation, eutrophication and pesticide contamination of rivers and dams. The system is also valuable to mitigate the environmental effects of droughts by ensuring some biological production, surface cover, and erosion control even under severe conditions, due to the greatly improved soil aggregation, biodiversity and organic matter status, and subsequent improved water infiltration and water storage in the soil (Campbell et. al., 1993). The old concepts about ploughing the fields had to be replaced with the Zero Tillage Technology, which could help the farmers to save the cost of production to the extent of Rs 600 to Rs 800 per acre. It would also help in decreasing pollution by saving 60 to 70 per cent diesel used by the farmers for sowing wheat. According to Dr Nanda, the farmers could save 30 to 40 per cent of water during the first irrigation by adopting this technique (Ludhiana Tribune, 2002).

xv. Nitrate leaching and its removal by drainage

In tropical climates rainfall often exceeds crop evapotranspiration, and in arid and semi-arid regions, unscientific application of irrigation water is common. As a result, nitrate derived from the fertilizer and from mineralization of soil organic matter is subjected to loss by leaching. Field experiment on non-rice crops (Cai et. al., 1986) showed that 92 to 95% of the total inorganic nitrogen found in the sub-surface drainage water was in the form of nitrate. Subsurface drainage helps in controlling nitrite-nitrogen concentration in the root zone. Sustained operation of subsurface drainage system could maintain a favourable salt balance in the top soil layer (0-30 cm) enhancing microbial activity and consequently nitrification. As a result, the nitrite concentration in soil water at field capacity was within the permissible limit of 0.9 mg/L in the rhizosphere (Singh, 2007).

xvi. Wastewater irrigation through subsurface drip system

Subsurface drip irrigation, combined with wastewater reuse, may offer the most effective and efficient way to cope with water shortage for crops minimizes the health risk to the farmers and product consumers due to reduced contact and protects the environment receiving wastewater (Singh et. al., 2006). The waste water can be used through drip irrigation because of the following reasons-

-:- High water use efficiency
-:- Minimum contact of users with water
-:- It does not form aerosols
-:- Restrict runoff & deep percolation
-:- Reduces weed growth and pollution hazard due to herbicides
-:- Potential for significant reduction of crop contamination, It can reduce exposure to pathogens by 2-6 log units

xvii. Application of models for control of water pollution

Lack of understanding of how soil water and nutrients distributions are affected by the unsaturated soil hydraulic properties has sometimes resulted in suboptimal management and low water and nutrients use efficiency particularly in micro irrigation systems. Application of mathematical model necessitates the development of appropriate water and fertilizer application strategies so as to maximize their application efficiency and minimize fertilizer losses through leaching. Models provide an understanding of the relationship amongst the amount and timing of water and nutrient application, the crop root uptake, yield and soil hazard and groundwater pollution (Antonopoulos, 2001). However, selection of an appropriate model is very important. Patel and Rajput (2008) and Gardenas et al. (2005) used a two-dimensional solute transport model Hydrus-2D to analyze the soil wetting and solute transport in surface and subsurface trickle irrigation under various irrigation and fertigation strategies. They reported that seasonal leaching was the highest for coarse-textured soils and that fertigation at the beginning of the irrigation cycle increased seasonal nitrate leaching in contrast to fertigation at the end of the irrigation cycle, which reduced the potential for nitrate leaching in all types of soils except surface drip and tape system in clayey soils.

7. Impact of water pollution on public health

Polluted water is a major cause of human disease, misery and death. According to the World Health Organization (WHO), as many as 4 million children die every year as a result of diarrhoea caused by water-borne infection. The bacteria most commonly found in polluted water are coliforms excreted by humans. Surface runoff and consequently non-point source pollution contributes significantly to high level of pathogens in surface water bodies. Improperly designed rural sanitary facilities also contribute to contamination of groundwater.

Agricultural pollution is both a direct and indirect cause of human health impacts. The WHO reports that nitrogen levels in groundwater have grown in many parts of the world as a result of "intensification of farming practice" (WHO, 1993). This phenomenon is well known in parts of Europe. Nitrate levels have grown in some countries to the point where more than 10% of the population is exposed to nitrate levels in drinking water that are above the 10 mg/l guideline. Although WHO finds no significant links between nitrate and nitrite and human cancers, the drinking water guideline is established to prevent methaemoglobinaemia to which infants are particularly susceptible (WHO, 1993). Nitrogen pollution of groundwater will be a problem in developing countries also.

Reiff (1987), in his discussion of irrigated agriculture, notes that water pollution is both a cause and an effect in linkages between agriculture and human health. The following health impacts (in descending order of health significance) which apply, in particular, to developing countries, were noted by Reiff:

-:- Adverse environmental modifications result in improved breeding ground for vectors of disease (e.g. mosquitoes). There is a linkage between increase in malaria in several Latin American countries and reservoir construction. Schistosomiasis (Bilharziasis), a parasitic disease affecting more than 200 million people in 70 tropical and subtropical countries, has been demonstrated to have increased dramatically in the population following reservoir construction for irrigation and hydroelectric power production. Reiff indicates that the two groups at greatest risk of infection are farm workers dedicated to the production of rice, sugar cane and vegetables, and children that bathe in infested water.

-:- Contamination of water supplies primarily by pesticides and fertilizers. Excessive levels of many pesticides have known health effects.

-:- Microbiological contamination of food crops stemming from use of water polluted by human wastes and runoff from grazing areas and stockyards. This applies both to use of polluted water for irrigation, and by direct contamination of foods by washing vegetables etc. in polluted water prior to sale. The most common diseases associated with contaminated irrigation waters are cholera, typhoid, ascariasis, amoebiasis, giardiasis, and enteroinvasive E. coli. Crops that are most implicated with spread of these diseases are ground crops that are eaten raw such as cabbage, lettuce, strawberries, etc.

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CORRELATION OF CHEMICAL FERTILIZERS AND PESTICIDES WITH NEMA POPULATION AND INTEGRATED TECHNOLOGY FOR ENVIRONMENT CONSERVATION

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Agriculture and allied activities sector is the most important basic activities of Indian Economy. The progress of this sector holds the key to the development of the whole economy. It continues to be the main source of livelihood for the majority of the country's population. The sector contributes an important share in national product. It fulfils the basic needs of the society and supplies raw material for various manufacturing and processing industries.

Agricultural products occupy a place of pride in the export sector of the country.
Farmers use chemical fertilizers and pesticides for the growth and protection of the plants but its use does not helpful for growth and control the infections. Chemical fertilizers increase the multiplication rate of nematode because it provides nutrition to the nematodes. Most of the farmers know that the plants of their grown crops are drying due to infection of termite or any insect who is damaging the crops. So farmers use hazardous pesticide for their control but due to infection of nematodes the rhizosphere roots of plants became vanish. Nematode is causal organism of virus, fungus & bacteria, therefore with interaction of these pathogens it causes heavy losses and plants became dry and used pesticides are not helpful for saving of the plants but it effects on yield of the major food crops. Some of them are consumed by human beings directly in fresh condition after immediate harvesting. Most of the farmers are doing their farming in the embankment of Islands river Ganga flowing through the districts of Meerut, Bulandshahar, Badaun, Moradabad, Etah, Kanpur, Pratapgarh, Allahabad and Varanasi. Most of the farmers are using NPK fertilizer 250 gm. per plant in cucumber, water melon, muskmelon, bottle gourd etc. at 15 days intervals and many hazardous pesticides i.e. Malathion, Chlorpyriphos, Monocrotophos, Streptocyclin etc., thus farmers are investing @ Rs. 50-100 per plant and estimated earning is Rs. 200-300 per plant. But due to nematode and wilt problems farmers are not getting any profit in the ratio of their input cost. But due to ignorance of farmers, thousands of metric tonnes of chemical fertilizer and pesticides are adding in the river Ganga every year. Ganga runs 1500 km. in the state U.P., 450 km. in Bihar and thus total run of over 2500 km, from the source to the sea via the Bhagirathi-Hooghly. A 20 years old survey mentioned that 1.5 m. tonnes of chemical fertilizer and 2,600 tonnes of pesticides are dumped in Ganga water every year in Varanasi district only. Physio-chemicals and bacteriological quality of Ganga water is decreasing day by day and the water of Ganga is far below the recommend standards due to addition of sewage water, industrial effluents, chemical fertilizer and hazardous pesticides etc. Ganga is among the first ten mighty rivers in the world and the largest river basin in our country covering over one fourth of its total surface area. Forty three per cent of total irrigated area in the country is located in the Ganga basin. Fifty per cent population live in U.P., ten per cent in Bihar and forty per cent in West Bengal near the bank of river Ganga. Among all the river basin in India, the Ganga basin has the largest irrigation facilities in which canals play a dominant role. These polluted water of Ganga is used by the farmers for irrigation purposes. Having heavy concentration of chemical fertilizer and hazardous pesticides of Ganga water are increasing

nematode population of major fruit crops grown in U.P. due to more feeding sites at higher fertility. Excess use of nitrogen changes in nitrate form and it increases nematode population in soil. Nematode act as vector of pathogens which are capable of self establishment, when in contact with the host and as a wounding agent. It provides necrotic infection courts for other pathogens. Mineral pollution is increasing day by day by the using of these water for irrigation purposes. Most of the soils of the farmers are becoming sterile day by day due to heavy accumulation of unwanted minerals and residual effect of different pesticides. 80% of all diseases are water borne and thus most of the population of human beings, animals, aquafauna are suffering from many diseases. Heavy contamination of pesticide in water in turn leads to oxygen starvation in Bioplanktons. Pesticides also disturb the calcium metabolism and eventually the thickness of egg cell is reduced in birds results in the large scale cracking of eggs,death of embryos and abrupt in population. Various factors like microbes, temperature moisture, soil, cultivation of crops and related environmental conditions effect the process of pesticide distribution in environment and biological systems.

Therefore use of biopesticide cum biofertilizer for the ecofriendly management of nematode insect-pest, fungal pathogen fruitfly wilt diseases & post harvest diseases of major food crop. It will also provide self employment rural unemployment youth for distribution of biopesticide cum biofertilizer under farmer's field condition.

On the basis of innovated Biopesticides viz. Bionema, Biodhan, Biopacunil and wiltnema, BRCC has established its well equipped air conditioned laboratory in its own purchased house building and providing employment to 50 research staffs, including technical and other staffs. BRCC has developed a portable low cost soil testing kit for soil analysis of different parameters viz. pH, NPK, organic carbon and organic matter at farmer's field in their eyes within 30 minutes and any trained person can earn @ Rs. 50 per samples and thus BRCC has provided self employment to 300 unemployed youths and they are earning @ Rs. 5000-10,000 p.m.

For water conservation in different ponds situated in each & every village BRCC has standardized the process of fresh water pearl culture eir technology in U.P. for the first time and provided direct self-employment to 50 graduates within two years duration. Pearls known as 'Queen of Gems' have been occupying a unique place due to their fascinating beauty ever since their discovery in ancient times. Pearls were considered as an exclusive privilege of royalty and through out history held presence within wealthy and powerful. They are viewed as magic charms, symbols of purity and love or sources of wisdom and power. A natural gem 'Pearl' is produced by a living organism i.e. mollusc found in marine and fresh water ecosystem unlike other precious stones and perhaps it is the only gem that does not require the treatment by lapidary. A natural pearl is formed when a foreign particle such as a piece of sand or parasite make its way into particular species of mollusc and cannot be expelled. As a defence mechanism, the animal secretes a substance, known as nacre, to coat the foreign body. Layer upon layer of this coating is deposited on the irritant, resulting in a shimmering and iridescent creation of a gem. The culture pearl under go the same process of formation as that of natural pearl. The only difference is that an irritant, otherwise called as nucleus of desired shape and size is surgically implanted into the body of bivalve mollusc where it cannot be expelled. The animal does the rest, creating the precious biological gem, the pearl. Thus, the nature's hand is not completely eliminated, infact it is the animal that determines the character of the pearl produced.

Allahabad is bestowed with enormous ponds and never lasting flowing rivers and canals. Mussels for pearl culture are easily available in bulk quantity in the ponds, canals and rivers in and around Allahabad. Most of the ponds are in rural areas near to colony of SC/ST and economically poor person and most of the ponds are in their possession on the lease basis. Therefore the adopting of pearl culture technology will be boon for self employment and for increasing their monthly income. Normally these mussels are not used for any purposes, which are easily available in these ponds.

For soil, water, forest and environment conservation Bioved has introduced Lac culture technology for income and employment generation Lac, an eco-friendly non toxic resinous produce of an insect Kerria lacca has been endowed by nature with vast forests of food plants viz. Palas (Butea monosperma), Kusum (Schleichera oleosa), Ber (Zizyphus mauritiana), Babul (Acacia nilotica), Khair (Acacia catechu) etc. The terrestrial eco system with the lac host plants are an integral part of human life. As per estimated of forest survey of India (2001), the area under forest cover in the country is only 20.55%, even the tribals who are basically forest loving have started looping and felling of forest tree for their livelihood. Involving tribals in the forest based programmes of which lac culture is one of the most sustainable alternative mean of livelihood and therefore also essential to saved forest. Lac a tree-based products of insect origin has got potential to play an important role in the economy of tribals people. Lac cultivation is simple with no involvement of high technology and investment. It is eminently suited to be farmers living in vicinity of the forest including women as it demands only their part time attention. Its cultivation provide an important additional income next only to agriculture. The valuable gift of nature emanates from the unique interaction of plants and insects and constituted nearly 28% of agriculture income of tribals population.

BRCC has introduced its own innovative Lac Culture Technology in U.P. and adopted one lac village and rehabilitated 70 families by selective one woman from each family and provided a minimum income @ Rs. 1500-2000 per month to each family on the basis of introduced its innovative Lac culture technology.

SOIL, WATER, FOREST AND ENVIRONMENT CONSERVATION THROUGH LAC CULTIVATION

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Lac, a natural resin, is cultivated and collected by tribals inhabiting the sub-hilly tracts of Jharkhand, Chhattisgarh, West Bengal, Madhya Pradesh, Maharashtra, Orissa and Uttar Pradesh. Before the advent of synthetic plastics and resins, lac was invaluable in moulding and insulating industries, and India, then under British rule, had an unparalleled global monopoly over the lac trade. Realising the strategic importance of this commodity, the then Imperial Government of India constituted the Lindsay-Harlow Committee in 1920, to look into all aspects of the country's lac trade and its development. On the suggestions of this Committee, lac merchants organized themselves into the Indian lac Association for Research, under the aegis of which, the foundation stone of the Indian Lac Research Institute was laid on September 20, 1924 at Ranchi.

In 1951 and 1956 four regional field research stations were set up at Jhalda (W.B), Damoh, Umaria (M.P) and Mirzapur (U.P). Jharkhand, West Bengal, Maharashtra, Chhattisgarh and M.P. have taken lead in lac production in India but U.P. has disappeared in the map of lac production in India. U.P. is largest populated state in India having 8 Prime Minister and 80 seats of M.P. and largest buyer of produced lac in India but production of lac in U.P is only 0.5%. It is a matter of a great concern than no University or any other Institute/Organization tried to re-introduce the lac culture technology in U.P. once it was abandoned. Lac host plants are available in large number in Uttar Pradesh, Bioved Research and Communication Centre, Allahabad has introduced lac culture technology for the first time in U.P. with technical collaboration of ILRI, Ranchi with the financial assistance of DBT, ICAR Govt. of India.

Lac is a natural resin of insect origin. It is secreted by lac insect (Kerria lacca Kerr). It possesses a rare combination of many valuable properties and consequently finds place in diverse and innumerable uses in varnishes, polishes, food, pharmaceutical, agricultural industry etc. It is collected either as ari (immature lac) or phunki (used up broodlac) from lac host trees. Lac encrustation is separated from the twigs by either breaking off by hand or scraping with a knife or sickle. Lac, thus, gathered is known as stick lac and it is in this form that cultivators bring it to the market for sale either to manufacturers or to their agents.

Removing the dye, insect body, fecal matter, sticks, stones, sand etc. as far as possible by crushing, sieving and winnowing; and washing out the dye with water, yields the semi-refined product known as seed lac. Generally, seed lac appear in the form of grain of 10 mesh or smaller and yellow or reddish brown in colour depending on the host tree and the place from which the stick lac has been collected. Adhering impurities on these grains of seed lac amount to 3-8 per cent, averaging 5 per cent. There is a market for this semi-refined product in foreign countries also.

Bioved has taken lead to disseminate the scientific method of lac culture among tribal women of Meja and Koraon of Allahabad. Demonstration and training of scientific method of lac culture have been started sine July,2003 with technical collaboration of ILRI. The cultivators are earning at least Rs. 1500-2000 per month on the adoption of scientific method of lac culture technology. Lac culture technology has changed the life of poorest people of largest areas. The lac host plants (69592) are in and around 20 villages include Palas, Ber, Babbol, Peepal and Jungle d 5

Jalebi available. During the year 2004-05, women lac growers of the areas have sold 5 quintal brood lac (seed) and 50 quintal scrape lac @ Rs. 60-80 per kg and thus was earned Rs. 3,00000/- by the adopted Gram Sabha. , Bioved Research and Communication Centre has taken cent per cent security and accountability of the lac growers for obtaining minimum monthly income @ 1500-2000 per month on the basis of adoption of Scientific Method of Lac culture Technology. 70 families (total 700 population) were rehabilitated on the basis of Scientific Method of Lac Culture Technology, and 993 families of 20 villages have started lac cultivation during the year 2004-06. 10137 lac host plants are utilized for lac cultivation. Maximum income per beneficiary per annum is Rs. 64125 and minimum i,e. Rs. 36,840. Maximum income per lac host plant was Rs. 601.75 and minimum was Rs. 435.75 per plant. There is no any technology/resources for the poorest families for obtaining maximum profit, in the ratio of their minimum input as compared with promising results shown by lac culture technology. Primary lac Processing unit has established at Bioved Krishi Prodyogiki Gram, Sringverpur Allahabad district for Primary Processing of lac & lac based value added product formation and also for Training for the interested women farmers of marginal communities.A marketing Co-operative of Lac was established as Bioved Lac & Wares Unit at Bioved Research & Communication Centre,Allahabad for Marketing & Primary Processing of Lac for Lac growing farmers of U.P. In the month of July 08, total matured lac produced in 4 representative district of U.P. i.e. 86.3 Q matured lac was produced by lac growers in Allahabad district,41.2 Q matured lac & 2.8Q ari lac was produced by lac growers of chitrakoot district, 44.3 Q matured lac was produced by lac growers of Mirzapur district and 33.7 Q matured lac was produced by lac growers of Sonbhadra district.Average income per farmer/season was evaluated in the month of July 08 in Allahabad district Rs. 4072, in Chitrakoot district Rs. 2392.50, in Mirzapur district Rs. 2022 and in Sonbhadra district Rs. 1522.50 .During Front-line demonstration of Scientific Method of Lac Cultivation total 354 farmers of Allahabad district, 332 farmers of Chitrakoot district, 291 farmers of Mirzapur district and 167 farmers of Sonbhadra district were trained about Scientific Method of Lac Cultivation and thus 1140 lac growers have got self employment directly and 3500 farmers are being self employed in scientific method of lac cultivation. Thus lac culture technology is eco-friendly, socially acceptable, economically viable and having no risk to plants animals and human beings. It is very cheap and congenial technology for soil, water, forest and environment conservation including income and employment generation as well as honey production.

PHYTOREMEDIATION TECHNOLOGY: A BOON FOR GREEN AND HEALTHY ENVIRONMENT

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ABSTRACT

In recent year, urban and industrial environment has changed with the highly pollutant load from emission of gasses and discharge of industrial effluent in India as well as whole world. In this paper, it has been illustrated that how we can manage our resources from the pollution and overexploitation because the resources have ability to maintain the ecological balances in the nature. Phytoremediation, a biological tool, in which we can use the plants for cleansing or stabilize contaminants in soil and groundwater, has newly received a great technology of attention from pollution control governmental and non-governmental bodies. Phytoremediation has developed into an effective substitute to other treatment and remediation technologies due to its reasonably low-cost, prospective proficiency and the inherently aesthetic nature of using plants to ameliorate polluted sites. This study will definitely meet out the needs to those persons which are going to carry out research in the field of pollution abatement. Phytoremediation has become tool and technology for researchers and pollution regulatory bodies and also has a popular and economic feasible for the management of pollution in developed countries. The developing countries like India this technique has yet to popularize. Keeping the aforesaid facts in mind, this study has been reviewed with particular reference to phytoremediation so as to disseminate the proper information and technology about phytoremediation to grass root level.

Key words : Phytoremediation, pollutant load

Introduction

Biosphere pollution by heavy metals and nucleotides was accelerated dramatically during the last few decades due to mining, smelting, manufacturing, treatment of agricultural soils with agro-chemicals and soil sludge, etc. Problems associated with the contamination of soil and water such as animal welfare, health, fatalities and disruptions of natural ecosystems are well documented (He et al., 2005). Human exposure to these metals through ingestion of contaminated food or uptake of drinking water can lead to their accumulation in humans, plants and animals. (Khan, 2006) Lead, Copper, Zinc and Cadmium are also found naturally in soils and they can cause significant damage to environment and human health as a result of their mobility and solubilities. They can occur in soil and water in several forms and their speciation in soils is determined by sequential extraction using specific extract ants, which solubilize different phases of metals (Shuman, 1985).

Many human diseases result from the buildup of toxic metal in soil, making remediation of these areas crucial in the protection of human health. Lead is one of the most difficult contaminants to remove from the soil, as well as one of the most dangerous. The presence of lead in the environment can have devastating effects on plant growth and can result in serious side effects including seizures and mental retardation - if ingested by humans or animals. (Lasat, 2000) Both humans and livestock can be exposed to toxic levels of lead through inhalation of particulate matter in the air as well as direct ingestion of contaminated food, water, or dust. (Lasat, 2000) Much of the global lead contamination has occurred as a result of mining and iron smelting activities. (Huang et al., 1996) Phytoremediation of lead contaminated soil involves two of the aforementioned strategies phytostabilization and phytoextraction. It is believed that a plant's ability to phytoextract certain metals is a result of its dependence upon the absorption of many metals such as zinc, manganese, nickel, and copper to maintain natural function. (Lasat, 2000) Most plants only accumulate these essential elements and prevent all others from entering. However, some plants, termed "hyperaccumulators", extract and store extremely high concentrations (in excess of 100 times greater than non-accumulator species) of metallic elements. (Lasat, 2000) Research has shown that these hyperaccumulators often do not exclude non-essential metals in the absorption process, thus resulting in plants that can extract high levels (1-2% of their biomass) of pollutants from contaminated soil. (Lasat, 2000) It is believed that plants initially developed this ability to hyperaccumulate non-essential metallic compounds as a means of protecting themselves from herbivorous predators, which would experience serious toxic side effects from ingestion of the hyperaccumulator's foliage. (Pollard et al.,, 1997) Lead is one of the non-essential compounds hyperaccumulated by several species of plants including Thalaspi rotundifolium and Brassica juncea. The difficulty with these models, in terms of performing phytoremediation, is that they grow very slowly and have a very low biomass. (Huang et al., 1996) Therefore, the bioremediation process would be extremely slow because the rate of bioremediation is directly proportional to growth rate and the total amount of bioremediation is correlated with a plant's total biomass. Because no plant yet discovered meets the ideal criteria of an effective phytoremediator (fast growing, deep and extensive roots, high biomass, easy to harvest, hyperaccumulators of a wide range of toxic metals), it is necessary to introduce the hyperaccumulating genes into non-accumulator to make the plants better suited as agents in the phytoremediation process. (Clemens et al., 2002)

Category of Phytoremediation

Though several regulatory steps have been implemented to reduce or restrict the release of pollutants in the soil, they are not sufficient for checking the contamination. Metal contaminated soil can be remediated by chemical, physical and biological techniques. These can be grouped into two categories (Baker et al., 1990)

Ex-situ method

It requires removal of contaminated soil for treatment on or of site, and returning the treated soil to the resorted site. The conventional ex-situ methods applied for remediating the polluted soils relies on excavation, detoxification and/or destruction of contaminant physically or chemically, as a result the contaminant undergo stabilisation, solidification, immobilisation, incineration or destruction.

In-situ method

It is remediation without excavation of contaminated site. Reed et al., defined in-situ remediation technologies as destruction or transformation of the contaminant, immobilization to reduce bioavailability and separation of the contaminant from the bulk soil (Reed, et al., 1992). In-situ techniques are favored over the ex-situ techniques due to their low cost and reduced impact on the ecosystem. Conventionally, the ex-situ technique is to excavate soil contaminated with heavy metal and their burial in landfill site (McNeil et al., 1992 and Smith et al., 1993)

Types of Phytoremediation

Rhizofiltration

Metal pollutants in industrial-process water and in groundwater are most commonly removed by precipitation or flocculation, followed by sedimentation and disposal of the resulting sludge (Ensley, 2000). A promising alternative to this conventional clean-up method is rhizofiltration, a phytoremediative technique designed for the removal of metals in aquatic environments. The process involves raising plants hydroponically and transplanting them into metal-polluted waters where plants absorb and concentrate the metals in their roots and shoots (Zhu et al., 1999). Root exudates and changes in rhizosphere pH also may cause metals to precipitate onto root surfaces. As they become saturated with the metal contaminants, roots or whole plants are harvested for disposal (Zhu et al.,, 1999). Dushenkov et al., 1995 explains that the translocation of metals to shoots would decrease the efficiency of rhizofiltration by increasing the amount of contaminated plant residue needing disposal. In contrast, Zhu et al., 1999 suggest that the efficiency of the process can be increased by using plants which have a heightened ability to absorb and translocate metals within the plant. Despite this difference in opinion, it is apparent that proper plant selection is the key to ensuring the success of rhizofiltration as a water cleanup strategy.

Phytostabilization

Sometimes there is no immediate effort to clean metal-polluted sites, either because the responsible companies no longer exist or because the sites are not of high priority on a remediation agenda (Berti and Cunningham, 2000). The traditional means by which metal toxicity is reduced at these sites is by in-place inactivation, a remediation technique that employs the use of soil amendments to immobilize or fix metals in soil. Although metal migration is minimized, soils are often subject to erosion and still pose an exposure risk to humans and other animals. Phytostabilization, also known as phytorestoration, is a plant-based remediation technique that stabilizes wastes and prevents exposure pathways via wind and water erosion; provides hydraulic control, which suppresses the vertical migration of contaminants into groundwater; and physically and chemically immobilizes contaminants by root sorption and by chemical fixation with various soil amendments (Berti and Cunningham, 2000). This technique is actually a modified version of the in-place inactivation method in which the function of plants is secondary to the role of soil amendments. Unlike other phytoremediative techniques, the goal of phytostabilization is not to remove metal contaminants from a site, but rather to stabilize them and reduce the risk to human health and the environment.

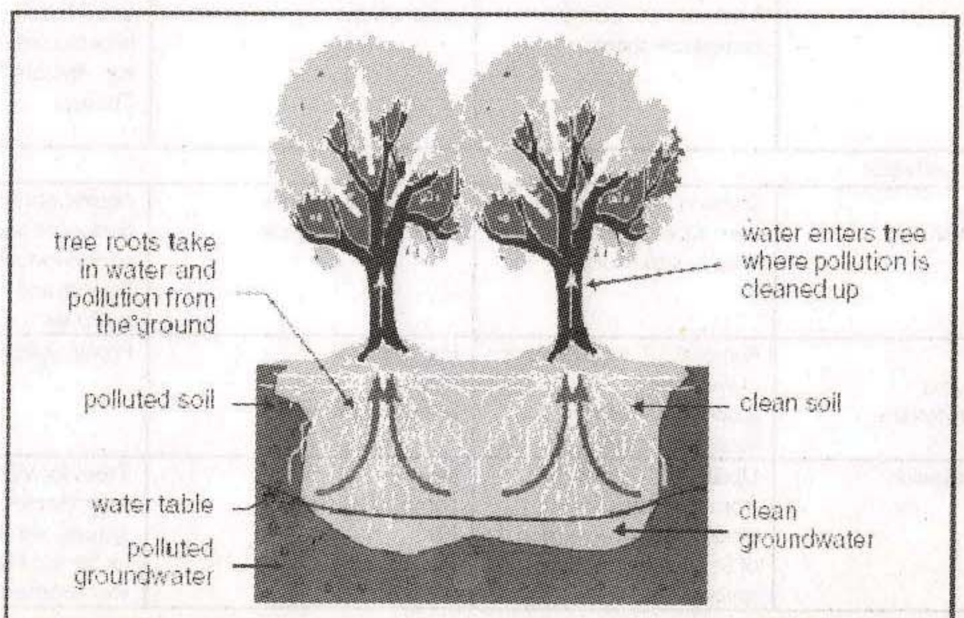
Phytovolatilization

Some metal contaminants such as As, Hg, and Se may exist as gaseous species in environment. In recent years, researchers have searched for naturally occurring or genetically modified plants that are capable of absorbing elemental forms of these metals from the soil, biologically converting them to gaseous species within the plant, and releasing them into the atmosphere. This process is called phytovolatilization, the most controversial of all phytoremediation technologies. Mercury and Se are toxic (Wilber, 1980; Suszcynsky and Shann, 1995), and there is doubt about whether the volatilization of these elements into the atmosphere is safe (Watanabe, 1997).

Phytoextraction

Phytoextraction is the most commonly recognized of all phytoremediation technologies, and is the focus of the research proposed in this prospectus. The terms phytoremediation and phytoextraction are sometimes incorrectly used as synonyms, but phytoremediation is a concept while phytoextraction is a specific cleanup technology. The phytoextraction process involves the use of plants to facilitate the removal of metal

Figure 1: Showing phytoremediation for decontamination of groundwater and soil.



Source: United States Environmental Protection Agency (April, 2001)

Table 1: Advantages and disadvantages of Phytoremediation.

S. No.	Advantages	Disadvantages / Limitation
1.	Amendable to a variety of organic and inorganic compounds.	Restricted to sites with shallow contamination within rooting zone of remediative plants.
2.	In Situ / Ex Situ Application possible with effluent/soil substrate respectively.	May take up to several years to remediate a contaminated site.
3.	In Situ applications decrease the amount of soil disturbance compared to conventional methods.	Restricted to sites with low contaminant concentrations.
4.	Reduces the amount of waste to be Land-filled (up to 95%), can be further utilized as bio-ore of heavy metals.	Harvested plant biomass from phytoextraction may be classified as a hazardous waste hence disposal should be proper.
5.	In Situ applications decrease spread of contaminant via air and water.	Climatic conditions are a limiting Factor.
6	Does not require expensive equipment or highly specialized personnel.	Introduction of nonnative species may affect biodiversity
7.	In large scale applications the potential energy stored can be utilized to generate thermal energy.	Consumption/utilization of contaminated plant biomass is a cause of concern.

Source : Ghosh and Singh, (2005)

Table 2: Applications of phytoremediation

Application	Description	Contaminants	Types of plants
Soils			
Phytotransformation	Sorption, uptake and transformation of contaminants	Organics, including Nitroaromatics and Chlorinated aliphatics	Trees and grasses
Rhizosphere biodegradation	Microbial degradation in the rhizosphere stimulated by plants	Organics such as PAHs, petroleum hydrocarbons, TNT, pesticides	Grasses, alfalfa, many other species including trees
Phytostabilization	Stabilization of contaminants by binding, holding soils or decreased leaching	Metals, organics	Various plants with deep or fibrous root systems
Phytoextraction	Uptake of contaminants from soil into roots or harvestable shoots	Metals, inorganics, radionuclides	Variety of natural and selected hyperaccumuators e.g. Alyssum, Brassica or Thelaspi
Water/Groundwater			
Rhizofiltration	Sorption of contaminants from aqueous solutions onto or into roots	Metals, radionuclides, Hydrophobic organics	Aquatic plants e.g. duckweed and pennywort; also Brassica and sunflower
Hydraulic control/plume capture/phytotrans	Removal of large volumes of water from groundwater and/or aquifers by trees	Inorganics, nutrients, chlorinated solvents	Poplar, willow trees
Phytovolatilization	Uptake and volatilization from soil water and groundwater, conversion of Se and Hg to volatile species	Volatile organic compounds, Se and Hg.	Trees for VOCs in groundwater, brassica, grasses, wetland plants for Se and Hg in soil/ sediments

Source : Schooner (2002)

contaminants from a soil matrix (Kumar et al., 1995). Phytoextraction should be viewed as a long-term remediation effort, requiring many cropping cycles to reduce metal concentrations (Kumar et al., 1995) to acceptable levels. The time required for remediation is dependent on the type and extent of metal contamination, the length of the growing season, and the efficiency of metal removal by plants, but normally ranges from 1 to 20 years (Kumar et al., 1995 and Blaylock and Huang, 2000). This technology is suitable for the remediation of large areas of land that are contaminated at shallow depths with low to moderate levels of metal- contaminants (Kumar et al., 1995 ; Blaylock and Huang, 2000).

Phytodegradation

In phytoremediation of organics, plant metabolism contributes to the contaminant reduction by transformation, break down, stabilization or volatilizing contaminant compounds from soil and groundwater. Phytodegradation is the breakdown of organics, taken up by the plant to simpler molecules that are incorporated into the plant tissues. (Chaudhry et al.,, 1998) Plants contain enzymes that can breakdown and convert ammunition wastes, chlorinated solvents such as trichloroethylene and other herbicides. The enzymes are usually dehalogenases, oxygenases and reductases (Black, 1995) Rhizodegradation is the breakdown of organics in the soil through microbial activity of the root zone (rhizosphere) and is a much slower process than phytodegradation. Yeast, fungi, bacteria and other microorganisms consume and digest organic substances like fuels and solvents. All phytoremediation technologies are not exclusive and may be used simultaneously, but the metal extraction depends on its bio available fraction in soil. (Ghosh and Singh, 2005)

Conclusion

The general public is more and more concerned about soil and water pollution and its probable effects on ecosystems and on human health. Therefore, considerable effort has been put into the development of economic feasible and efficient method to clean up contaminated sites. In situ methodology decrease soil disturbance and the possibility of contaminant from dispersion passing through air and water reduce the amount of waste to be landfilled sites and are economical compared with other treatment methodologies. In addition to this, it is easy to execute and sustain, does not require the use of expensive and sophisticated equipment or highly specialized personnel and is environmentally friendly and aesthetically pleasurable to the public. On the other hand, phytoremediation is restricted to sites where toxic metal pollution, organic compound pollution concentration is low and near the surface, may take lot of time duration to remediate a contaminated site. Phytoremediation is measured to be an innovative tool and expectantly by increasing our awareness and understanding of this complicated remediation method, it will grant as an economical feasible, eco-friendly substitute to conservative treatment methodology.

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GLOBAL CLIMATE CHANGE AND ITS IMPACT ON AGRICULTURAL, LIVESTOCK AND FISHERIES PRODUCTION

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The term "global warming" is a specific example of the broader term climate change, which also refers to global cooling. In common usage the term refers to recent warming and implies a human influence. The UNFCCC uses the term climate change for human caused change and climatic variability for other changes. The term anthropogenic climate change is sometimes used when focusing on human induced changes.

Climate change and variability

Climate change is the variation in either mean state of the climate or in its variables persisting for an extending period, typically decades or longer. It encompasses temperature increase (global warming) and decrease (global cooling), sea level rise, changes in precipitation pattern, and increased frequencies of extreme weather events. Climatic variability refers to sudden and discontinuous seasonal or monthly or periodic changes in climate or its components without showing any specific trend of temporal change. Thus climate change follows a specific pattern of change in climate or its variables over the time.

Mechanism of global warming

Global warming and climate change has emerged as an important global concern cutting across geographical and national boundaries. Global warming is defined as the increase in the temperature of globe due to transmission of incoming short-wave radiation from the sun and the absorption of outgoing long-wave radiation from the earth by GH gases. The phenomenon is called Greenhouse effect or more precisely called "Natural greenhouse effect". The term "Greenhouse effect" is derived from the phenomenon of warming effect that take place inside greenhouses (glasshouses) used for off-season cultivation in temperate areas. An increase in the concentration of greenhouse gases such as CO2, CH4, N20 in the atmosphere is thought to have been responsible for increasing the air temperature (Hansen et al., 1984). This is called as "Enhanced greenhouse effect", which is the additional effect induced by human activities.

Evidences of global warming

A: Physical Evidence

- -:- Rise in atmospheric temperature (land & sea)
- -:- Shifting and shrinking of cooling period with prolonged warmer duration and hastened spring season
- -:- Rise in sea water level and melting of glaciers
- -:- Occurrence of climatic extreme & natural disaster
- -:- Spatial pattern of climate (rain fall & temperature) has changed markedly
- -:- Number of cloudy days has reduced drastically
- -:- PH of seawater has decreased substantially

B: Biological Evidence

- -:- Early blossoming of trees
- -:- Appearance of grasses in Antarctic
- -:- Changes in cropping pattern from wheat to maize in Bihar
- -:- Geographical shifting of temperate fruits toward high latitude
- -:- Causality in Europe due to high temp.
- -:- Vulnerability of frog to devastating fungus
- -:- Killing of large Dimb tree population in Senegal
- -:- Spatial shifting of marine fish population in Bay Island
- -:- Northward movement of ticks and bleaching of corals

Causes of Global Warming

Greenhouse gas emission: Most of the observed increase in globally averaged temperature since the mid century is very likely due to the observed increase in anthropogenic greenhouse gas concentration through greenhouse effect. Industries, energy, transportation, vehicles, intensive agriculture etc. contribute to GHG emission. Energy and industries contribute 72% and agriculture alone accounts for 28% to total GHG emission. Natural phenomenon such as solar variation combined with volcanoes have probably had small effect from pre-industrial to 1950, but a small cooling effect since 1950 (controversial)

Deforestation: Rapid deforestation has led to depletion in CO2 fixation through photosynthesis thereby increase in the atmospheric CO2 level, as forest is a major biological sink of CO2. Contribute only 1% to total GHG emission

Population: A major cause of global warming through developmental activities

Global warming scenario

A. Global temperature

-:- Since 1979, land temperature has increased about twice as fast as ocean temperature (0.25 0C per decade against 0.13 0C per decade).

-:- Global average temperature near the earth surface rose by 0.75 0C+-0.18 0C (0.56-0.920C) during the 20th century relative to period 1860-1900.

-:- Temperature is believed to have been relatively stable over the one or two thousand years before 1850.

-:- Sea temperature increases more slowly than those on land both because of larger effective heat capacity and because the ocean can lose heat by evaporation more readily than land.

-:- The last 50 years have reported to be warmest in the last 1300 years.

-:- The last eleven of twelve years have been reported warmer since 1980

-:- The magnitude of increase in temperature has been reported to be higher at high latitude as compared to low latitude.

-:- The rate of increase in atmospheric temperature was due to both maximum and minimum temp.

B. Greenhouse gases

-:- The level of atmospheric CO2 has increased from 280 ppm in 1850 to 385 ppm presently (+37%). The major sources of CO2 emission are fossil fuel burning in industries, energy production, transportation, and due to deforestation.

-:- Agriculture is not the source of CO2 emission. It has increased @ 2.33ppm every year during the last decade.

-:- CO2 accounts for about 65% of total GHG emission in India. The present atmospheric level of greenhouse gases (GHG) is around 423ppm and their cumulative rate of emission is around 3.30%, which is very high compared to the past rate of emission of these gases (0.5-1.0 %).

-:- Carbon dioxide alone accounts for 55-60% contribution in global warming but has lowest warming potential

-:- Methane concentration increased @149% since 1850 (1.94 ppm).

-:- It accounts for 15-20 % contribution in global warming with 21-25 times higher warming potential compared to CO2

-:- It accounts for 31% of total GHG emission in India.

-:- Agriculture contributes about 78% of total methane emission in India.

-:- The ruminant animals like cattle and buffaloes are the largest contributors (59%) of methane emission followed by rice paddy fields (23%) in India

-:- Nitrous oxide concentration in the air has increased substantially but now there is no further increase.

-:- It contributes only 4% to total GHG emission with 5% contribution to global warming and about 140 times greater warming potential as compared to CO2.

-:- Agriculture contributes about 84% to total N2O emission in India.

-:- These levels are considerably higher at any time during the last 650000 Years.

-:- Ozone concentration has been doubled as compared to 1850 level.

C. Rise in sea water level: Sea water level has increased by 75mm in the last century.

D. Rainfall: The number and frequencies of extreme rainfall, floods, droughts & cyclone have increased especially during the last 50 years.

Changes in the concentration of GHG and their warming potential and contributio

G H G	Concentration (ppm)		Increasing Trend	Warming Potential	Percent contribution to GW
	Pre 1850	Post 1850			
CO_2	280	380	37%	1	55-60
CH_4	0.75	1.94	149%	25	15-20
N_2O	0.285	0.385	35%	140	5
O_3	0.020	0.040	100%	430	2
CFC 11	Nil	250ppb	4	14600	6
CFC 12	Nil	450ppb	4	17000	12

Measures to reduce greenhouse gas emission from agriculture

-:- Improve management of rice paddies production through judicious use of organic manure, fertilizers, irrigation water, nitrification inhibitors, fertilizer placement and their schedulingImprove management of livestock population especially ruminants and its diet Increase soil organic carbon through minimal tillage and residue management Improve energy use efficiency in agriculture through better designs of machinery, and by resource conservation practices

-:- Change land use by increasing area under bio-fuels, agro-forestry - but not on the cost of food production.

Projections of Global Warming Scenario

-:- There is a general agreement that temperature is likely to rise by 1.1 to 6.4 0C by the end of 21st century with a probable 2.0-4.5 oC range if CO2 concentration doubles from pre-industrial level, with a best estimate of about 3 0C, and is very unlikely to be less than 1.5 0C.

-:- Values substantially higher than 4.5 0C cannot be excluded. (IPCC, 2007) Best estimate for low scenario (B1) is 1.8°C (likely range is 1.1°C to 2.9°C), and for high scenario (A1FI) is 4.0°C (likely range is 2.4°C to 6.4°C).

-:- Projected warming in 21st century expected to be greatest over land and at most high Northern latitudes and least over the Southern Ocean and parts of the North Atlantic Ocean.

-:- For the next two decades a warming of about 0.2 0C per decade is projected.

-:- Even if all future emission of GHG were stopped now, a further warming of about0.1 0C per decade would be expected.

-:- It is likely that future tropical cyclone will become more intense with large peak wind speed and heavier rain.

-:- Snow cover is projected to contract. It is very likely that hot extremes heat waves, and heavy precipitation events will continue to become more frequent.

-:- Increase in the amount of precipitation are very likely in high latitude, while decreases are likely in most subtropical land reasons, continuing observed patterns in recent trends.

-:- The projected sea level rise by the end of this century is likely to be 18-59 cm with an additional 10 cm 20 cm possible if recent melting of polar ice sheets continues.

Future Projections of climate change (IPCC, 2007)

Case	Temperature between 2000-2100		CO2 Con(ppm)	Sea level rise (mt)
	Best Scenario	Likely range		
By 2005	0.74	0.3-0.9	380	75mm
B1	1.8	1.1-2.9	540	0.18-0.38
A1T	2.4	1.4-3.8	575	0.20-0.46
B2	2.4	1.4-3.8	611	0.20-0.43
A1B	2.8	1.7-4.4	703	0.21-0.48
A2	3.4	2.0-5.4	836	0.28-0.51
A1FI	4.0	2.4-6.4	958	0.26-0.59

Impacts of global warming

A. Physical impacts

-:- Melting of glaciers may cause flooding followed by droughts in near future.
-:- Water availability may be another severe social and agricultural problems due to greater loss of moisture through evapo-transpiration and more demand for drinking/ industry and irrigation.
-:- Coastal inundation due to sea level rise and water expansion may lead to greater loss of coastal biodiversity especially mangrove plant/animal species responsible for coastal ecosystem protection.
-:- Occurrence of natural calamities such as severe storms, floods, droughts, cyclone, tsunami, hurricane etc. could be more frequent due to global warming.
-:- Pole ward expansion of arable land in the regions where low temperatures are limiting for crop cultivation mainly due to rise in temperature, which may be conducive for crop cultivation.
-:- Changes in Carbon/nitrogen dynamics of soil and increase in loss of nitrogen due to greater volatilization.

B. Biological impacts

Direct and indirect effects of rising CO2

-:- C3 crops are benefited while C4 crops are unaffected, but positive effect is manifested only when other factors are not limited
-:- Photosynthetic rate of C3 crops increased mainly due to reduced photorespiration
-:- Growth and productivity of C3 crops increased directly by rising CO2 level but may be offset by increased atmospheric temperature and C3 weeds in C3 crops
-:- Input (fertilizers, irrigated water) and natural resource (radiation, water) use efficiency of C3 crops is enhanced under rising CO2 level
-:- C3 crop plants behave physiologically like C4 plants without changing their biochemical pathway
-:- Biomass, leaf area and yield of C3 crops are increased significantly without proportional increase nitrogen uptake, which leads to greater nitrogen use efficiency but lower protein content both in straw and seeds/grains
-:- C/N ratio of C3 plants is likely to increase thereby depleting nutritional quality especially protein content.
-:- More beneficial for fodder, sugarcane, potato, root foliage crop where sink is not a limiting factor

Direct and indirect effect of warming

-:- Global warming may be beneficial for alpine regions mainly by expanding arable lands and extending crop growth duration, but harmful for temperate, subtropical and tropical regions
-:- High temperature may reduce growth and yield of both C3 and C4 crops at their growing sites mainly due to fostering growth and developmental processes leading to shortening of crop growth duration
-:- Global warming reduces growth and productivity of both C3 and C4 crops owing to increase in the rate of both dark and photorespiration (respiratory losses)
-:- Flowering and fruiting of several temperate crops viz. apple, cabbage, cauliflower potato, carrot, cherry, plum, etc. may be severely affected by warming
-:- Contrary to CO2 fertilization, global warming reduces resource utilization efficiency of crops mainly due to low biomass and grains/seeds production
-:- High temperature may lead to spatial and temporal loss of crop biodiversity
-:- Chemical integrity and both physical and nutritional quality especially sweetness and compaction of protein and starch of valuable food and fruit crops may be reduced substantially
-:- Geographical shifting of temperate crops from their traditional areas of cultivation to upper latitude for acquiring optimum thermal regime for flowering and fruiting.
-:- Spread of existing disease and insect pests and emergence of new biotypes and diseases
-:- Greater crop/weed competition for their growth and productivity

C. Social impacts: Migration of population from warmer prone areas to urban areas in search of jobs.

D. Economic impacts: Reduction in agricultural income due to low productivity and higher cost of production.

Impact of Climate Change on crops productivity and quality

-:- Rising atmospheric CO_2 to the level of 660ppm increased rice yield by 6-50 %, photosynthetic rate by 20-60%, while decreased transpiration rate and stomatal conductance approximately 16 and 33% respectively. But expanding leaf surface finally offset the benefit of water economy effect.
-:- The productivity of rice reduced by 10% for every 10C increase in growing season mean temperature between 30 & 40 0C.
-:- The rise in minimum temperature caused greater reduction in rice grain yield as compared to negligible effect of rise in maximum temperature.
-:- The productivity of wheat reduced @ 3-4 % per 0C increase in mean atmospheric temperature. The yield of wheat, maize, sorghum and soybean reduced by 5% for every 10C rise in mean daily temperature.
-:- High temperature caused detrimental effect on reproductive organs such as pollen and spikelets, while the growth of vegetative organs like leaf and stem is stimulated by high temperature.
-:- Both rice and wheat plants appear to be most sensitive to high temp. at anthesis as it induces high percentage of pollen and spikelet sterility. Exposure to high temperature of a time span of few hours can greatly reduce pollen viability and therefore cause irreversible yield loss
-:- A key mechanism of high temperature induced floret sterility in rice appears to be decreased ability of pollen grains to swell, resulting in poor thecae dehiscence
-:- High temperature and CO_2 caused alteration in the chemical integrity of tissues and physical and nutritional quality characteristics of seeds, grains such as amylose, protein and the ratio of amylose/amylopectin, chalkiness and higher C/N ratio in grains.
-:- The protein content of rice grain grown under elevated CO_2 reduced markedly, while chalkiness of kernel was increased.

Impact of Global Warming on milk production

The studies on the impact of high temperature and humidity on milk production of cattle and buffaloe carried out at National Dairy Research Institute, Karnal under the Network project on climate change indicated that small change in Temperature-humidity Index (THI) due to rise in atmospheric temperature is not likely to affect both the physiological function and milk production of cattle and buffalo significantly, but both milk production and reproductive function of cattle as well as buffaloes are likely to be affected adversely by projected temperature rise of 2-6 0C by the end of this century. The negative impact of warming on milk production is likely to be more in northern India than in other parts. The crossbreed cattle showed maximum hyper-thermal sensitivity followed by buffalo and indigenous cattle.

Impact of Global Warming on Oil Sardine

Massive fishery in India; probably the largest stock in the Indian Ocean, which play a crucial role in marine ecosystems as a plankton feeder and as food for larger fishes and
low priced staple sustenance and nutritional food for millions. A tropical fish with preference for SST > 28C is likely to change its habitat and production/breeding site in Indian peninsular coastal regions due to rise in ocean temperature.

Bio-geographic shift of fishes in Ganges

The cool upper stretch with the presently elevated maximum temperature of 25.5oC at Haridwar has become conducive to the warm water fishes. Warm water fishes like G. giuris, P. ticto, X. cancila, M. vittatus, Catla catla, mainly inhabiting middle and lower Ganga, are now available in upper Ganga at Haridwar and above.

Advancement of fish breeding season

Fish seed hatchery in North 24 Parganas showed advancement of the breeding season by more than a month in the last two decades. Indian major carps breeding started during 24-31 May during 1980 but during 7-14 April in recent times. This results in an extended breeding season (from 110-120 to 160-170 days)

Implications of global warming for crops: IPCC 2007

-:- Increases in the frequency of droughts and floods are projected to affect production negatively, especially in subsistence sectors at low latitudes.

-:- Regional changes in the distribution and production of fish species are expected due to continued warming, with adverse effects projected for aquaculture and fisheries

-:- Crop yields to increase slightly at mid to high latitudes for temperature increase of 1-30C, and then decrease beyond that.

-:- At lower latitudes, crop yields tend to decrease for even small temperature increases (1-2oC).

-:- Globally, the potential for food production is projected to increase with increases in 1-3oC temperature, but to decrease above this.

-:- Simple adaptations such as altered cultivars and planting times allow cereal yields to be maintained at or above baseline yields for modest warming.

Projected impacts of global warming on Indian agriculture

-:- Productivity of most crops may decrease due to increase in temperature and decrease in water availability especially in Indo-gang tic plains.

-:- Greater loss expected in Rabi as compared to Kharif season crops. Cultivation of wheat and other hypo-thermophilic crops like cauliflower, cabbage in central India and temperate crops like apple, cherry, plum, peach, in northern India are likely to be threatened by global warming.

-:- Reduced frequency of frost damage in Northern India is expected.

-:- Impacts on food quality could be variable depending on the magnitude of thermal increase and type of crop.

-:- Sustainability of endemic crops like Basmati rice and lichi could be severely affected by GW.

-:- Considerable effect on microbes, pathogens, and insects population and virulence.

-:- Imbalance in food trade due to positive impacts on Europe and N. America, and negative impacts on tropical and sub-tropical countries like India, Brazil, Mexico

-:- Increasing temperature would increase fertilizer requirement for the same production targets and result in higher GHG emissions, ammonia volatilization and cost of crop production

-:- Increased frequencies of droughts, floods, storm and cyclones are likely to increase production variability.

-:- Increased water, shelter, and energy requirement for livestock.

-:- Increasing sea and river water temperatures are likely to affect fish breeding, migration and cost and quality of agricultural produce..

Adaptation to climate change

Natural or self adaptation: Crops and animals show varying ability to adapt them to warming through different adaptive mechanism such as shifting their optimum thermal range, escaping, avoidance, thermal cooling, stomatal closure, cutinization, waxination, development of heat shock protein, osmoregulation etc.

Genetic adaptation: Breeding crop varieties for heat tolerance through conventional and modern breeding techniques. Screening heat tolerant crop genotypes followed by exploitation of desirable genes mainly from the germplasm adapted to such warmer condition.

Non-genetic adaptation: Agro-physiological manipulation such as dates of sowing, frequent irrigation, higher dose of chemical fertilization, crop diversification, green manuring etc. to reduce vulnerability to climate change. Identification of crop genotypes for faster grain growth rate with delayed leaf senescence under higher thermal regime.

Biotechnological approaches: Selective gene transfer from donor without major changes in genetic makeup

Crop insurance: Reducing climatic risk of crop productivity through crop insurance.

Better support price and credits: Better support r price of agricultural produce is and bank credits are essential for crop sustainability and to meet the additional adaptation cost of climate change

Measures to adapt agriculture to climate change

-:- Greater investments in adaptation research capacity by changing varieties, land use systems, resource conservation technologies, pest surveillance etc.
-:- Changes in policies e.g. incentives for resource conservation (C, W, E) and use efficiency, pricing of resources, credit for transition to adaptation technologies
-:- Investments in infrastructure for water management
-:- Relocation to more productive areas
-:- Greater insurance coverage for the farm Improved communication of climate changes and options to adapt them
-:- Creating alternate livelihood options and reducing dependence on agriculture

Constraints in adaptations

Availability of inputs at desired time and scale
-:- Time lag in responses
-:- Unpredictable extreme events
-:- Seeds of adapted varieties and supply of electricity and diesel
-:- Irrigation water, fertilizer and machinery
-:- Environmental, social and economic costs of adaptation could be high
-:- Marginal and small farmers may not be able to bear coping strategies

Global warming and biodiversity

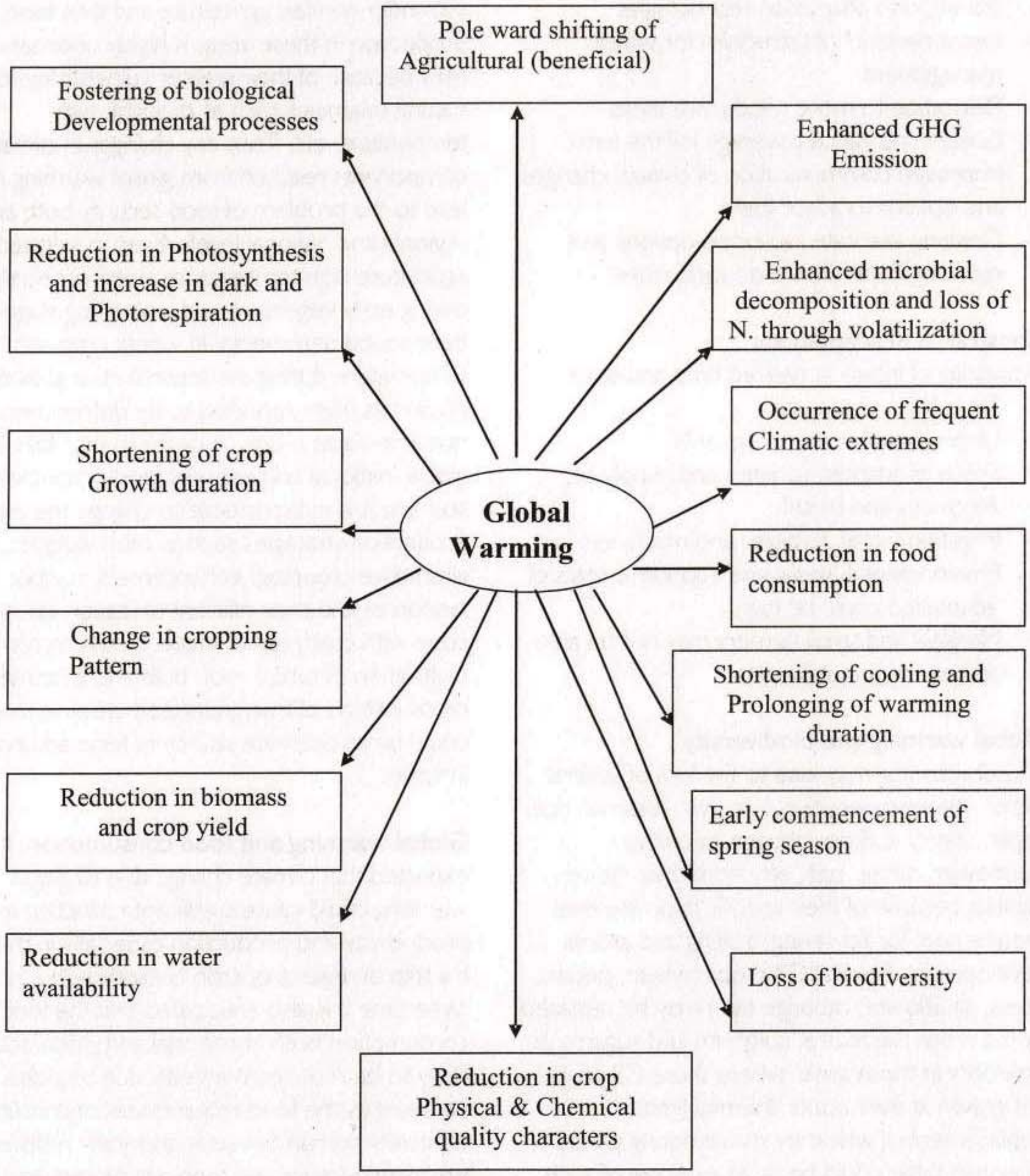
Global warming may lead to the loss of several hyper - thermo-sensitive crops viz., basmati rice, apple, cherry, saffron cabbage, snowball cauliflower, carrot, pea, etc. from their native habitats because of their specific hypo-thermal requirement for flowering, fruiting and aroma development. Several C3 crops (wheat, potato, beets, cauliflower, cabbage etc.) may be replaced by C4 crops like maize, sorghum and sugarcane especially in those areas where these C3 crops are grown at their upper thermal limit.
Replacement of wheat by maize during winter season in Bihar could be as an example of such cases Vulnerability of tropical/temperate crops due to coastal inundation and loss of biodiversity Sex determination in some animal like crocodile and plants may also be affected by GW, which may lead to their spatial loss
Finally the spatial and temporal cropping pattern may be affected in future

Global warming and food security: Food security is a major problem around the world both in developed and developing countries. The efforts should not only be made toward increased dependency on trade but towards attaining self-sufficiency by each nation or a group of nations. The large countries like India, Brazil and Mexico where large area of arable lands are still under rain fed agriculture and thus food production in these areas is highly uncertain and risky because of their greater vulnerability to natural calamities such as drought, high temperature etc. Thus any changes in climatic components resulted from global warming may lead to the problem of food security both at regional and national levels. Even in irrigated agriculture high temperature stress especially during early vegetative and grain filling stages has been found detrimental in wheat crop and low temperature during the reproductive growth phase has been reported to be detrimental in rice and maize crops. In order to maintain the global, national and regional food production scenario it is indispensable to change the crop production strategies such as crop varieties, alternative cropping, enhancement in input resources and their efficient utilization etc. to cope with changes in climate in days to come. Cultivation of tuber, root, bulb and rhizomatous crops instead of fruit/grain/seed crops in tropics could be an alternate source of food and energy in future.

Global warming and food consumption: It is expected that climate change due to global warming could cause significant reduction in crop productivity and production especially in the traditional regions of crop cultivation, but at the same time it is also anticipated that the food consumption both at regional and global scales is likely to be reduced markedly due to global warming as the food requirement of consumers especially human beings is drastically reduced by warming because less food will be required to generate metabolic energy to maintain body temperature. Warming of course would enhance the water demands but diminish the food demands due to less consumption of food for less energy requirement to keep body temperature normal because warming of surroundings would reduce thermal loss of body as compared to cooling period where more food is required to keep the body temperature normal against rapid diffusion of body temperature.

There is a general principle that cooling enhances the appetite, warming impairs the same. Apart from less food requirement, global warming would also reduce the adaptation cost to combat the problem of cooling during winter by reducing the consumption of electricity and fuel and demands for warmer woolen cloths as well. This aspect of global warming could perhaps be beneficial to the society.

AGROBIOLOGICAL IMPACT OF GLOBAL WARMING



SUSTAINABLE MANAGEMENT OF WATER HYACINTH

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Water Hyacinth [***Eichhornia crassipes*** (Mart.) Solms], popularly known as Jalkumbhi, is a troublesome aquatic weed that has spread in almost all wetlands, marshes, lakes, streams, ponds, reservoirs, waterways, backwater areas and rivers in the entire tropical world. It is believed that this weed have originated in the Amazon basin and marshes of Venezuela and Brazil in South America which has now naturalized in many warm areas of world including Central America, North America, Africa, Asia, Australia and New Zealand. Plants can tolerate extremes of water level fluctuation, nutrient availability, pH, temperature and toxic substances. It takes nutrients directly from water and has got very high water content up to 95% and flourishes in nutrient enriched waters.

In India Water Hyacinth has become a serious menace in the states of Assam, Bihar, Orissa, Eastern UP, Kashmir, MP and Kerala and it is assumed to have spread in 200,000 ha of water surface.

It is the most invasive and gregarious aquatic weed in India widely distributed all over the country in paddy fields, rivers, lakes, ponds, marshy places and multiplying rapidly in stagnant waters making large areas uncultivable and most times occupies the entire water surface from bank to bank stretching over distances along the canal courses, blocking all lagoons, rivers and backwaters.

The thick floating carpet of Hyacinth prevents sunlight entering into the water and thus reducing the dissolved oxygen presence in water. This adversely affects the ecosystem of water bodies and upsets the aquatic ecosystems; biodiversity, fisheries and agriculture as the weed outgrows and suppresses growth of other aquatic plants. Moreover when massive quantities of plats die, they deoxygenate water that results in eutrophication which causes the death of fish and other aquatic creatures. It is contaminating water used for domestic purposes, disrupted drinking water supply and fishing activities in many areas. It clogs inland waterways and entangle motors and propellers of the boats engaged in transport, fishing and tourism. The fishing lines, hooks and fishing nets get entangled with the weed. All these make the life hard and difficult for the people who are engaged in these activities.

The weed obstructs water flow in irrigation and drainage channels and streams and also interferes with hydropower generation; besides, facilitating rampant mosquito breeding in the aquatic systems, hinders mosquito control operations and fostering malaria, encephalomyelitis and other water-borne diseases. It also blocks water flow, slow down navigation, power generation, tourism etc, harbour large number of vectors, reduces aquatic biodiversity and affects fish and agricultural production.

Water Hyacinth reproduces by seeds and from stolen production. The plant flowers round the year producing abundant amounts of long lived seeds. It has been reported that a single plant can produce up to 3000 fresh ones of its type within 50 days. In nutrient rich waters, such as polluted ponds and lakes, it can grow quickly that surface covered by the mats doubled every 4-7 days and therefore management of this weed has become laborious and difficult. Non-judicial application of chemical fertilisers in agricultural fields causes leaching of nutrients enables luxuriant growth of Water Hyacinth. Studies reveal that the weed absorbs 13 times more water than the other aquatic weeds. One flower can generate 1000 new plants in 50 days and 10 plants multiply to 6 lakhs plants with a density of 200 tons/acre and having seed viability up to 15 years. Because of its lush growth and spread, it prevents sunlight penetration and deoxygenates the water and increases evapo-transpiration. This also causes quick drying of water bodies leading to water shortage in the regions.

Attention has been focused on its environmental impact since its luxuriant growth in the water bodies interferes in the activities of mankind, which has caused great concern. States like Kerala are spending crores of rupees every year to remove the weed but not been able to attain anywhere near the desired results.
Land based clamshell buckets, cranes, draglines and water based machinery such as mowers, dredges, barges and specially designed aquatic weed harvesters are being used for mechanical removal of Water Hyacinth in different parts of the world. These are found to be expensive and labor intensive and not successful in complete eradication of the weed and hence it multiplies fast soon after the operations.

Herbicides like glyphosphate, 2,4-D, Paraquat, copper sulfate and copper chelate have been tried to control the weed chemically but spraying on an entire infestation can cause Water Hyacinth to sink and the rotting weed mass may also decrease Oxygen in water, causing a harmful secondary pollution to fish.

Arthropods like ***Neochentia bruchi*** and ***Neochentia eichhorniae*** and a moth named ***Niphographta albiguttalis*** and Mycoherbicides (fungi) are being tried for biological control of Water Hyacinth. However, much studies and efforts are required for effective and sustainable control of the weed.

Some uses are reported for this weed such as compost making, paper industry, biogas plants, cattle/pig/fish feed, mushroom cultivation, handicrafts and furniture making, waste water treatments, manufacturing of Cellulase (an enzyme that converts cellulose into glucose) and ethanol etc. However, no one utilizes this weed on a large scale for these purposes in India whereas the weed still continues to be a menace. Sustainable management of water hyacinth can only be possible through an integrated approach including physical/mechanical, chemical or biological means and developing economically viable projects for converting to organic manures and other products mentioned earlier which will greatly benefit the people whose livelihood security and health are threatened by the spread of this weed. This requires great deal of studies, efforts and resources.

If we carefully analyze the virtues of Water Hyacinth, we can see the hydrophyte is a "blessing in disguise" and an economic asset and a potent agent for eradicating rural poverty. Sustainable management of Water Hyacinth implies developing an ecological system in a manner that satisfies current needs without compromising the needs or options of future generations. Beneficial products such as composts, vermicompost, mushroom, hydroponics, briquettes, biogas, fish feed, feeds for pigs and cattle and cellulose. "Water hyacinth should be conceived as a great socio-economic opportunity in disguise. The idea of converting water hyacinth into value-added products to generate wealth and sustain heath in society that have been hit hard by this floating weed stems from this unique capacity of man to adjust and adapt in the universe". The following research and development needs are identified:

- Organisation of a research seminar to review the works so far carried out
- Identification of thrust areas of research in the area of Water Hyacinth
- Preparation of suitable research proposals for funding by national and international agencies
- Inter departmental collaboration to work out scientific aspects of Water Hyacinth
- Industrial collaboration in the process of extraction of enzyme
- Industrial collaboration in the mass removal of Water hyacinth from water bodies

The Allahabad Agricultural Institute University Kochi Extension Centre and Kerala Higher Education Trust conducted a Scientific Seminar on Management of Water Hyacinth in association with the Kerala Agricultural University and Rajeev Gandhi Chair of CUSAT on 12 June 2008 with the following objectives:

1. To initiate discussions and interactions with all concerned and interested scientists, institutions, organizations, sectors, communities and other persons associated with Water Hyacinth
2. To identify the extent of Water Hyacinth affected areas and study the intensity of menaces caused by the weed in different parts of the country
3. To coordinate and plan for follow up meetings, interactions and researches with all concerned parties/sectors
4. To identify viable projects for cost effective and sustainable management of Water Hyacinth in the affected areas in the country
5. To prepare viable project funding proposal documents for submitting to funding agencies.
6. To make valuable suggestions, resolutions to recommend to the government and other concerned agencies
7. To identify project implementing agencies/team
8. To nominate a team of delegates for follow up and future actions.

Appropriate actions need to be taken in these lines for the effective management of Water Hyacinth in water bodies of our country in order to avoid the serious environmental pollution and menace caused by this plant.

IMPACT OF ACID RAIN ON SOIL QUALITY AND CROP PRODUCTIVITY: INDIAN SCENARIO

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Abstract

India faces increasing threat from acid rain with industrial revolution and reliance on the use of coal and petroleum product which have led to acidification of atmosphere. Sulfur dioxide (So2) and nitrogen oxide (N2O) emitted from power plant combine with moisture in the atmosphere and produce acid rain. Estimate reveal that a super thermal power plant using even normal or low sulfur coal will emit about 100 tonnes of So2 day-1. Where as with 0.5% carbon content in the coal a 500 mw thermal power plant would release 8,500 tonnes of Co2 day-1. It is predicted a possibility of 31.5% increase in So2 emission over present levels in India by 2020. No doubt, acid rain has deleterious effect on the environment causing reduction in soil quality and crop productivity alongwith destroying vital organisms in soil. Though systematic research in this direction is under way, our efforts should be to minimize the risk of acid rain on soil quality and crop productivity. Short term control of acid rain/acid deposition can be achieved using liming materials as amendment.

Introduction

Acid rain is an environmental problem that has no any national/ international boundaries. Increasing acidity in nature, water and soil is becoming a problem all over the world particularly in North- Eastern America, North - Western Europe and India. Acid rain has become an invisible threat to rivers, lakes and forest of Norway, Germany, U.K. USA, USSR(now CIS) and Canada (World Resource , 1998-99).
Robert Angus Smith (1872) a first English Chemist who coined the term acid rain. In fact, acid rain is cocktail of mainly H2So4 and HNo3, where the ratio of these two varies depending upon the relative quantities of So2 and N2o. H2So4 is major contributor (90-70%) and HNo3 ranks second (30-40%).What is Acid Rain ?Acid rain is primarily caused by emission of SO2 and N2o from electric utilities, burning fossil fuels especially coal. These chemicals are converted to H2 So4 (Sulfuric acid) and HNo3 (Nitric acid) and can be carried out by the winds for many miles away from where the original emission took place. Acid rain is one phase of acid deposition which can be either wet or dry.

Wet Acid Rain :

It occurs when the acid falls in rain, snow or ice. In moist/wet deposit, acid is trapped in cloud or fog droplets. This is very common in high altitude and coastal area.

Dry Acid Rain :

It caused by very tiny particles (or particulate) in combustion emission. They may stay dry as they fall or pollute cloud, water and precipitation. Whatever its form, acid rain can create dangerously high levels of acidic impurities to water, soil and plant. A typical analysis of acid rain sample in given in table-1.
The variation of cations and anions depend on the time and location of collection of the acid rain water samples.

Indian Scenario of Acid Rain :

India is a developing country, get into the race of industrialization in early fifties. Scientists then were some what aware of the manifestation of air pollution originating from large scale industrialization resulting the rain water acidity.

Table -1 Analysis of a typical acid rain sample.

Cation	Concentration mole/Lx10^6	Anion	Concentration mole/Lx10^6
H^+	56	So_4^{2-}	51
NH_4^+	10	No_3^-	20
Ca^{2+}	07	Cl^-	12
Na^+	05	-	-
Mg^{2+}	03	-	-
K^+	02	-	-
Total	83		83

Scanty efforts to monitor acid rain started in 1953s. Mukherjee documented H+ of monsoon rain water at Calcutta and it was reported that rain water has a pH 5.7 due to dissolved Co2 in water scavenged from atmosphere.

A number of studies have been reported by several workers (Baker and Christensen, 1991; Kaiser, 1996 ; Mohan and Kumar, 1998; Sahu, 1994; Sparling, 1995), that in general the nature of rain water is alkaline having pH more than 5.6. Kulshreshtra (2003) has compiled precipitation studies from about 100 sites in India and found the pH of rain water in most of the sites as alkaline nature which was due to abundance of Ca in rain water that nutrilize the acidity. Calcium Carbonate (CaCo3) is contributed by the loose soil dust in the atmosphere.

Results from Indian Ocean Experiment (INDOEX) revealed that situation over the Indian ocean was very different as compared to Indian continental sites. The pH of rain water over Indian ocean have been observed between 3.8 and 5.6, while continental sites between 5.6 and 7.0. The acidic nature of rain water over Indian ocean is due to insignificant influence of soil dust and dominance of anthropogenic sulphate from long rage transport.

In the present scenario, in India only certain pockets in area like Central-East and North-East Regions are observed to high deposition of acid where further investigation is needed. Interestingly, a continental sites with the present 5% annual increase in sulfur with no increasing trend in acidity is reported.

The mean and medium of the concentration of different chemical constituents and pH of rain water of different sites in India is presented in table-2.
All sites show alkaline nature of rain water (pH) >5.6. It is to be noted that at rural sites, the concentration of HCo3 was the highest. The concentration of So4 increases from rural to Industrial site indicate some influence of industrial So2. However, it remain alkaline as the soil dust is rich in CaCo3 and neutralizing the acidity caused by oxides of nitrogen and sulfur.

Table-2 Mean chemical composition (μeq l^{-1}) and pH studies at four categories of sites in India.

Site	Na^+	NH_4^+	K^+	Mg^{2+}	Ca^{2+}	Cl^-	No_3^-	So_4^{2-}	HCo_3^{2-}	pH
Rural	55	12	15	40	105	49	25	21	54	6.5
Sub-Urban	79	15	11	51	121	82	15	21	40	6.7
Urban	76	22	11	36	105	36	36	34	37	6.4
Indus-trial	38	26	8	28	89	21	31	85	33	6.1

Table -3 Soils and their pH in India

Category	pH range
Alluvial soil	8.3-8.6 and 9.2-10.6
Black soil	8.8-9.4
Red soil	6.0-6.9
Late rite soil	5.4-5.8
Salt affected soils	9.2-10.3
Desert soil	8.0-8.3
Forest soil	4.6-5.6 and 6.6-7.6

The Indian soils are highly alkaline (Table-3) which contribute alkaline suspended dust into the atmosphere during the dry weather condition. Even during the monsoon period (June-September), the rain is often intermittent at several locations and soil dust is responded again into the atmosphere. The dust so emitted preferably sevenges So2 in the presence of sufficient moisture farming CaCo4 (Calcium Sulphate). This may be one of the region for increasing So2 levels in most of the sites. Anthropogenic sources have very less influence in certain parts like Central-East part which is mining area of acid rain with several thermal power plants. In the region like Kerela and North East part acidity is reported due to natural vegetation.

Sources of Acid Rain in Atmosphere :

1. Natural sources :

Sources

(A) Sulphate

-:- Ocean spray, volcanic eruption

-:- Hydrogen sulphide released from decomposition of organic matter

(B) Nitrate

-:- Lightening during thunder/storm

-:- Forest fires

-:- Produced by micro organism

2. Human activity :

(A) Sulfur dioxide (So2) and Nitrous oxide (N2O)

-:- Resulting from burning of fossil, fuel especially from coal, oil and natural gaseous.

-:- Fuel combustion through vehicle and power plants it accounts for 80-85% So2 and N2o emission.

-:- Agriculture sector contribute 7% So2 and N2o emission due to wind blown-fertilizers

-:- Pollution of No3 through water due to leaching and surface run off.

-:- No3 pollution due to sewage, animal and industrial wastes

-:- Air borne nitrate account for 1/4 of all nitrogen.

-:- Ammonia emission largely come form agricultural waste such as manures and fertilizers handling.

The above narrated pollutant / sources largely contribute to acid rain.

Factors affecting the acid rain deposition :

There are several factors which contribute to the acid rain deposition.

1. Air Movement:

-:- The movement of air distributed acid rain emission in definite pattern around the planet.

- -:- The movement of air masses emitted pollutant many miles away.
- -:- The emitted pollutant converted into H_2SO_4 and HNO_3 by mixing with cloud and water.

2. Climate:

- -:- In arid and semi arid regions, wind blown alkaline dust which move freely throughout air and tend to neutralize atmospheric acidity.
- -:- The effect of acid rain can be greatly reduced by the presence of alkali substances such as Na, K and Ca.
- -:- When basic and acidic substances come into contact they react chemically and neutralize each other.
- -:- In humid region there is less dust load which lead to more acidic precipitation.

3. Topography /Geology

- -:- Area most sensitive to acid rain contain hard, crystalline bed rock and very thin surface soil.
- -:- In contrast, a thick soil covering or soil with high buffering capacity flat land neutralize acid rain better.
- -:- Lakes and ocean tend to be most susceptible to acid rain because of low alkaline content.

Impact of Acid Rain on Soil quality and Crop productivity :

In nature the combination of rain and oxide is a part of natural balance that nourished soil, plant and aquatic life. However, when the balance is upset the result of the environment can be harmful and destructive. Some important impact of acid rain on soil quality and crop productively are as follows:

- -:- Soil exposed to acid rain can gradually loss valuable nutrients such as Ca, Mg and K and become concentrated with dissolved in organic aluminum (Al) which is toxic to most of the crop.
- -:- Long term change in soil chemistry due to acid rain directly affect the saturation in nitrogen which adversely affect in retention of other nutrients required for healthy crop production.
- -:- Acid rain washed away the nutrients. Nutrient deficient crop, forest trees are more vulnerable to biotic and a biotic stresses.
- -:- Soil acidification suppress the decay of organic matter, valuable nutrients like Ca, Mg which are normally very helpful in bound the soil particles.
- -:- Acid rain however, accelerates the breaking of bound nutrients thus it decreases the plant uptake of vital nutrients.
- -:- Acid deposition severely retards the growth of leafy vegetables such as lettuce, spinach beans, broccoli etc.
- -:- Acid deposition weakens the forest trees and retorted the growth of forest.
- -:- Root system of plant damaged by the uptake of Al released from the soil. NO_3 may leached from the soil by run off water.
- -:- Acidification lead the cadmium toxicity in soil, its high level is toxic to plant, animal and human beings.
- -:- It has been also observed that carbohydrate production decreases in the photosynthesis process of some plant exposed to acid condition.
- -:- Many bacteria and BGA are killed due to acidification disrupting the whole ecological balance.
- -:- The activity of symbiotic nitrogen fixing bacteria present in the nodule of leguminous crops is inhibited thereby destroying quality and fertility status of soil.
- -:- Spread of spores of wheat rust from Himalaya to the northern plains and from Nilgiris and Pulni hills to south to central India due to acid rain is well known.
- -:- Spores of brown and black rust directly spread quite often from Southern to Central part of India which are mainly deposited by rains. Such spread may occur to a distance of more than 600 km.
- -:- It has also been observed that SO_2 around thermal power plant in India

pose a danger to agricultural crops. Varshney (1999) has studied around 26 crops to see the impact of SO2 emission from thermal power plants on the yield and biomass loss. He observed decline in wheat production which is shown in Table-4.

Conclusion

-:- In India acidity of rain water is mainly due to SO2 from coal fired power plant and petroleum refinery.-:- The continental sites with the present 5% annual increase in sulfur with no increasing trend in acidity is reported. The pH value of rain water of these sites lies between 5.6 and 7.0 due to abundance of Ca in rain water that neutralize the acidity.

-:- The pH of rain water over Indian ocean has been observed between 3.8 and 5.6 due to insignificant influence of soil dust and dominance of anthropogenic sulphate from long range transportation.

-:- In the region like Kerela and north east acidity in rain water is reported due to natural vegetation.

-:- As per BARC Air Monitoring Section, the pH of rain water of metropolitan cities such as Delhi, Calcutta, Chennai, Bombay lies 6.21,5.80,5.85 and 4.80 respectively due to heavy industrial load/emission of SO2.

CAUTION

The situation of acid rain may become worsen in future due to increasing installation of thermal power plants and coal consumption. Therefore, the acidity of rain water is yet to monitor adequately in developing countries like India to coup with the problem of Acid Pollution.

GOING GLOBAL DOES NOT MEAN JUST SELLING TO MARKET AROUND THE WORLD. IT MEANS SHARING THE CONCERNS OF THE WORLD AS WEL, LIKE THE ENVIRONMENT.

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Table-4 SO2 Emission from Thermal Power Plant and Reduction in Wheat yield.

S.N.	Power Plant	Capacity (Megawatt)	Mean yield reduction % (in 10km range)
1.	Singrauli (Sonbhadra disstt.)	2,050	59
2.	Koradi (Nagpur disstt.)	1,080	36
3.	Dadri (Gaziabad disstt.)	630	19
4.	Bhusawal (Jalgaon disstt.)	420	16
5.	Sikka (Jam nagar disstt.)	440	13

CARBON TRADING: GLOBAL BUSINESS FOR REALIZING POLLUTION REDUCTION

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Abstract

It has been predicted that through carbon trading projects under the Clean Development Mechanism (CDM), more than 5 million tonnes of carbon dioxide will be avoided by 2012 and similarly cutting back 10 % of India's greenhouse gas emissions every year. Indian Government has cleared more than 1000 projects related to carbon trading, highest in the world, followed by china, attracting investments worth Rs.1,19,662 crore in green ventures. Realizing the reduction of greenhouse gas emissions by a fixed percentage would be costlier in developed countries and the treaty allows rich countries to instead fund green transitions in developing countries and claim credit of the reduced emissions against their targets. Companies or entities in India undertake a change in their existing processes that reduces emissions against which they are provided carbon credit certificates each worth a tonne of carbon dioxide not emitted, which they can sell to the rich countries.

Key words : Clean Development Mechanism, Carbon Trading, Greenhouse gas emissions, Carbon credit certificate

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INTRODUCTION

A series of workshops and conferences related to global warming, climatic changes and GHGs emission finally concluded with adding new chapter to human society in the name of carbon trading. Carbon trading is emissions trading specifically for carbon dioxide calculated in tonnes of carbon dioxide equivalent (tCO_2e) and currently makes up the bulk of emissions trading. The concept of carbon trading came into existence as a result of increasing awareness about the need for pollution control. It was formalized in the Kyoto Protocol, an international agreement between more than 160 countries. During 1st to 11th December, 1997 more than 160 nations gathered in Kyoto, Japan to negotiate binding limitations on green house gases emission popularly known as Kyoto Protocol. It emphasizes carbon credits, the certificates awarded to countries that are successful in reducing emissions of greenhouse gases. It is an agreement made to set target for reduction of emission of green house gases (GHG) from 1990 levels by about 5% in the period of 2008-2012. Kyoto protocol covers the gases like Carbon dioxide (CO_2), Methane (CH_4), Nitrous oxide (N_2O), Hydroflorocarbons (HFCs), Perflurocarbons (PFCs) and Sulfur hexafluoride (SF_6).

Carbon trading emerges out as an asset to minimize the cost of reducing emission up to desirable level. At today's perspective, carbon trading is a business of buying and selling of the carbon credits achieved either by carbon sequestration or reducing the emission of GHGs lower than emission allowance. This trading can be done in between the nations, states even industries. Carbon trading needs the familiarity with certain inventory used to understand the process.

Carbon credit

Carbon credits are a tradable permit scheme and they provide a way to reduce greenhouse gas emissions by giving them a monetary value (about \$5 to \$10). A credit gives owner the right to emit one tonne of carbon dioxide. International treaties such as the Kyoto Protocol set quotas on the amount of greenhouse gases that countries can produce and countries in turn, set quotas on the emissions of businesses. Businesses that are over their quotas must buy carbon credits for their excess emissions, while businesses that are below their quotas can sell their remaining credits. Credits can be exchanged between businesses or bought and sold in international markets at the prevailing market price. There are currently two exchanges for carbon credits: the Chicago Climate Exchange and the European Climate Exchange. The benefits of carbon credits include provision of funds for reduce emission (RE) project implementation, strengthening economic development in different sectors of country, creation of employment through carbon sequestration and uplifting of degraded environment.

Carbon sequestration

Carbon sequestration is a practice to provide sink zone for atmospheric carbon dioxide in term of biological accumulation by increase in forest cover. There are certain guidelines set under Kyoto protocol for such forest cover known as 'Kyoto Forest'. Carbon sequestration is only permitted from forest compatible with Article 3.3 of the Kyoto Protocol. For making eligible for carbon trading, the forest should be,

-:- Planted on land, which historically has not been covered by forest (i.e. afforestation).
-:- Planted on land which historically was forests but which has since been used for some other purpose (i.e. reforestation).
-:- Additional to those that would otherwise have been planted.
-:- Grower who sells carbon credits and then go on to harvest the same forest will incur carbon debits.
-:- Forest planted from 1990 on, and prior to 2008, will always have a carbon emission at harvest (i.e. carbon debit) greater than the carbon sequestration during the eligible 2008 to 2012 period (i.e. carbon credit).

Emission permit

The government can set a limit for GHGs emission within the country. It can issue permits also called allowances or quotas to emit green house gases. An emission permit is a certificate that gives the holders the right to emit a certain amount of greenhouse gases to the atmosphere. The government can decide how and in which manner those are given permits should be allowed to sell them to other.

ROLE OF KYOTO PROTOCOL

The protocol is designed as an environmental instrument though the negotiations were largely driven by the desire to manage economic impact and to minimize the costs of a transition away from growth in fossil fuel used society. This cost minimization approach led to the inclusion of flexibility mechanism in the protocol, which significantly reduce the cost of compliance with national emission target. It will also lead to the evolution and rapid growth of a whole new class of investment and securities related to environmental impact mitigation or environmental improvement including proposals for emission trading. It comprises,

-:- The Clean Developmental Mechanism (CDM), a way to earn credits by investing in emission reduction projects in developing countries.
-:- Joint Implementation (JI), a way to earn credits by investing in emission reduction projects in developed countries that have taken on a Kyoto target.
-:- International Emissions Trading (IET), which will permit developed countries that have taken on a Kyoto target to buy and sell emission credits among themselves.

The clean development Mechanism (CDM)

-:- Under the CDM, firms in the developed countries will invest in projects in developing countries that reduce or avoid net GHGs emissions. This promises to be an important new avenue through which government and private corporations will transfer clean technologies and promote sustainable development. Credit will be earned in the form of "certified emission reduction".

-:- The CDM allows industrialized countries to acquire emissions credit (the right to emit greenhouse gases) by paying for emissions reduction measures in developing countries that do not have emission targets. These measures must also contribute to sustainable development in the recipient country. Detail rules and regulations to ensure that the emissions reduction measures meet all the requirements are worked out.

-:- The CDM has the potential to assist the start of a transition towards sustainable energy in developing countries and, in the long-term, benefit the climate however some of the proposals on the table could result in the transfer of polluting, unsafe and unsustainable technology, including coal, large dam and nuclear power.

-:- CDM projects must demonstrate that they add "real, measurable, and long term benefits related to the mitigation of climate change" and are meant to contribute to sustainable development in developing countries. Whether or not these goals are reached depends very much on the rules for the CDM.

Joint Implementation (JI)

-:- JI project are a means by which firm in developed countries can invest in other developed countries, including those with economies in transition in central and Eastern Europe, in ways that reduce or avoid GHG emissions. Credit will be earned in the form of "emission reduction unit".

-:- Joint implementation implies that an industrialized country pay for measures to reduce emissions in another industrialized country. This will give the buyer the right to emit more domestically, while the seller will be required to emit correspondingly less.

-:- Article 6 of the protocol allows developed countries to obtain emission credits for projects undertaken in another developed country. JI can be a tool to transfer environmentally sound technology.

International Emission Trading (IET)

-:- The Kyoto Protocol permits the trading of emission credits among countries. It provides for countries with emission reduction commitments to buy and sell part of their assigned amount of CO_2 emissions among themselves.

-:- Reporting rules, a verification system and guidelines are being developed for IET. The idea is to foster a free market in emission credits and reward countries that are most efficient at meeting their target.

There are two main approaches to emissions trading system viz. cap and trade system and credit trading system (Srinivasan Venkataraghavan, 2007)

Cap and Trade System

In a cap and trade system, a regulatory body would first need to set an overall limit or cap on emissions. Defined groups of emitters would be allocated either for free or via auctioning a proportion of the total allowed amount, which they could then trade among one another in the form of permits. Thus emitters that took measures to reduce their pollution below the level represented by permits they held could sell their unused permits to other emitters that were emitting at the level higher than that represented by their permits. Participants that emitted beyond their limits without the necessary permits would face stiff penalties. This system would guarantee that the overall environmental objective was met because total emissions would be limited under the cap.

Credit Trading System

In this credit trading system, companies would be allowed to certify emissions reductions below a certain voluntary or imposed level as "tradable credit" that could then be sold to emitters that needed them to meet their own target level of emissions. Credit trading could be used in conjugation with a cap and trade system to enable sources not regulated by the cap to gain credit for reduction in greenhouse gases caused by their new initiatives. However, it is anticipated that credit creation would be limited to certain sectors and activities.

THE CARBON MARKET

Developed countries within the trading scheme can sponsor carbon projects that provide a reduction in greenhouse gas emissions in other countries, as a way of generating tradeable carbon credits. The Protocol allows this through

Clean Development Mechanism (CDM) and Joint Implementation (JI) projects, in order to provide flexible mechanisms to aid regulated entities in meeting their compliance with their caps. The UNFCCC validates all CDM projects to ensure they create genuine additional savings and that there is no leakage.

Market trend

Carbon emissions trading have been steadily increasing in recent years. According to the World Bank's Carbon Finance Unit, 374 million metric tonnes of carbon dioxide equivalent (tCO_2e) were exchanged through projects in 2005, a 240% increase relative to 2004 (110 $mtCO_2e$) which was itself a 41% increase relative to 2003 (78 $mtCO_2e$). In terms of dollars, the World Bank has estimated that the size of the carbon market was 11 billion USD in 2005, 30 billion USD in 2006, and 64 billion in 2007.

Business reaction

London: The London financial market place has established itself as the center of the carbon finance market, and to have grown into a market valued at $60 billion in 2007.

Australia: On 4 June 2007, former Prime Minister John Howard announced an Australian Carbon Trading Scheme to be introduced by 2012. Prime Minister Rudd announced that a cap-and-trade emissions trading scheme would be introduced in 2010. Professor Ross Garnaut draft report, the Rudd Labor government issued a Green Paper that described the intended design of the actual trading scheme. Draft legislation will be released in December 2008, to become law in 2009.

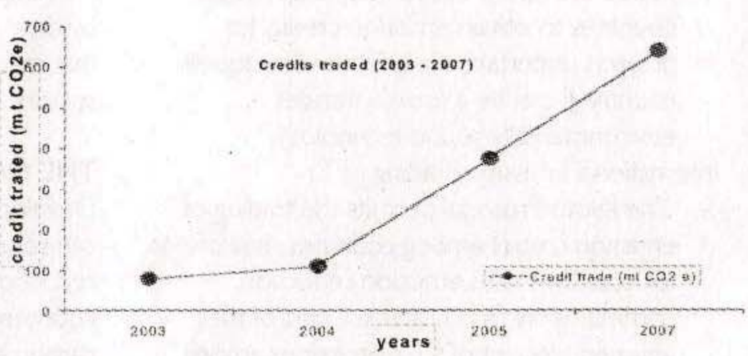
European Union: The European Union Emission Trading Scheme (EU ETS) is the largest multi-national, greenhouse gas emissions trading scheme in the world and was created in conjunction with the Kyoto Protocol.

New Zealand: The New Zealand Government introduced a bill for emissions trading schemes before a select committee. Various reports by a range of groups support the scheme but differ in opinion as to how it should be implemented. An interesting feature of the New Zealand ETS is that it includes forest carbon and creates deforestation liabilities for landowners. The Emissions trading bill passed into law on 10 September 2008.

United States: In 2003, U.S. corporations were able to trade CO2 emission allowances on the Chicago Climate Exchange under a voluntary scheme. In August 2007, the Exchange announced a mechanism to create emission offsets for projects within the United States that cleanly destroy ozone-depleting substances. In 2007, the California Legislature passed the California Global Warming Solutions Act, AB-32, which was signed into law by Governor Arnold Schwarzenegger. California is also one of seven states and three Canadian province that have joined together to create the Western Climate Initiative, which has recommended the creation of a regional greenhouse gas control and offset trading environment

Independently 23 multinational corporations came together in the G8 Climate Change Roundtable, a business group formed at the January 2005 World Economic Forum. The group included Ford, Toyota, British Airways, BP and Unilever. On 9 June 2005 the Group published a statement stating that there was a need to act on climate change and stressing the importance of market-based solutions. It called on governments to establish "clear, transparent, and consistent price signals" through "creation of

S.No	year	Credits in trade ($mt CO_2 e$)
1	2003	78
2	2004	110
3	2005	374
4	2006	-
5	2007	640



a long-term policy framework" that would include all major producers of greenhouse gases. By December 2007 this had grown to encompass 150 global businesses. Businesses in the UK have come out strongly in support of emissions trading as a key tool to mitigate climate change, supported by Green NGOs.

Current status of international market

-:- Toyota has created an $ 800,000 model forest which is being monitored with emissions measuring equipment to calculate CO_2 absorbed. They are also working with botanists to develop genetically engineered tree that absorb CO_2 faster.
-:- Nebraskan energy company Tenaska has invested $ 500,000 into Costa Rican rainforest protection as a way of reducing their CO_2 emissions.
-:- BP has initiated an internal carbon trading system, involving 10 business units around the world. The scheme will see trading amongst the business units well as trading between the units and out side parties. One of the first external trades has been between BP's Kwinana refinery in Western Australia, and the state forestry organization.
-:- Pacific power, one of Australia's largest electricity generators has purchased the carbon credit from a newly planted 1, 00 hectare forest plantation on the north coast of New south Wales (NSW) from the NSW forest organization. The trade covers ten year period during which the plantation is expected to sequester 250,000 tonnes of CO_2.
-:- Canadian firm invests in the wind firm in Africa. The African country decrease its reliance on fossil fuel use as a result of the wind farm, decreasing the green house gas emission reduction credits in proportion to the GHGs reduced by its investment and these credit can be used towards meeting Canada's Kyoto protocol.

INDIAN SCENARIO FOR CARBON TRADING

Almost all industrialized countries are huge buyer of carbon credit and all developing countries, where industrialization has not reached its peak, are supplier of carbon credit. Japan is the largest buyer of carbon credit while India and Brazil are amongst the largest suppliers of carbon credit. Being a developing country, India is exempted from the requirement of adherence to Kyoto protocol. India, however can sell the carbon credits to the developed countries.

Most of the beneficiaries of the carbon trading are those companies that are investing in windmills, Biodiesel, Biogas etc. Actually by investing in such an alternative non-polluting source of energy, these companies will earn carbon credit in the form of CERs (Certified Emissions Reductions) to the tune they have not polluted the environment. These CERs will be sold by the Indian companies to companies, say in Japan, at market prevailing rate of CERs and make profit. Companies like Torrent Power have started projects, which enhance energy efficiency and in turn have earned CERs points. These CERs will be sold by Torrent Power to companies in developed countries and is expected to earn approximately Rs 200 crores. Several Indian companies are adopting such processes in their production units, which result in earning of CERs. Companies like Chennai Petroleum, Jaypee Associates, Grasim Industries, TERI and Gujarat Fluro Chemicals are planning and initiated steps to make huge profits through carbon trading. (Ravi Kant, 2007)

According to TERI, India has the highest number of industry sectors that have adopted methods to reduce carbon emissions in the atmosphere by using non fossil fuel. These ranges from cement, steel, biomass power, bagasse cogeneration, municipal solid waste to energy and municipal water pumping to natural gas power. Among the projects selected under Annex I government tenders and carbon funds, the largest numbers of projects are from India. Further India's share of the international CDM market, as estimated by national strategy study "a world bank project for CDM implementation in India could be at least 10% earning revenues of upto $100 million per year,"

-:- Gujrat Flurochemical was one of the first projects to be certified for CDM by Britain. This firm by investing in the project to burn the HFCs being emitted into the air is now getting revenue that will soon pay off its investment while helping to clean environment pollution.

-:- A village Powerguda in Adilabad district (AP) has pioneered a sale to the World Bank for $645. The village was selling 147 tonnes equivalent of saved carbon dioxide credits. Powerguda's claim of having saved 147 MT of CO_2 is based on the bio-diesel they extracted from 4500 Pongamia trees in their village. Using this instead of petroleum in oil engines would enhance air quality. (Good News, 2004).

-:- Indian government has cleared more than 1,000 projects for carbon trading the highest in the world, attracting investments worth Rs 119,662 crore in green ventures. (Nitin Sethi, 2008)

Carbon trading has brought a huge opportunity for Indian companies. Companies can earn CERs by adopting energy saving and environment protecting methods and in turn can earn huge incomes by selling them. This opportunity will not exist forever for Indian companies. Once India is accepted as an industrialized country, she would have to adopt strict emission norms like other industrialized countries of the world and India may turn into a net buyer of carbon credit from other developing countries when that happens.

CRITICISM

The growing recognition that carbons markets are not helping alleviate the climate crisis is an encouraging step toward a more constructive approach. More discussion is required of the ways that carbon markets damage more effective initiatives, and are steering societies away from needed structural change. Second, the question needs to be raised whether carbon markets ever could work, so that time is not wasted trying to fix an unfixable approach. Third, it is crucial to probe the reasons why, if carbon trading is a failure in climatic terms, it has nevertheless been a success in political ones. Only if the complex reasons why carbon trading is still being pursued by political elites are understood will it be possible to clear away the obstacles it presents. (Larry Lohmann, 2008)

In case of sequestration if credit is given to those who choose not to cut existing forests, the increasing total demand for forest products will ts shift deforestation to other areas. Frequent audits will be needed to determine current carbon uptake, insurance will be necessary to protect past carbon credits from destruction by fire or windstorms, and payments will be necessary if the forest is cut. All these efforts will be costly to administer, diminishing the value of the rather modest carbon credits expected from forestry and agriculture Clarification about the methodology for measuring and verifying the quantity of sequestrated carbon to credit market is required, cost of services and transaction associated with carbon credit are unclear so are the return, but will certainly be subjected to economies of scale

Unavailability of any sound infrastructure and guideline for trading increases numbers of critics challenging the rosy win-win portrait of the CDM market that has been painted. Some commentators in the countries in which the projects are being undertaken, have seen it as creating a new colonial commodity in which the ability to make cheaper reductions in the developing world is being treated as a new resource to be extracted and profitably used for the benefit of Western countries. its has been sighted that the market has been draped in benevolent rhetoric of sustainable development, so that projects are only supposed to qualify for carbon financing if they have some sort of development benefits. An article in the September 2007 academic journal, Climatic Change, stated that, "Close to 200 studies on the CDM have been carried out since its birth in 1997… The main finding... is that, left to market forces, the CDM does not significantly contribute to sustainable development." (Kevin Smith, 2008)

CONCLUSION

Carbon Trading is still in its initial stage, but aspects of growth in this market is tremendous. Apart from the fact that "Carbon" will become the single most biggest commodity ever traded, another aspect of it which makes it important is the solution it offers to a common problem which we all have just started to realize and probably talk about more, "Global Warming". Although Critics doubt whether these trading schemes can work as there may be too many credits given by the government, such as in the first phase of the European Union's scheme.

Once a large surplus was discovered the price for credits bottomed out and effectively collapsed, with no noticeable reduction of emissions. Meaningful emission reductions within a trading system can only occur if they can be measured at the level of operator or installation and reported to a regulator. For greenhouse gases, all trading countries maintain an inventory of emissions at national and installation level. But still there is huge opportunity for India to stand itself in this market. Carbon trading has opened a new earning source for the Indian companies. Although this opportunity is time bound, as once recognized as a developed country, India would require sticking to stricter norms of greenhouse gases pollution restriction.

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ENVIRONMENT SAFETY THROUGH PROMOTING USE OF BIO-FERTILIZERS & BIO-PESTICIDES IN AGRICULTURE

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Nearly 60-70% of India lives in rural areas and is dependent primarily on agriculture or allied activities and therefore, sustainable environment for our country can generally be perceived through sustainable agriculture. Rapidly increasing human population and decreasing land resources has resulted in heavy demand for producing more and more food per unit area, thus resulting in chemicalization of the Indian agriculture scenario. Indiscriminate and non-judicious application of synthetic agro-chemicals, including fertilizers & pesticides, in crop cultivation during past almost 4 decades, has resulted in alarming degradation of environment (soil, air, water), reduction in bio-diversity including population of beneficial micro-organisms / fauna / fauna and accumulation of hazardous toxic residues in food chain, thus posing a serious threat to not only environment but also endangering the life of humans & livestock.

Even though the per hectare consumption of pesticides for India is less than that for Japan and other developed countries of the world, but their faulty application by farmers (due to lack of knowledge on use of these chemicals), nearly 25% of Indian food products are reported to contain pesticide residues above tolerance levels, compared to 2% globally including cereals, pulses, edible oils, vegetables, fruits, dairy & poultry products, meat and even water! According to WHO estimates, nearly 30-35 million cases of acute occupational poisoning occur in developing countries including India, with almost 10% injuries turning to be fatal! Symptoms of pesticide poisoning in humans include convulsions, dermatitis, allergies, anemia, pulmonary and respiratory diseases, carcinogenicity, leukemia, blindness, organ failures, paralysis, impairment of reproductive functions, immuno-suppression, neuro-toxicity etc Due to excessive use of nitrogenous and other chemical fertilizers increasing number of cases of nitrate poisoning, methaemoglobonenia (blue baby syndrome) are being reported, besides the choking of natural water bodies. Imbalance of soil nutrients, changes in soil acidity & alkalinity, soil structure are some other serious problems associated with fertilizer abuse. A vision of "Sustainable Environment" for all can be foreseen through use of biologically derived pesticides and fertilizers for crop pest / disease and nutrient management, respectively. Bio-pesticides & bio-fertilizers can provide in a major way, an ecologically sound and economically viable alternative.

"Bio-pesticides" are beneficial micro-organisms including bacteria, fungi, viruses, nematodes, bio-chemicals which act as predators, parasites, pathogens, parasitoids, antagonists, competitors and which can be exploited for eco-friendly management of plant pests, pathogens & weeds,

"Bio-fertilizers" are living soil microbes of bacterial / fungal / algal origin which help in increased and more efficient absorption of nutrients from the soil. They function through processes like fixing free atmospheric nitrogen either symbiotically (in legumes) or non-symbiotically in soil / solubilizing insoluble phosphates / mobilizing potash / inoculants for sulfur and zinc etc for their enhanced use by crops. Their use should be promoted for nutrient management.

In natural eco-system, several beneficial associations (to man) of micro-organisms with crops / pests / pathogens etc exist. Through human technical interventions, suitable and more efficient strains of beneficial micro-organisms for use as bio-fertilizers and bio-pesticides can be identified, isolated, selected / improved, mass multiplied / cultured in laboratory, mixed / formulated in suitable carrier materials and packed for easy application by the farmers in soil / on seeds / or spray. Such formulations should provide absolute value for farmer's money besides giving healthy environment, better health to all, higher nutritional value and enhanced taste and ultimately higher financial returns!

Some well known bio-pesticide formulations include microorganisms of bacterial origin (Bacillus thuringiensis, Bacillus sp); viruses (nuclear polyhedrosis virusesNPV, granulosis viruses-GV, non-occluded-baculoviruses), fungal entomopathogens (Beauveria bassiana, Metarhizium anisopliae, Verticillium lecanii, Paecilomyces liliacinus), fungal & bacterial competitors / antagonists (Trichoderma, Pseudomonas fluresecens), entomopathogenic nematodes (Steinernema, Heterorhabditis, Romanomermis), egg/larval parasitoids & predators (Trichogramma, Chrysoperla, coccinelid beetles). Biochemical formulations like pheromone lures are like naturally occurring chemicals with non-toxic mode of action which interfere with mating / molting processes and their use should be promoted in management of agricultural pests besides also some botanical formulations like neem derivatives etc,..

Some well known bio-fertilizer formulations include microorganisms like Rhizobium, Azotobacter, Azospirillum, Acetobacter, Azolla, blue green algae as source of nitrogen; phosphate solubilising microbes (mycorhiza, bacteria), potash mobilizing microbes etc

Some successful examples of pest / disease management using bio-agents / bio-pesticides are quoted as follows:

- -:- Trichograma egg parasitoid for borers in tomato, brinjal, paddy, sugarcane etc
- -:- Chrysoperla carnea for aphids, jassids, eggs of some lepidopteran pests
- -:- Apanteles for diamond back moth
- -:- Trichoderma & Pseudomonas for rots, wilts and other nursery & seed and soil-borne diseases
- -:- Bt for Plutella, Helicoverpa, Earias etc
- -:- Metarhizium, Beauveria, Verticillium, Paecilomyces etc for soil-borne pests like termites, white grubs, phyto- nematodes and many foliar pests
- -:- EPNs for a wide range of soil borne and foliar pests

Application of bio-fertilizers at recommended dosages & methods, generally give 20-35 % boost to crop growth with financial savings amounting to Rs.500-750/- per acre. Rhizobium cultures are equivalent to 45-60 kg urea OR 20-25 kg N per acre; Azotobacter application in soil / on seeds is equivalent to 18-22 kg urea OR 8 - 10 kg of N. Similarly, application of PSB in soil is equivalent to 15 - 20 kg of DAP OR 8 - 9 kg of phosphorus, while application of potash mobilizer microbes is equivalent to 8 10 kg of MOP OR 5 - 7 kg of potassium.

Besides being eco-friendly tools of plant protection, other advantages of using bio-pesticides in Plant Protection are that they have narrow host-range; are generally specific in their mode of action, have no residue problems, are cheap and are safer to humans and environment. However, unlike chemical pesticides, they are disadvantaged in being slow acting, having short shelf-life and are susceptible to harsh environmental conditions like UV radiations, extremes of temperature etc.

However, these biological tools of crop nutrient and pest/disease/weed management, once introduced in environment are more durable and continue to do their jobs well over relatively prolonged periods of time. Besides, unlike chemical pesticides, the resistance in pests against them is less likely to develop, because they being living will keep adapting to newer strains of pest species by selective breeding.

CONCLUSION

It is indeed heartening that despite limitations, the use of these very potential and environment friendly tools for use in agriculture, is increasing at the rate of nearly 10-15% per year. They appear to be the only options in areas where pests have developed resistance to available pesticide formulations (cotton boll-worm in Maharashtra) or for niche market areas which limit / ban the use of agro-chemicals like "organic farms" or protected environmental bodies etc.

With growing awareness in people towards environment and the harmful residual toxic effects of agro-chemicals in food chain, resulting in rapidly increasing demand for "Organic Food" the world over, promoting use of bio-fertilisers and bio-pesticides in agriculture & horticulture, appears to be the only panacea to mitigate this burning problem of pollution.

NOISE ATTENUATION CHARACTERISTICS OF DIFFERENT ROAD SURFACES DURING TRACTOR TRANSPORT

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ABSTRACT

Tractors are the agricultural machines which are fitted with diesel engines. Besides their on-farm application in India, they are also engaged in transportation of agricultural products and human beings on the grassland, asphalt, and dirt rural roads. In spite of their adverse effects due to noise on operators and bystanders, limited information is available concerning the noise investigation of these machines. So the objectives of this research were to study the noise attenuation characteristics of tractor on different surfaces in transportation conditions. The tractor used in this study was fitted with a 35-hp diesel engine. During measurements and recording of noise level the variables of engine speeds and gear ratios were varied to cover the most normal range of the tractor operation in transportation conditions for the asphalt, dirt rural roads, and grassland. The test sites were prepared according to SAE noise measurement test procedures. The results show that the maximum attenuation effect was observed at rural dirt road, this is due to the uneven traveling surface and sudden changes in gear ratios and engine speeds. Similarly the minimum noise attenuation effect was observed at grassland this is due to the damping effect of grass cover which is distinguished from the reflecting surface of asphalt and rural dirt road. The overall noise in this case is about 2.5 dB(A) lower than the asphalt and dirt rural roads. The maximum overall noise measured at driver ear's position at different gear ratios in asphalt, dirt rural roads and grassland was about 92 dB(A) for 2300 rpm engine speed which is higher than allowable noise exposure prescribed by National Institute for Occupational Safety and Health (NIOSH).

INTRODUCTION

Tractors are agricultural machines which are fitted with diesel engine. Tractors have become the main source of power in Indian farm. Besides their on-farm application in India, they are engaged in transportation of agricultural product and human beings on the different road surfaces. The use of tractor for transportation is more intensive in Punjab, Hariyana, Rajasthan and Utter Pradesh (Anon.1990). If they produce noise more than 85 db (A) for 8 hours exposure (based on NIOSH noise exposure recommendation) it will harmful both drivers and bystanders. The Occupational Safety and Health Administration (OSHA,1983) noise exposure standards for general industry use a permissible limit of 90db (A) for eight hours. National Institute for Occupational Safety and Health (NOISH) recommended an exposure limit of 85 db(A) for an 8hr time weighted average. The exchange rate is 5 db (A) in OSHA and 3 db(A) in NOISH (1998), i.e., prescribed exposure time becomes half with increase of 5 and 3 db(A) noise level, respectively. OSHA suggests that feasible administrative and engineering controls must be implemented whenever employee noise exposures exceed 90 db(A).

Besides the use of tractor on farm, their use for transport and other domestic jobs has continuously increased day by day. It implies that source of noise are not during agricultural operations but also during transportation and other domestic works. So it becomes more important to study the noise attenuation characteristics of tractor during transportation condition.

According to survey carried out to study the tractor utilization pattern by the farmers in Akola, Maharashtra (India) during 1999-2000. It was found that, the tractor was employed for 131.83

days during the year, out of which, it is employed for 126.56 (96 %) in agricultural activities were as for transport it employed for 5.27 days (4 %) only (P.K.V. research journal). In Punjab it shows that tractor is being used for not more than 600 hours in year, out of which, it was used for 435 hours in farm operations whereas for transport it was used for 106 hours (18.51 %) (A boon for Punjab farmers by Bhatia, B.S.).

The study conducted in Himachal Pradesh on mechanization reported that the average annual utilization of tractors was 705.4 hours of which 170.73 hours (24.2 percent) used for land preparation, 99.47 hours (14.5 percent) used for threshing, and 435.29 hours (61.72 percent) used for transportation,(Vasta and Saraswat 2003).

The survey carried out on utilization pattern of tractors in jamunapar region of Allahabad district shows that the maximum utilization of tractor was 677.47 hours, annually for agricultural operation and 140.70 hours (20.77 percent) for non-agricultural operation (M.Tech thesis by pandey 2004)

Hence, the present study was undertaken, for better understanding of noise attenuation characteristics of tractor at different road surfaces in transportation conditions in Department of Farm Power and Machinery at Allahabad Agricultural Institute-Deemed University, Allahabad with the following objectives.

OBJECTIVES

1. To measure the noise transmitted by tractor while traveling on different roads surfaces viz; asphalt, rural dirt road and grassland.
2. To study the effect of different speed and gear ratio on noise transmission of tractor.
3. To study and measure the noise level of tractor at operator's ear level and bystander's position.

MATERIALS AND METHODS

The present investigation was carried out at AAI-DU, Allahabad.

Experimental details

The tractor used in this study was four year old Mahindra B275-DI with trolley. The noise level measurements are taken for different road surfaces viz; Asphalt, Rural dirt road, and grassland at operator's ear level and bystander's position for selected gear ratios and engine speeds.

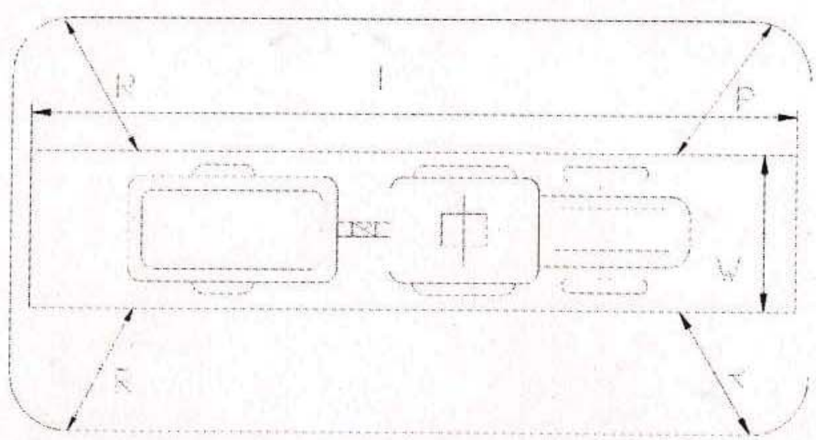
Test site

For taking noise measurements at asphalt and rural dirt road, the selected site was at village Bangana 15km away from AAI-DU Allahabad. The test was free from obstacles and traffic noise. Similarly, for taking noise measurement at grassland the test area was selected at AAI-DU Allahabad

Variables under study :

The following variables were kept under consideration :

(i) Engine speed or rpm viz; 1500 rpm, 2000



Dimension of the Measurment area for operators ear level

Where: R- Distance of obstacles from measurement zone
L- Length of measurement zone
W- Width of measurement zone

rpm, and 2300 rpm.

(ii) Different transmission gear. viz; First High, Second High, Third High, and Fourth High

(iii) Different road surfaces. viz; asphalt, rural dirt road and grassland

Experimental method

Operator's ear level

The test area was free from obstacles and consisted of flat open space free from effect of signboard, buildings, and hillsides for at least 20m from measurement zone. The tractor was placed on the test track having a length of 20m of straight section and it was ensured that speed of the tractor was stabilized for an adequate time. The measurement device was mounted 1.5 m above the ground surface and 100 mm away from driver's right ear in a horizontal position.

Bystander's position

The test area was consisted of flat open space free from the effect of signboards, buildings or hillside for at least 30m from the measurement zone other test specifications were chosen similar to the specification mentioned earlier for the operator's ear level with exception that the measurement device was mounted 5m away from the center line path of the tractor and 1.2 m above the ground surface. Figure 3.2 shows the dimension of the test area for bystander's position at different road surfaces. The minimum value of R and L were 20 m ad 15 m, respectively. The distance between the center line path of the tractor and measurement device (X) was 5 m

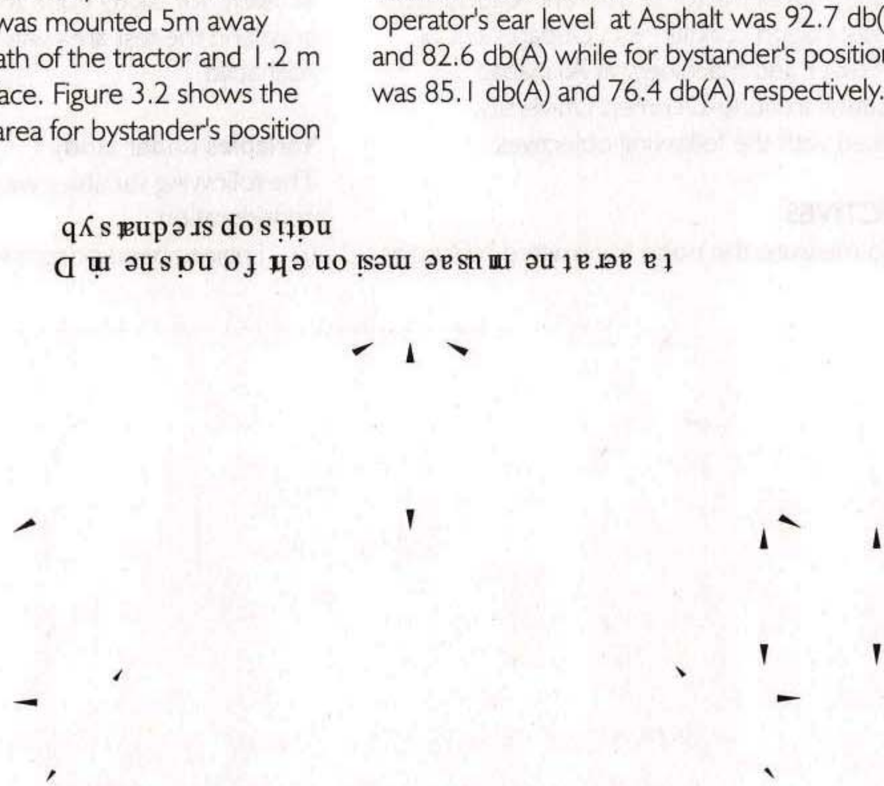
Procedure

The test tractor Mahindra B-275-DI was run on the test track. The engine speed was fixed at selected rpm in the forward speed gear selected for the experiment and noise at the operator's ear level and bystander's ear level was measured on the different road surfaces. Three replications were taken for each trail. The noise level observation were taken for, different road surfaces viz. asphalt, dirt road and grassland at selected gear engine speed.

RESULTS AND DISCUSSION

The results obtained during the experiment are presented in Table 1. From the table the results obtained for the different road surfaces are as follows :

For Asphalt Road : It is observed that the maximum and minimum noise level for operator's ear level at Asphalt was 92.7 db(A) and 82.6 db(A) while for bystander's position it was 85.1 db(A) and 76.4 db(A) respectively.



Where: R- Distance of obstacles from measurement zone

L- Length of measurement zone

W- Width of measurement zone

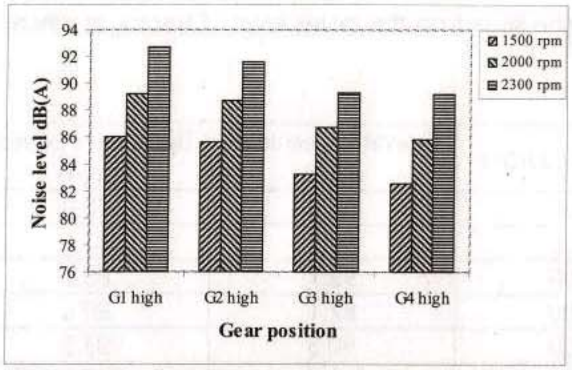


Fig. 1 The effect of different gear ratios with change in engine speed on noise level of tractor for operator's ear level at asphalt

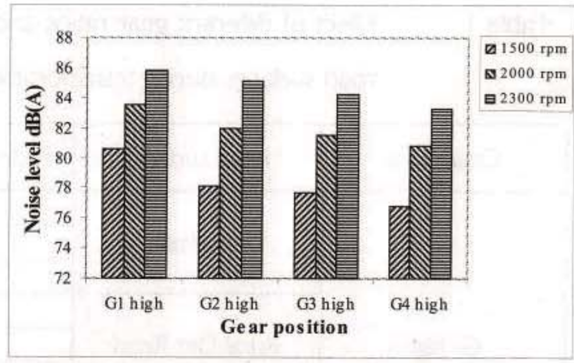


Fig. 4. The effect of different gear ratios with change in engine speed on noise level of tractor for bystander's position at rural dirt road

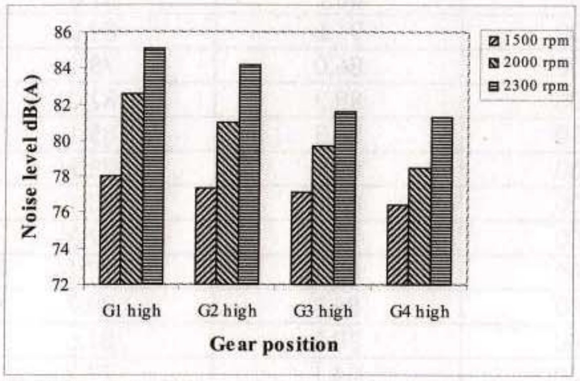


Fig. 2 The effect of different gear ratios with change in engine speed on noise level of tractor for bystander's position at asphalt

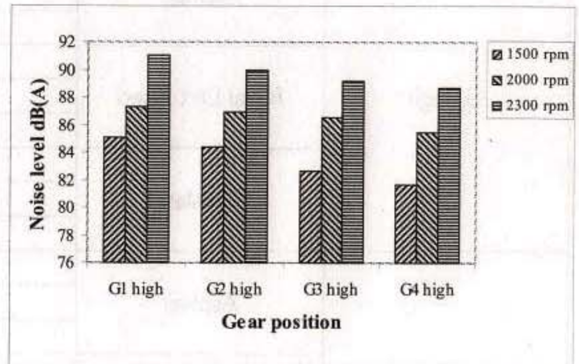


Fig. 5. The effect of different gear ratios with change in engine speed on noise level of tractor for operator's ear level at grassland

For Rural Dirt Road : The maximum and minimum noise level for operator's ear level at Rural Dirt Road was 93.8 db(A) and 83.8 db(A) while for bystander's position it was 85.8 db(A) and 76.8 db(A) respectively.

For Grassland : The maximum and minimum noise level for operator's ear level at Grassland was 91 db(A) and 81.7 db(A) while for bystander's position it was 83.3 db(A) and 75.3 db(A) respectively.

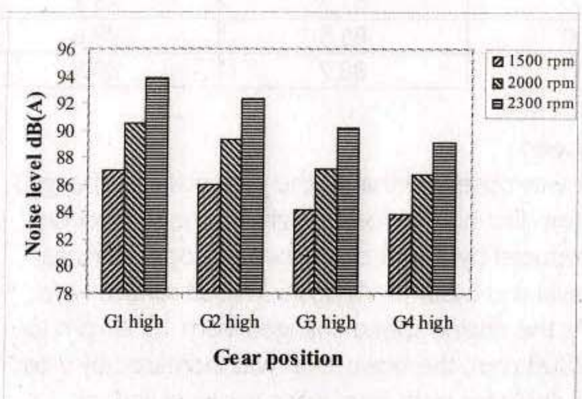


Fig. 3.The effect of different gear ratios with change in engine speed on noise level of tractor for operator's ear level at rural dirt road

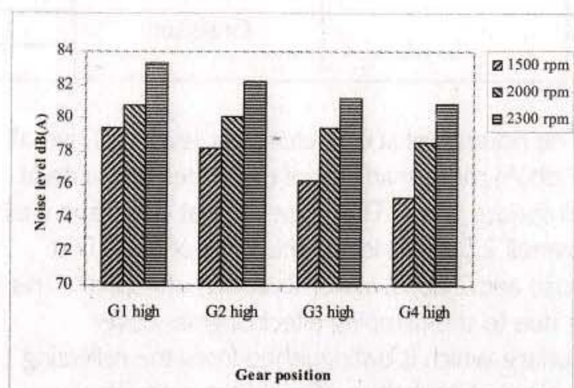


Fig. 6. The effect of different gear ratios with change in engine speed on noise level of tractor for bystander's position at grassland

Table 1 Effect of different gear ratios and engine speed on the noise level of tractor at different road surfaces during transportation.

Gear ratios	Road surfaces	Engine speed (rpm)	Operator's ear level db(A)	Bystander's position db(A)
G_1 high	Asphalt	1500	86.0	78.0
		2000	89.2	82.6
		2300	92.7	85.1
	Rural Dirt Road	1500	87.1	80.6
		2000	90.5	83.5
		2300	93.8	85.8
	Grassland	1500	85.1	79.4
		2000	87.3	80.8
		2300	91.0	83.3
G_2 high	Asphalt	1500	85.6	77.3
		2000	88.7	81.0
		2300	91.6	84.2
	Rural Dirt Road	1500	86.0	78.1
		2000	89.3	82.0
		2300	92.3	85.1
	Grassland	1500	84.4	78.2
		2000	86.9	80.1
		2300	90.0	82.2
G_3 high	Asphalt	1500	83.3	77.1
		2000	86.7	79.7
		2300	89.8	81.6
	Rural Dirt Road	1500	84.1	77.7
		2000	87.2	81.5
		2300	90.2	84.2
	Grassland	1500	82.6	76.3
		2000	86.5	79.4
		2300	89.2	81.2
G_4 high	Asphalt	1500	82.6	76.4
		2000	85.8	78.5
		2300	89.2	81.3
	Rural Dirt Road	1500	83.8	76.8
		2000	86.7	80.8
		2300	89.1	83.3
	Grassland	1500	81.7	75.3
		2000	85.5	78.6
		2300	88.7	80.9

The noise level at operator's ear level was overall 7 db(A) more than that of bystander's position at all surface types. The noise level at Grassland was overall 2.5 db(A) lower than that of Rural Dirt road and 2 db(A) lower than that of Asphalt. This is due to the damping effect of grass cover surface which is distinguished from the reflecting surface of Asphalt and Rural Dirt road. The maximum noise level was found at Rural Dirt road, this due to the uneven traveling surface and sudden changes in gear positions and engine speed.

It was observed that as the gear position changed from first high to fourth high, the noise level was reduced by 3 to 4 db(A) for both operator's ear level and bystander's position at all surface type. As the engine speed changed from 1500 rpm to 2300 rpm, the noise level was increased by 7 to 8 db(A) for both operator's ear level and bystander's position at all surface type.

The maximum overall noise produced by tractor at operator's ear level at different gear ratios and engine speed at Asphalt, Rural Dirt road and Grassland was reached up to 92 db(A), which is higher than the allowable noise exposure prescribed by NOISH. Thus it can be said that a conservation and management programs is needed to be applied to the tractor operators.

SUMMARY AND CONCLUSION

The results show that the maximum noise produced by test tractor was at rural dirt road and minimum at grassland. The maximum overall noise measured at operator's ear level at different gear positions for asphalt, dirt road and grassland was about 92 db(A) at 2300 rpm, which is higher than the allowable noise exposure prescribed by National Institute of Occupational Safety and Health (NOISH).

SUGGESTIONS FOR FUTURE WORK

-:- An elaborate survey should be conducted for different models of the tractor with respect to vibration level, noise level and their effect on the performance and safety of the operator.

-:- Improved design of engine component should be incorporated to reduced vibration and noise level.

-:- An economically efficient muffler should be design for tractor to overpower this means.

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WATER QUALITY ASSESSMENT OF RIVER GANGES AT SANGAM, ALLAHABAD

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ABSTRACT

Study of the water quality of the Ganga river has been carried out at two different sampling stations around Sangam in Allahabad during (March 2004 to May 2004). The variation of six water quality parameters, namely temperature, total solids, pH, DO, BOD and sulphate were monitored. During the months of March and April the river was slightly basic (pH 8.55-9.05). Total solids were well within the permissible limit. The river water holds enough dissolved oxygen for biochemical activities in the river. The water quality indicates higher level of BOD5. The influx of organic pollution have been attributed to inputs from flood, dumping of unguided municipal waste waters of the city discharges from the cities located in upstream of Allahabad.

Key words : Monitoring, Variation, Water quality, Ganga river, Sangam.

INTRODUCTION

An accurate and rational assessment for river water quality is required for determining the extent of usefulness of water bodies for various uses. Due to rapid population growth, agricultural and industrial developments, the quality of water in rivers is being degraded continuously making it unsuitable for various uses. In India, all the major river basins are facing the threat of pollution from the disposal of unguided and untreated municipal and industrial waste waters.

Allahabad is one of the important city in India and is a center of cultural, religious and educational activities and is located at a longitude of 81° 56'E and latitude of 25° 26' N. All its settlements are concentrated along two perennial rivers the Ganga and the Yamuna. The river Ganga originates at Gangotri and traverses a course of 2525 km up to the Bay of Bengal, where it finally merges. The river Yamuna originates at Yamunotri and covers a distance of about 1000 km up to Allahabad where it merges into the river Ganga.

In this study, we monitor the fortnightly six water quality parameters at selected sampling stations around Sangam. The analysis was performed using standard methods for the analysis of water (APHA, 1995). The aim of this study is to quantitatively describe the trend and variability of the selected water quality parameters of the river.

MATERIALS AND METHODS

The present study was confined to the surrounding area of Sangam at Allahabad where a huge masses of devotees offer holy dip especially during Magh mela and a sizable numbers of tourists and locals do perform bathing through out the year.

Two important sampling locations were selected for the study: stations 1 and 2 at Sangam (Sangam 1/3rd and Sangam mid). The sampling locations are shown in Figure 1.

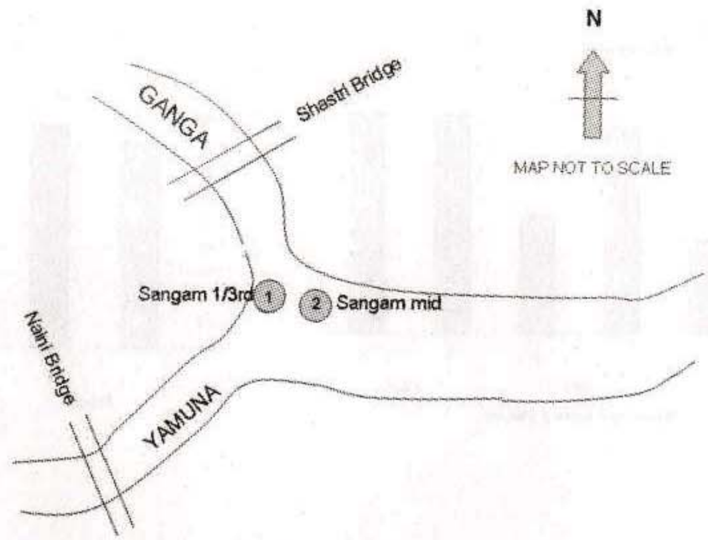

Figure 1. Location of Sampling Stations

DATA ANALYSIS

The mean values of the measured water quality parameters along with standard deviations for all the three months at two sampling stations are presented in table 1. To observe the pattern and monthly variations of all the monitored water quality parameters at all three sampling locations, the mean monthly profiles are presented in Figure 2.

RESULTS AND DISCUSSION

Preliminary results show that the Ganga river is colorless in appearance and odorless during the period of monitoring. From Table 1 and figure 2, it is gleaned that the water temperature varies between 23.10C in March to a maximum of 26.50C in May indicating a gradual rising trend.

Table 1. Average value of water quality parameters with standard deviations during Mar'04 to May 04 at different sampling stations.

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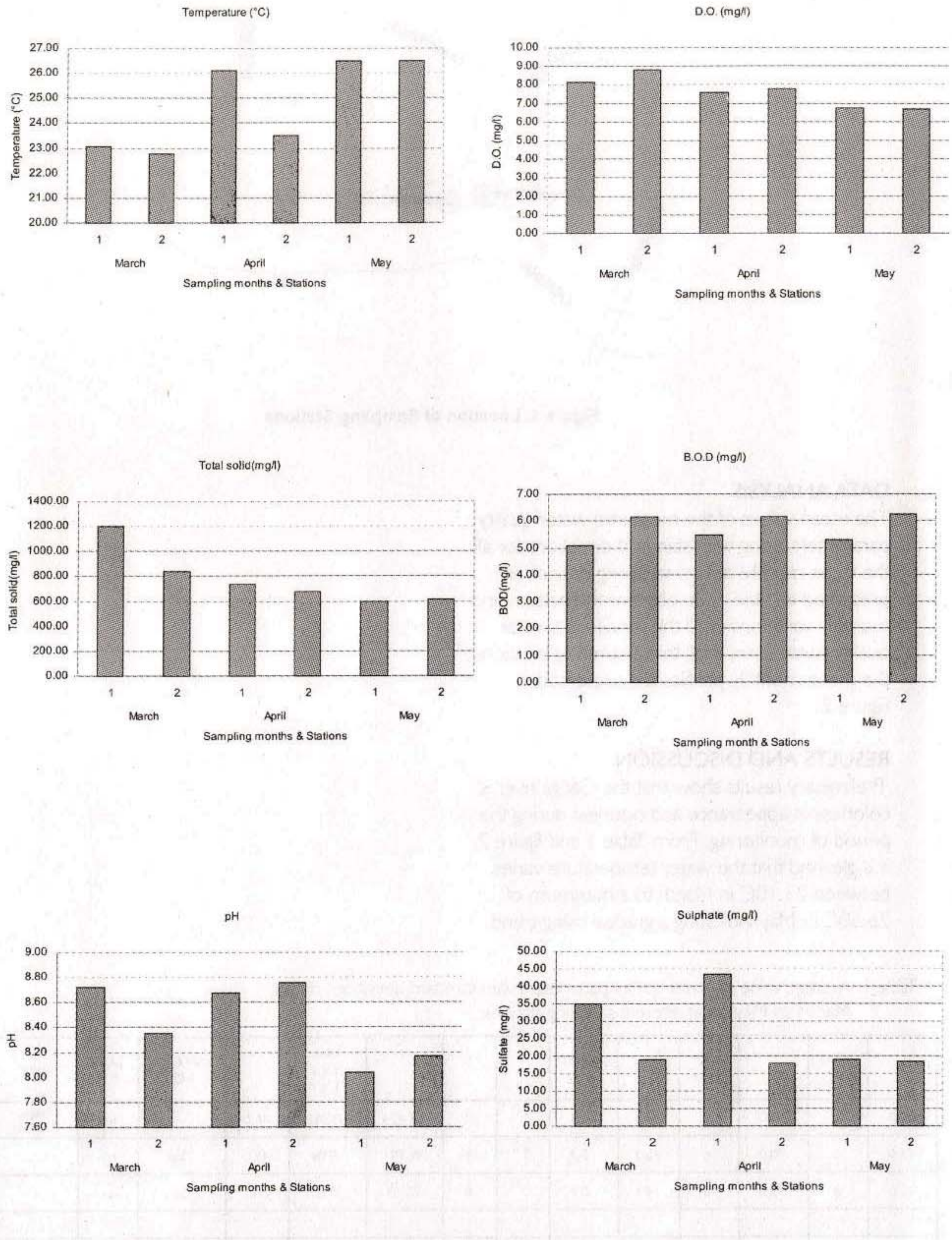

Figure 2. Plots of mean variation of water quality parameters during March' 04 to April 2004 at four sampling stations

range of 6.5 to 9.

Results (Figure 2) show that DO in river decreases from values as high as 8.8 mg/l O2 in March to value 6.7 mg/l O2 between the months of April and May. Such levels of DO in river Ganges have been reported elsewhere (Shukla et. al, 1989). This decrease in DO level has been attributed to bacterial utilization of some fractions of the DO in organic biodegradation as well as to the decreased solubility of O2 in summer months.

The results from BOD determination indicate that the river can be described as slightly polluted at Sangam region (BOD greater than 3 mg/l) BOD values greater than 6.3 mg/l were also recorded due to organic waste discharges from domestic and industrial activities. This is also an indication of the biochemical activities along the course of the river because of a relatively high level of organic feed.

The sulfate concentration varies between 17 to 43.5 mg/l and also has irregular variations without any definite trend. But, the sulfate concentration is well below the set standards (200 mg/l) by Ministry of Urban Development, New Delhi (1991).

CONCLUSIONS

The investigation in this communication has shown that the river water is above saturated with DO and has more solid. Slightly higher BOD concentration in river water indicates organic pollutions from municipal and industrial discharges. Based on the higher levels of BOD in river water, the water is unfit for drinking as well as bathing purposes. Therefore, urgent and immediate attention need to be paid towards prevention of any kind of influx of organic contaminants into the river to safeguard the precious human and other lives.

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INDUSTRIAL NOISE POLLUTION AND ITS EFFECT ON NEARBY ENVIRONMENT

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ABSTRACT

For a long time noise was considered as a part of the environment. However, over the years the general incidences of noise have been increasing. The development of various engines, technological machinery in industries and others all contributed to an increasing noisy environment. Now it contributes to the deterioration of the environment. The term noise is applied to the sounds that cause irritation on hearing of healthy human being. Industrial noise pollution has been recognized as a major pollutant especially in context to nearby environment and causing various types of ill effects to human being. Government has the Noise Pollution (Regulation and Control) Rules 2000 under the provision in Environment Protection Act 1986. These measures need strict enforcement along with environmental awareness.

INTRODUCTION

Industrial noise pollution is the most common occupational health hazard in to the cities and big industry. It includes the noise from big machines working at a very high speed and high noise intensity. Noise pollution has been recognized as a major pollutant affecting health and well being of our urban as well as in rural localities.

Industries of various sizes are the major source of noise pollution harmful especially for their immediate environment. The poor people are most affected due to lack of serious attention paid to them. A survey in Delhi, Bombay and Calcutta conducted by various researchers in 1988 showed day time noise levels is ranging between 60dB to 90dB in residential localities and many times during the day this level exceeded 100dB. Near aerodromes, railway tracks, busy highways and industrial establishments a noise ranging between 95 to 105 dB has been recorded during most of the day time (cited in Santra 2001).

The loudness values for different types of sound from various studies showed that the threshold of damage to hearing under prolonged exposure to noise is between 80-85dB, and the loudness of heavy city traffic goes between 85-95dB, Jetliners 150metres overhead 100-115dB, running motorcycle 115-120dB, the threshold of pain to human ears ranges from 120-150dB. Jet planes taking off 140-150dB, and launching of space rocket gives loudness of 160-180dB. The threshold limit for hearing in human beings is 0 dBA, a level at which the ambient sound intensity is equal to the reference intensity of noise. Noise can range from 0 to more than 120dBA, at which physical discomfort begins.

NOISE LEVEL OF SOME COMMON SOUNDS

Noise level of various types of sound generated through various means including factories/industries was found in affecting to their nearby environment (Fig. 1). Some examples of noise pollution of decibel scale is given in Table 1. Industrial Noise is complex and varies with the design, direction of movement of working parts and the method of mounting of. The noise is often is produced in three stages i.e. there is an initial disturbance at the point of the sound followed by amplification often caused by the resonance of the machine parts, the work piece or the floor and finally radiation of the sound to the surrounding environment.

Thus the industrial noise can be classified into three types (Santra 2001):

I. Impact and percussive noise is produced by presses, punch and stamp machines pneumatic, milling machines, cutters and routers.

II. The impact noise is caused when two surfaces meet each other, sometimes at high speed and

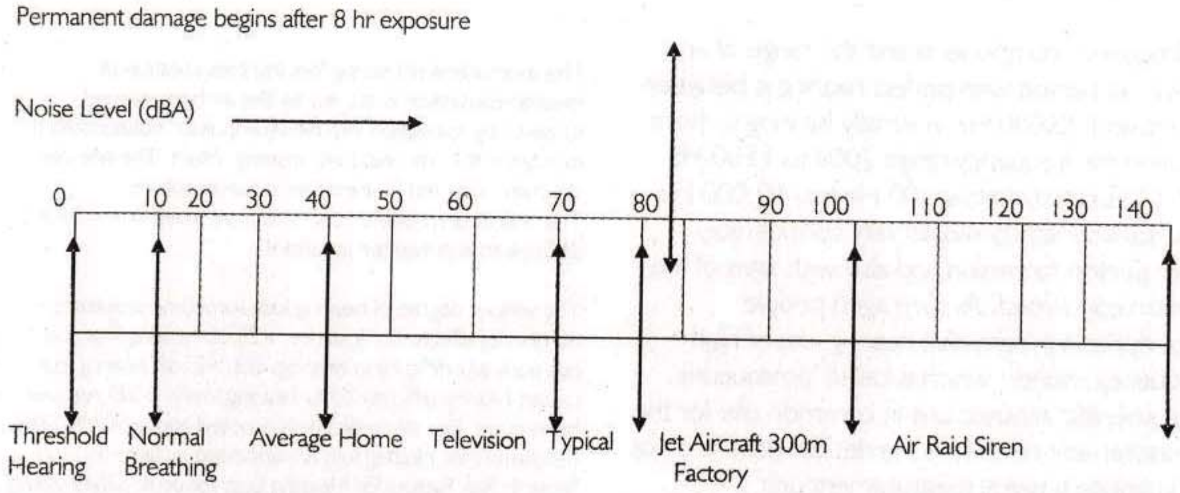


Fig. 1: Noise level of some common sounds (based on Miller jr. 1988)

Table-1 : Some Examples of Noise Pollution of Decibel Scale

Example	dB A	General effects/perception
Hearing threshold	0	
Normal Breathing	10	Very quiet
Average home	40	Quiet
Television/vacuum cleaner	70	Moderately loud
Washing machine/typical factory	80	Very loud
Jet aircraft at 300 m	100	Very loud-uncomfortably loud
Jet aircraft at take off	150	Painfully loud

Table-2 Hearing Loss by Workers

Occupation	Workers Age (years)	Length of occupational Service (years)	Hearing loss (dB)
Gravure Printers	55.3	21.8	35
Iron moulders	54.8	36.4	43
Bus drivers	53.7	21.2	44
Boiler, makers	59.8	30.5	52
Weavers	55.0	31.5	55
Fettlers (carting metal chipping)	53.5	21.3	65
* Average hearing loss 30 dB			
Source: Santra (2001)			

vibration occurs at the point of contact followed by amplification and resonance

III. The third type of industrial noise is aerodynamic noise. Aerodynamic noise is produced by a blowlamp or torch, fans and dust extractors.

Noisy industrial process and conditions produce hearing loss to the workers involved. A result of a study from Manchester University in 1971 is shown is Table-3.

MECHANISMS OF HEARING LOSS BY NOISE

The human ear receives sound waves and these set up oscillations in the tympanic membrane or eardrum. Their oscillations cause sympathetic movements of their ossicles or small bones in the middle ear behind the ear drum. The oscillations then pass through fluid in the inner ear to the auditory nerve and on to the brain. In the brain the oscillations or sound are identified and interpreted. The ear is able to analyse sounds in to frequency components and the range of an 18-yr old person with perfect hearing is between 20 Hz and 20,000 Hz. normally hearing is more acute in the frequency range 2000 to 5500 Hz but it falls rapidly below 200 Hz and 10,000 Hz. The ear's sensitivity ranges vary considerably from person to person and also with ages of the person concerned. As such aged people experience a progressive hearing loss of high frequency sounds, which is called 'presbucusis'. The scientific acoustic unit in common use for the measurement of noise is the decibel (dB). It is not an absolute physical measurement unit comparable to the gram, volt or meter but it is a ratio expresses as a logarithmic scale relative to a reference sound pressure level and is defined as :

The mechanism of hearing loss involves creation of mechanical motion in the ear by the air borne sound followed by translation into nerve impulses ,noise induced damage in this path will lead hearing. effect .The hair-cell structure is injured by excessive noise exposure.
The overall permissible noise exposure leve(cited in Santra 2001) is thus presented in table 4

The various degree of hearing loss sometime possesses a number of effects. For instance >25 db hearing loss does not pose any difficulty in hearing, but >25dB hearing loss causes hearing difficulty. Only hearing loss> 50dB requires hearing aid. Complete deafness is noted above 90 dB. The Risk factors for hearing loss is elaborated in Table 4.
Table 4: Risk Factors for Hearing Loss (Source: Santra 2001)
The sound level also causes damages to various body functions as revealed through various studies(table 5) showed that the noise level of > 100 dBA is the cause of various types of damages.

$$\text{Sound intensity level} = 10\log 10 \frac{\text{intensity measured}}{\text{reference intensity}}$$

Table-3: Permissible Noise Exposure

Duration per day (hrs)	Sound dB (A) slow response
8	90
6	95
4	95
3	97
2	100
1	102
½	110
¼ or less	115

Table 4: Risk Factors for Hearing Loss (Source: Santra 2001)
A-Primary factors:

- Occupational noise exposure (85 dBA)
- Military history
- Noisy hobbies
  - Musical instruments
  - Shooting /hunting
  - Gardening with gas mower etc.
  - Work with cars/engines;
  - Wood working/power tools

Medication usage (may initiate as well as potentiate hearing loss:
  - Kanamycin, cisplatin,
  - Aspirin
  - Diuretics

- Age (may initiate potential hearing loss)
- Residential factors (highly urban environmental, outdoor activities)

B-Secondary activities:

- Anatomic and genetic factors (history of hearing loss in families)
- Diabetes
- Elevated cholesterol
- Cigarette smoking
- Elevated blood pressure

CONTROL OF NOISE POLLUTION PERMISSIBLE LIMITS/ STANDARDS

General Standards as prescribed by Environmental Protection Agency (USEPA), Department. of Environment, UK (DOE-UK) and Central Pollution Control Board, India are given in Tables. 6 & 7.

1.In India the Central Pollution Control Board has recommended the zone-wise Ambient Noise levels under The Noise-Pollution (Regulation & Control) Rules 2000 formulated as per important directives of the Honorable Supreme Court under Environment Protection Act (1986). The details of permissible level are set in Table 6 & 7.

Some other details as per the Act are as below:

1. Silent zone is an area and less than 100 meters around schools, hospitals and is considered comfortable for patients and school children.

2. 'Silent zone' around 100 meters of schools, hospitals, is considered comfortable for patients and school children.

3. Putting up some kind of shield between noise producer and the hearer was found useful. Putting up ear-plug in factories is useful and is being used also.

4. Forests and dense growth of bushes around factories can reduce the negative effect of noise pollution.

5. Noise impact assessment studies should be conducted to assess the impact of noise pollution and accordingly the remedial mitigatory measures need to be worked out. The impact assessment study includes monitoring the present status of noise levels within the impact zone and prediction of future noise levels resulting from the proposed project and related activities including increase in vehicular movement.

6.In heavy industries sound proof insulated jackets or filters are used by workers to reduce noise from machines. Details on industrial noise

Table-6: General Standard of Noise (dB): Indoor environment: (USEPA and DOE UK)

Places /Location	Noise level dB(A)
Bedrooms	15
Libraries	30
Living room	40
Classroom	55
Business offices	60
Street traffic	80
School	35
Residential area at night	35
Restaurants	45
Shop	55
Workshops	70-75
Theaters	30

Table-7: Zone-wise Ambient Noise levels according to Central Pollution Control Board of India.

Area Code	Zone Time	Noise level dB(A) Time	
		Day (6 to21 hr)	Night (21 to 6 hr)
(A)	Industrial area	75	70
(B)	Commercial area	65	55
(C)	Residential area	55	45
(D)	Silence Zone *	50	40

Table 5 Sound level that causes damage to body function

Noise level (dBA)	Damages
100	Prolonged exposure causing permanent damage of hearing.
180	Ear drum rupture
194	Lung damage

NOISE MAPPING

In order to assess the impact of noise on human health and to understand noise levels in different parts of city topographs of residential area has been prepared. In India such kinds of noise mapping has been done in various townships (Fig 2:Santra,2001) and studies revealed that in most of the Indian cities the noise level already crossed the limit (75 dBA at day and >60 dBA at night). Cited in Santra (2001)

Fig. 2: Ambient Noise Levels in Residential Areas of Metropolitan Cities

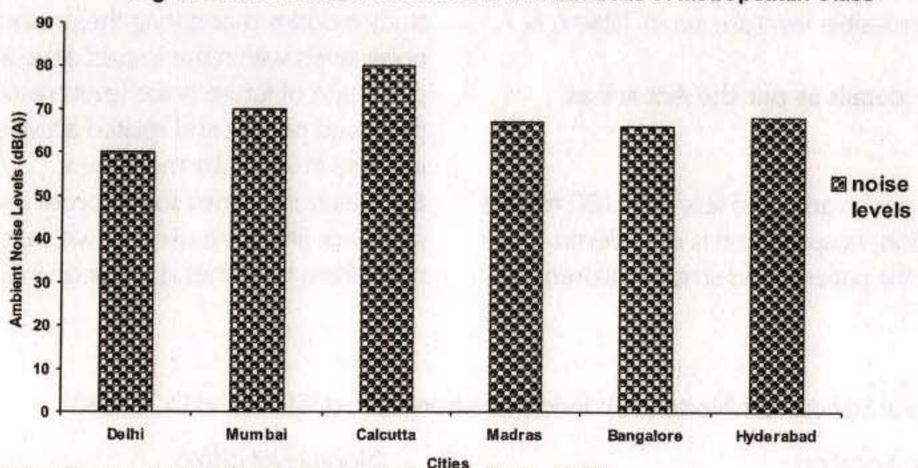
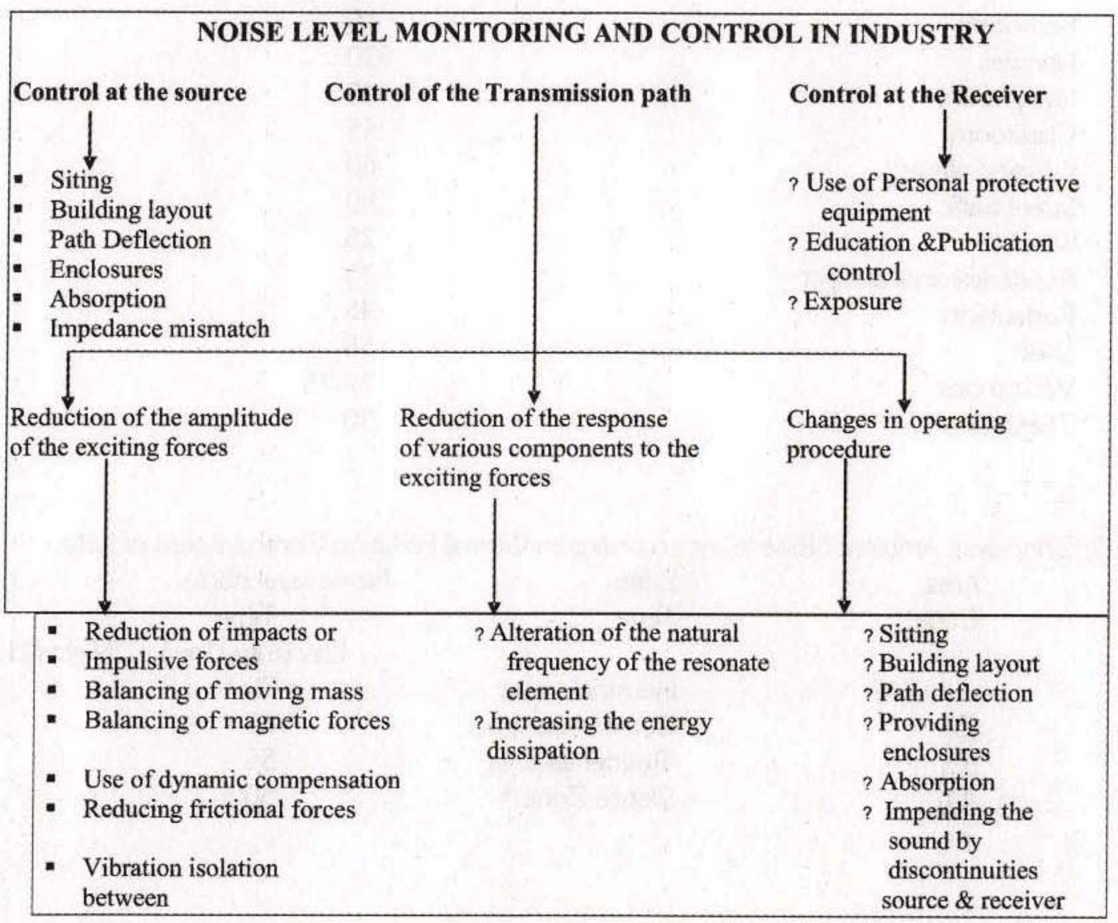


Fig. 3. Detailed Chart on Industrial Noise Control Techniques (Santra 2001)



control techniques are suggested herewith Fig.2.
7. Efforts are required to create awareness among the general public about harmful effect of noise pollution.

Reduction of noise at the source of its origin, by replacement of noisy machines with quieter ones, providing better greases to parts, application of sound proofing techniques, keeping residential localities free of noise of noisy industries, and enactment of strict legislation and its effective compliance may be the remedy for control of noise pollution. As per policy statement on Policy Statement Abatement of Pollution the Government seeks to ensure that the policies in every sector are based on a set of principles that harmonies economic development and environmental imperatives as per Policy Statement (1992). The objective is to integrate environmental considerations into decision making at all levels. To achieve this, the following steps need to be taken:

-:- prevent pollution at source
-:- encourage, develop and apply the best practical technical solutions
-:- ensure that the polluter pays for the pollution and control arrangements
-:- focus protection on heavily polluted areas, and
-:- involve the public in decision making

The policy document in the critically polluted areas states that setting up of industrial estates and clusters of small industrial units in rural areas will include pollution abatement measures as an essential component of infrastructure.

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THE USE OF EMERGING TECHNOLOGIES IN MINIMIZING POLLUTION BY DAIRY EFFLUENT

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ABSTRACT

The primary means of reducing BOD in food processing wastewaters is through biological treatment. Anaerobic treatment of wastewater has emerged as an economical and viable alternative for conventional aerobic treatment particularly for high BOD wastewaters. In anaerobic process, digestion of effluents having less than 3000mg/l, would requires long detention time, which requires large containers and capital cost soars exorbitantly. Membrane process can be intelligently employed provided the flow are smaller and concentration high. During this period, there have been improvements in membrane performance and reliability, as well as a decrease in the cost of membranes. Membrane Technology (MBR) is designed to simplify wastewater treatment

Introduction

Milk processing consumes large amount of water and generates 610 liters of effluent/l of milk processed (Tiwana 1985). Effluent volume is approximately four times the volume of milk processed (Subrahmanyam and Mohan Rao 1972). The effluent is organic, slightly alkaline, but becomes acidic due to decomposition of lactose into lactic acid followed by precipitation of casein into a highly odoriferous black sludge (Pandit et.al. 1996), (Datar and Kale 1997). When discharged into water body, especially a stagnant one, the effluent brings about rapid depletion of the dissolved oxygen, adversely affecting its ecosystem (Sharma et.al. 2000), Chockalingam and Balaji (1991) (Amudha et.al. 1997), (Rai et.al. 1999).

Regional pollution control authorities are applying more pressure on industries to reduce their organic biological oxygen demand (BOD) and chemical oxygen demand (COD) and solids loading to the sewers. Enforcement of wastewater discharge regulations and escalating sewage surcharges have forced the food processing industry to look for cost-effective technologies to provide pretreatment or complete treatment of their wastewater. Dairy and Food processing wastewaters are particularly targeted because of the high BOD concentrations (Table-1) typically contained, especially high-strength wastewaters with high levels of suspended solids, ammonia and protein compounds (Table-2) (Jones 1974). Pollution load can be estimated as the product of weight of waste and BOD in mg/lit and divided by 106 (Royal 1978).

Tolerance limits for industrial effluent discharge - as per ISI Standards for effluent discharge there are three media for disposal of treated effluent viz.,

(a) Inland surface water IS: 2490-1974
(b) Public sewers IS: 3306-1974
(c) Land for irrigation IS: 3307-1965

Out of these three media the treatment requirement would be maximum for discharge into inland surface water and minimum for discharge into irrigation land or into sewers. (Table-3) One has to choose the most cost effective technology for waste treatment.

Current Technologies:
The primary means of reducing BOD in food

Table 1: **Kg BOD Arising from per lit of Milk Processed from Various Dairying Operations.**

Operation	Kg BOD/Lit of Milk Processed	
	Average	Range
Milk reception	0.26	0.11-0.66
RM cooling	0.19	0.07-0.31
Skimming	0.14	0.09-0.24
Cream Pasteurization	0.66	0.46-0.12
Butter churning	0.46	0.25-0.80
S M Evaporation	0.23	0.16-0.30
Roller Drying	0.53	0.25-1.30
P M Storage	0.29	0.10-0.54
Bottle washing	0.23	0.05-0.37
Cheese making	0.89	0.23-2.0
SCSM	1.4	1.2-1.70

(Source Royal, 1978)

RM=Raw Milk, PM=pasteurized milk, SCSM=Sweetened condensed milk, SM=skim milk

processing wastewaters is through biological treatment. Land applications including aerobic treatment such as ponds and lagoons are also used. Both aerobic and anaerobic technologies have been used, while anaerobic treatment of wastewater has emerged as an economical and viable alternative for conventional aerobic treatment particularly for high BOD wastewaters (Green and Kramer 1979).

Aerobic technologies include

- -:- Trickling filter
- -:- Activated sludge
- -:- Rotating biological contactors
- -:- Oxidation ditch
- -:- Sequencing batch reactor
- -:- Controlled wetlands.

Anaerobic technologies currently available

- -:- Contact reactor
- -:- Up flow sludge blanket
- -:- Anaerobic filter (up flow and down flow)
- -:- Expanded or fluidized bed and two-stage systems that separate the acid-forming and the methane-forming phases of the anaerobic process.

In many cases, aerobic and anaerobic processes are combined in one treatment system. Anaerobic treatment is used for removing organic matter in higher concentration streams, and aerobic treatment is used on lower concentration streams or as a polishing step to further remove residual organic matter and nutrients from the wastewater. The Activated Sludge Treatment System is known for high performance rates, Except that it has high running cost. The Plastic Media Biotowers is an advanced form of stone trickling filters; the major advantage of this system is low power consumption than Activated sludge process. The advanced technologies of anaerobic treatment system like Up flow Anaerobic Sludge blanket (UASB) can handle dairy effluent far more economically than one operating with The Activated Sludge Treatment. As energy is becoming costlier, the aerobic processes are becoming very costlier to operate. The first immediate alternative is to go for anaerobic treatment.

For example, it has been shown that liquid waste with BOD around 850 mg/l and 500 cubic meters of/day of flow would be treated anaerobically to generate around 250 cubic meters of bio gas which would be equivalent to about 160 kg of LPG per day and can earn revenue of about Rs.1500/-per day as compared to aerobic process which would require Rs. 1500/-per day as operating cost for treating the same.

In anaerobic process, digestion of effluents having less than 3000mg/l, would requires long detention time, which requires large containers and capital cost soars exorbitantly.

Emerging Technologies:

Effective handling of high levels of suspended solids (>2%) in the wastewater is still a challenge

Table 2: Pollution Characteristics of Various Dairy Products

Product	TS(g/lit)	Nitrogen(g/lit)	Phosphorous(mg/lit)	BOD(g/lit)	COD(g/lit)
Whole milk	125	6	950	114	183
SM	92	6	980	90	147
BM	87	6	90	61	143
Cream 30%	379	4	672	400	750
CM	260	11	2050	271	378
Whey(R)	62	1.2	490	42	65
Whey(A)	56	1.2	160	35	600
WP/kg	950	20	6950	60	929
SMP/kg	957	60	9950	70	950

(Source: Hale et al, 2003)
SM=skim milk, CM=Condensed milk, R=Rennet, A=Acid, SMP= Skim milk powder, WP=Whey

for most of these current technologies.

- -:- Thermophilic Processing
- -:- Bioadditives
- -:- Biodenitrification
- -:- Hydrothermal Processing
- -:- Solvent Extraction
- -:- Membrane technology

The membrane technology can be used to separate the Bio-degraded waste from the water with low BOD as permeate which may be taken for aerobic treatment, while the used concentrate can be taken for anaerobic treatment, while the concentrate (retaintate) can be treated anaerobically. Thus reducing the capital cost of the anaerobic containers as the volume of liquid waste is drastically reduced. Membrane Technology (MBR) is designed to simplify wastewater treatment, the MBR process replaces secondary clarifiers with membranes.

Table 3: ISI Standards for Disposal of Industrial Effluent

Characteristics	Tolerance Limits for Industrial Effluent Discharge		
	Inland Surface Water(IS 2490-1974)	Public Sewers (IS 3306-1974)	Irrigation Land (IS 3307-1965)
BOD5 at 20°,mg/lit	30	500	500
COD mg/lit	250		
Ph	5.5-9.0	5.5-9.0	5.5-9.0
Suspended solids,mg/lit	100	600	_
Total dissolved solids (inorganic),mg/lit	_	2100	2100
Temperature°C	40	45	-
Oil and grease,mg/lit	10	100	30
Chlorides,mg/lit	_	600	600
Boron,mg/lit	_	2	2
Sulphates,mg/lit	_	1000	1000
Sodium,mg%	_	60	60
Ammoniacal Nitrogen,mg/lit	50	50	_

Source : Saxena and Subramanyan (1978)

The result is reduced capital and operating costs, increased reliability and high quality effluent at all times (Khojare et.al. 2003). MBR are alternatives to biotreatment being used for BOD reduction in dairy wastewaters. Reverse osmosis has been installed at a dairy cheese plant to reduce BOD in the wastewater and allow direct discharge of the filtered water into a nearby creek. In this case the reduction of BOD is from 35-40 mg/ liter down to 8-9 mg/liter. The feed is evaporator condensate from a cheese-whey concentrator and is essentially 50% of the plant's discharge water.. Membranes are immersed directly in the bioreactor resulting in plant footprints up to four times smaller than conventional systems. Membranes can extend the life of current plant infrastructure, greatly reducing capital expenditures and enhancing productivity (Khojare et.al. 2005).

In the dairy industry, greater use of membrane processes, as an alternative to conventional process will require:

-:- Development of cheaper and more efficient membranes with a longer life than the current average of seven years.

-:- Continued laboratory trials with ceramic layers and the development of novel ceramic supported polymer membranes.

-:- Development of high throughput 'zeolite' membranes and membranes for gas separation.

-:- Optimization of membrane supports and equipment in industrial trials.

-:- Development of new applications (mainly in waste treatment and food processing).

-:- Research into hybrid systems, eg a combination of solar evaporation and reverse osmosis.

Conclusion

The liquid waste should be reduced as far as possible through economic alternatives, anaerobic treatment may be economical however it needs to be followed by aerobic treatment before the final disposal. Membrane process can be intelligently employed provided the flow are smaller and concentration high. The use of membranes for treatment of water and wastewater has increased in the last several years. This increase is because the membranes produce a higher quality effluent than achieved using sand filtration as a final polishing step. During this period, there have been improvements in membrane performance and reliability, as well as a decrease in the cost of membranes, which corresponds to an increase in the number of manufacturers. As fresh water becomes increasingly scarce, membranes will play a more important role in the production of water for subsequent use (i.e., treatment of wastewater for reuse). This will help utilities continue to provide safe, clean, and affordable water for dairy and food Industry.

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